Switching, General Purpose, and RF Transistors Metal Can

High Speed Switches
General Purpose Amplifiers
RF-IF Amplifiers and Oscillators

SWITCHING, GENERAL PURPOSE, AND RF TRANSISTORS (METAL CAN) NUMERICAL INDEX

SWITCHING, GENERAL PURPOSE, AND RF TRANSISTORS (METAL CAN) NUMERICAL INDEX

Additional General Purpose Amplifiers and Switches

MILITARY APPROVED TRANSISTORS

JAN2N656/JAN2N657	**MIL-S-19500/74D**	**JAN2N1893**	**MIL-S-19500/182A**
JAN2N696/JAN2N697	**MIL-S-19500/99D**	**JAN-TX-2N1893**	**MIL-S-19500/182B**
JAN2N706	**MIL-S-19500/120B**	**JAN2N2218/JAN2N2218A/JAN2N2219/JAN2N2219A**	**MIL-S-19500/251D**
JAN-TX-2N708/JAN-TX-2N914	**MIL-S-19500/312A**	**JAN-TX-2N2219**	**MIL-S-19500/324**
JAN2N718A/JAN2N1613	**MIL-S-19500/181B**	**JAN2N2221/JAN2N2221A/JAN2N2222/JAN2N2222A**	**MIL-S-19500/255D**
JAN-TX-2N720A	**MIL-S-19500/311**	**JAN-TX-2N2222**	**MIL-S-19500/325**
JAN2N744	**MIL-S-19500/273**	**JAN2N2369A**	**MIL-S-19500/317A**
JAN2N869A	**MIL-S-19500/283A**	**JAN-TX-2N2369A**	**MIL-S-19500/317A**
JAN2N910/JAN2N911/JAN2N912	**MIL-S-19500/274**	**JAN2N2481**	**MIL-S-19500/268A**
JAN2N916	**MIL-S-19500/271A**	**JAN-TX-2N2481**	**MIL-S-19500/268B**
JAN2N918	**MIL-S-19500/301**	**JAN2N2484**	**MIL-S-19500/376**
JAN-TX-2N918	**MIL-S-19500/326**	**JAN2N2904/JAN2N2904A/JAN2N2905/JAN2N2905A**	**MIL-S-19500/290A**
JAN2N929/JAN2N930	**MIL-S-19500/253A**	**JAN-TX-2N2905A/JAN-TX-2N2907A**	**MIL-S-19500/314A**
JAN2N1131/JAN2N1132	**MIL-S-19500/177B**	**JAN2N2906/JAN2N2906A/JAN2N2907/JAN2N2907A**	**MIL-S-19500/291A**
JAN2N1711/JAN2N1890	**MIL-S-19500/225C**	**JAN2N3013**	**MIL-S-19500/287**
JAN-TX-2N1711/JAN-TX-2N1890	**MIL-S-19500/342**		

HIGH SPEED SWITCH SELECTION GUIDE

Rated V_{CEO} Volts	Optimum Collector Current mA 0.1 — 50 NPN	PNP	10 — 100 NPN	PNP	100 — 300 NPN	PNP	300 — 500 NPN	PNP	500 — 1000 NPN	PNP
6	FT709	2N4207	FT709	2N4207						
	2N4251*		2N3010							
12	2N3011	2N4208	2N3011	2N4208	2N3426	2N3012	2N3426		2N3426	
		2N3012		2N3012	2N3303	2N2894A	2N3303		2N3303	
		2N4872*		2N2894A	2N5065*		2N5065*		2N5065*	
		2N5292*		2N4872*						
		2N2894A		2N5292*						
15	2N2369A	2N4209	2N2369A	2N4209	2N3009	2N5056	2N3013			
	2N4873*	2N5056	2N3009	2N5056	2N3013	2N5057	2N914			
		2N5057	2N3013	2N5057	2N3646					
			2N914		2N914					
			2N4873*							
20-25	2N4137	2N3209	2N4137	2N3209	2N3014	2N3209	2N3014			
		2N2927	2N3014	2N2927	2N2847	2N2927	2N2847			
		2N2695, 6	2N2847	2N2695, 6	2N2848	2N2695, 6	2N2848			
			2N2848							
30-45	2N3299	2N4034	2N3299	2N5023	2N3299	2N5023	2N3299	2N5023	2N4013	2N5023
	2N3300	2N2904-7	2N3300	2N4034	2N3300	2N2904-7	2N3300	2N3467	2N3724	2N3467
	2N3301	2N3120, 1	2N3301	2N2904-7	2N3301	2N3120, 1	2N3301		2N4046	
	2N3302	2N3502, 4	2N3302	2N3120, 1	2N3302	2N3467	2N3302		2N5144*	
	2N5106*		2N2845	2N3467	2N2845	2N3502, 4	2N2845		2N5145*	
	2N5107*		2N2846	2N3502, 4	2N2846		2N2846			
			2N3015		2N3015		2N3015			
			2N4013		2N4013		2N4013			
			2N3724		2N3724		2N3724			
			2N4046		2N4046		2N4046			
			2N5144*, 5*		2N5106*, 7*		2N5106*, 7*			
			2N5106*, 7*		2N5144*, 5*		2N5144*, 5*			
45-60		2N3072, 3	2N3722	2N5022	2N3722	2N5022	2N3722	2N5022	2N3722	2N5022
		2N3503, 5	2N4014	2N3072, 3	2N4014	2N3072, 3	2N4014		2N4014	
		S18000	2N3725	2N3503, 5	2N3725	2N3503, 5	2N3725		2N3725	
			2N4047	S18000	2N4047	S18000	2N4047		2N4047	
80			2N3723		2N3723		2N3723		2N3723	

*Radiation Resistant devices

HIGH SPEED SWITCHES (METAL CAN) NUMERICAL INDEX

HIGH SPEED SWITCHES (METAL CAN) NUMERICAL INDEX

GENERAL PURPOSE AMPLIFIER AND SWITCH SELECTION GUIDE

Rated	Optimum Collector Current mA									
V_{CEO}	0.10 —	50	— 10	100	100 —	300	300 —	500	500 —	1000
Volts	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP	NPN	PNP
10-20	2N4251* 2N5200* 2N5201*		2N4251*							
25-30	FT107A 2N3299-3302 2N5106*, 07*	2N2695, 96 2N2927	2N3299-3302 2N5106*, 07* SE8041, 42	2N7695, 96 2N2927	2N3299-3302 2N5106*, 07* SE8041, 42	2N2695, 96* 2N2927	2N3299-3302 2N5106*, 07* SE8041, 42		SE8041, 42	
40-45	FT107B 2N3109, 10 2N3642	2N4034, 35 2N3964 2N4359 2N5244*	2N3109, 10	2N3120, 21 2N3504, 02 2N5042 2N2904-07 2N5244*	2N3109, 10	2N3120, 21 2N3504, 02 2N5042 2N2904-07	2N3109, 10	2N3504, 02 2N5042	2N3109, 10	2N5042
60	FT107C 2N2483, 84 2N4960, 62	2N3962 2N3965 2N4359 2N4026, 28 2N4030, 32	2N3107, 08 2N4960, 62	2N3505, 03 2N4026, 28 2N4030, 32 2N3072, 73	2N3107, 08 2N4960, 62	2N3505, 03 2N4026, 28 2N4030, 32 2N3072, 73	2N3107, 08 2N4960, 62	2N3505, 03 2N4026, 28 2N4030, 32	2N3107, 08	2N4026, 28 2N4030, 32
80	2N4961, 63	2N3963 2N4027, 29 2N4031, 33	2N4961, 63	2N4027, 29 2N4031, 33	2N4961, 63	2N4027, 29 2N4031, 33	2N4961, 63	2N4027, 29 2N4031, 33		2N4027, 29 2N4031, 33
120	SE7002		SE7002							
150	2N3114 SE7001 2N3923		2N3114 SE7001							
180		2N3930, 31								
240		2N4357, 58								

*Radiation Resistant devices

GENERAL PURPOSE AMPLIFIERS (METAL CAN) NUMERICAL INDEX

RF/IF AMPLIFIER SELECTION GUIDE

f MHz	Polarity	Device	Power Gain dB (min)	@ f MHz	NF dB (max)	@ f MHz	C_{cb} pF (max)
27	NPN	SE8010	10.8	27			9.0
45	NPN	SE5055	27	45	5.0	45	0.22
60	NPN	2N4134	17	60	2.5	60	0.50
100	PNP	2N4034	25 typ	100	6.0	100	3.5
	PNP	2N5244*	25 typ	100	6.0	100	3.5
	NPN	SE5050	20	100	4.0	100	0.5
200	NPN	2N918	15	200	6.0	60	1.7
	NPN	2N2616	15	200	6.0	60	2.8
	NPN	SE5020	20	200	3.3	200	0.5
250	NPN	2N3137	6	250			3.5
	NPN	2N5236*	6	250			3.5
450	NPN	2N4135	8	450	5.0	450	0.5

RF/IF OSCILLATOR SELECTION GUIDE

f MHz	Polarity	Device	OSC P_O mW (min)	@ I_C mA
100	PNP	2N4034	200 typ	10
	PNP	2N5244*	200 typ	10
500	NPN	2N918	30	8
	NPN	2N2616	30	8
	PNP	2N4208	10 typ	10
	PNP	2N4872*	10 typ	10
1000	NPN	FT17	35	15

*Radiation Resistant devices

RF/IF AMPLIFIERS & OSCILLATORS (METAL CAN) NUMERICAL INDEX

Additional General Purpose Amplifiers and Switches

FT107A • SE4022

NPN LOW LEVEL, LOW NOISE AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **LOW 1/f NOISE . . . . NF = 8.0 dB (MAX) AT 10 Hz, 1.0 kΩ**
- **HIGH GAIN . . . . h_{FE} = 900 (MIN) AT 10 μA**
  h_{FE} = 1200 (MIN) AT 10 mA
- **LOW SATURATION VOLTAGE . . . $V_{CE(sat)}$ = 0.2 V (MAX) AT 10 mA/0.5 mA**
- **LOW LEAKAGE . . . . I_{CBO} = 2.0 nA (MAX) AT V_{CB} = 20 V**
  I_{CBO} = 50 nA (MAX) AT V_{CB} = 20 V, T_A = 65°C (SE4022)
  I_{CBO} = 1.0 μA (MAX) AT V_{CB} = 20 V, T_A = 125°C (FT107A)

ABSOLUTE MAXIMUM RATINGS (Note 1)

		FT107A	SE4022
Maximum Temperatures			
Storage Temperatures		−65°C to +150°C	−65°C to +125°C
Operating Junction Temperatures		+150°C	+125°C
Lead Temperature (Soldering, 10 seconds time limit)		+300°C	+260°C
Maximum Power Dissipation (Notes 2 and 3)			
Total Dissipation at 25°C Case Temperature		0.86 Watt	0.5 Watt
25°C Ambient Temperature		0.26 Watt	0.2 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	30 Volts	30 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	30 Volts	30 Volts
V_{EBO}	Emitter to Base Voltage	8.0 Volts	8.0 Volts
I_C	Continuous Collector Current	50 mA	50 mA

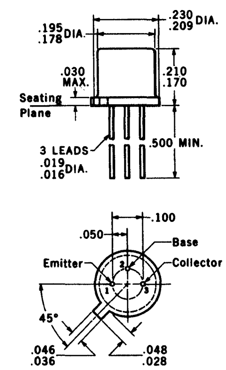
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
NF	Narrow Band Noise Figure (f = 1.0 kHz)		4.0	6.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 1.0 kΩ BW = 400 Hz
NF	Narrow Band Noise Figure (f = 1.0 kHz)		1.0	3.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 10 kΩ BW = 400 Hz
NF	Narrow Band Noise Figure (f = 1.0 kHz)		2.0	6.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 100 kΩ BW = 400 Hz
NF	**Narrow Band Noise Figure (f = 10 Hz)**		**5.0**	**8.0**	**dB**	**I_C = 100 μA V_{CE} = 5.0 V R_S = 1.0 kΩ BW = 10 Hz**
h_{FE}	**DC Current Gain**	**900**	**1100**			**I_C = 10 μA V_{CE} = 5.0 V**
h_{FE}	DC Current Gain	1000	1580			I_C = 100 μA V_{CE} = 5.0 V
h_{FE}	DC Current Gain	1200	1735			I_C = 1.0 mA V_{CE} = 5.0 V
h_{FE}	**DC Pulse Current Gain (Note 5)**	**1200**	**1540**	**2200**		**I_C = 10 mA V_{CE} = 5.0 V**
h_{FE}(−55°C)	DC Current Gain	300				I_C = 10 μA V_{CE} = 5.0 V
h_{FE}(100°C)	DC Pulse Current Gain (Note 5) (FT107A)		2140	3300		I_C = 10 mA V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.0	2.8			I_C = 10 mA V_{CE} = 5.0 V

Additional Electrical Characteristics on Page 2

Notes on Page 4

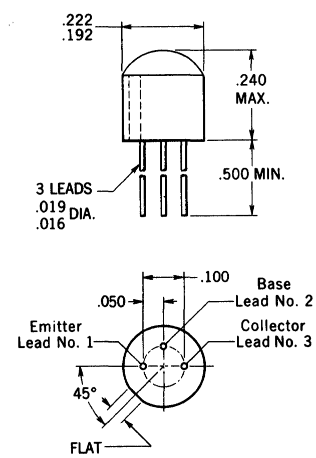
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



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

FT107A

PHYSICAL DIMENSIONS
in accordance with JEDEC (TO-106) outline



NOTES: All dimensions in inches
All leads electrically isolated from case
Package weight is 0.31 gram. Package
is electrically non-conductive material

SE4022

*Planar is a patented Fairchild process.

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

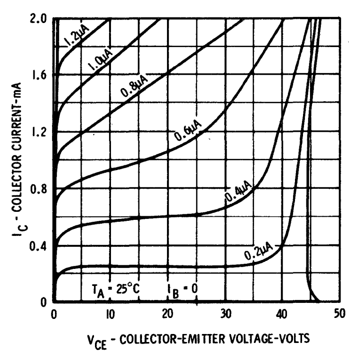
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

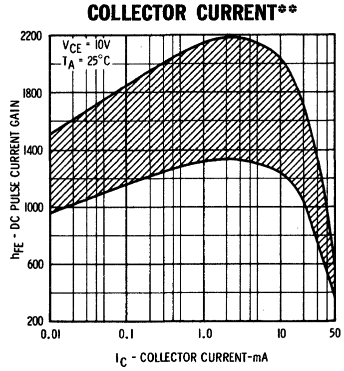
SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{CBO}	**Collector Cutoff Current**		**0.02**	**2.0**	**nA**	**$I_E = 0$**	**$V_{CB} = 20$ V**
I_{CBO}(65°C)	**Collector Cutoff Current (SE4022)**		**0.3**	**50**	**nA**	**$I_E = 0$**	**$V_{CB} = 20$ V**
I_{CBO}(125°C)	**Collector Cutoff Current (FT107A)**		**0.02**	**1.0**	**μA**	**$I_E = 0$**	**$V_{CB} = 20$ V**
I_{EBO}	Emitter Cutoff Current		0.03	1.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{cb}	Collector Base Capacitance		2.5	4.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{eb}	Emitter Base Capacitance		2.9	6.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	30			Volts	$I_C = 5.0$ mA	$I_B = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	30			Volts	$I_C = 10\ \mu$A	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0			Volts	$I_C = 0$	$I_E = 10\ \mu$A
$V_{CE(sat)}$	**Pulsed Collector to Emitter Saturation Voltage** (Note 5)		**0.085**	**0.2**	**Volt**	**$I_C = 10$ mA**	**$I_B = 0.5$ mA**
$V_{CE(sat)}$	Pulsed Collector to Emitter Saturation Voltage (Note 5)		0.14	0.3	Volt	$I_C = 50$ mA	$I_B = 5.0$ mA
$V_{BE(on)}$	Base to Emitter On Voltage		0.6	0.7	Volt	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

TYPICAL ELECTRICAL CHARACTERISTICS

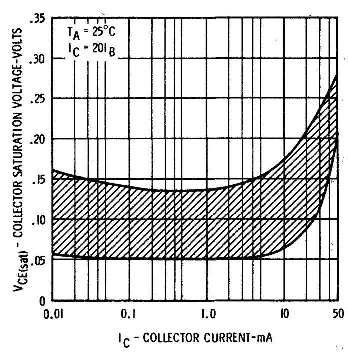
COLLECTOR CHARACTERISTICS* ACTIVE REGION



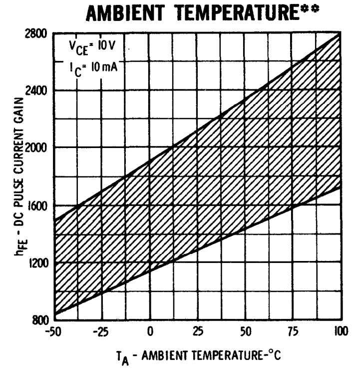
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT**



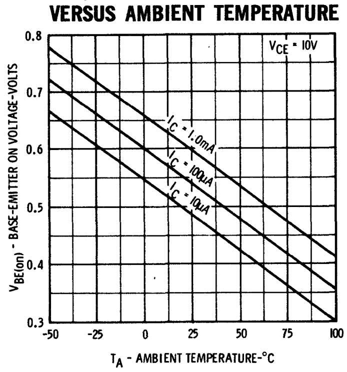
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT**



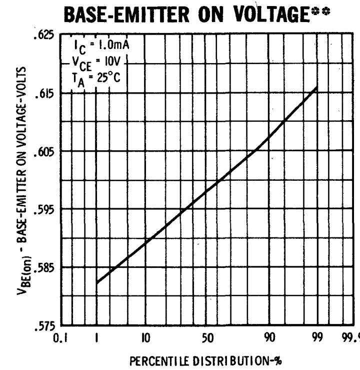
DC PULSE CURRENT GAIN VERSUS AMBIENT TEMPERATURE**



BASE-EMITTER ON VOLTAGE VERSUS AMBIENT TEMPERATURE



DISTRIBUTION OF BASE-EMITTER ON VOLTAGE**

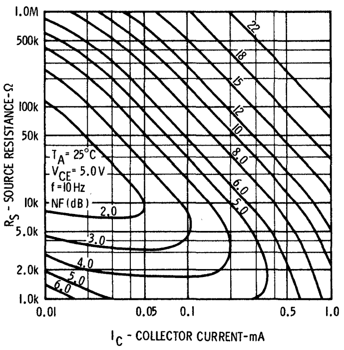


* Single family characteristics on Transistor Curve Tracer.

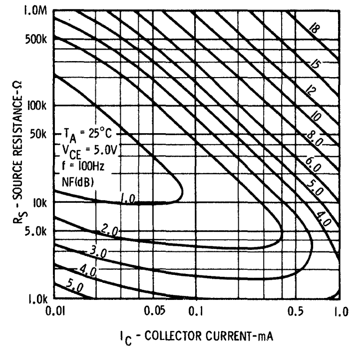
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

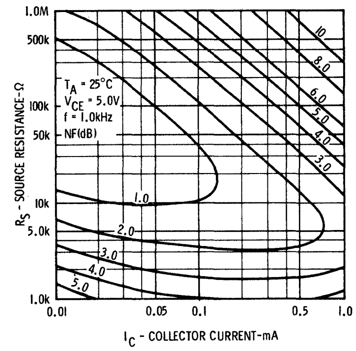
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



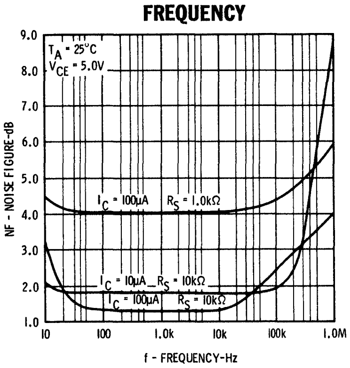
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



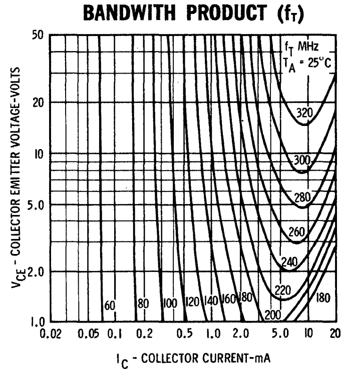
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



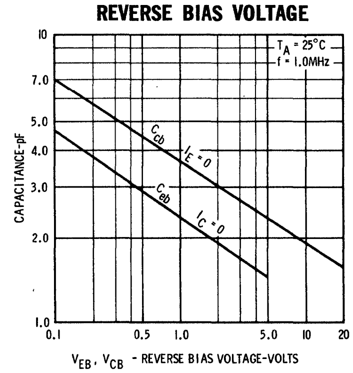
NOISE FIGURE VERSUS FREQUENCY



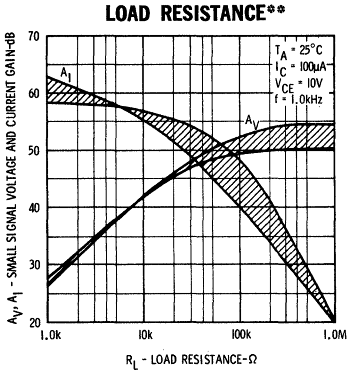
CONTOURS OF CONSTANT GAIN BANDWITH PRODUCT (f_T)



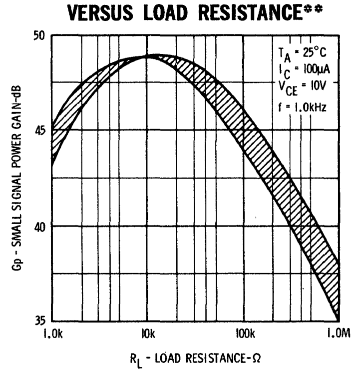
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



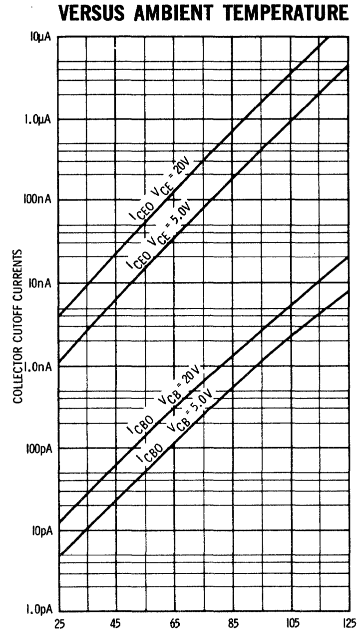
SMALL SIGNAL VOLTAGE AND CURRENT GAIN VERSUS LOAD RESISTANCE**



SMALL SIGNAL POWER GAIN VERSUS LOAD RESISTANCE**



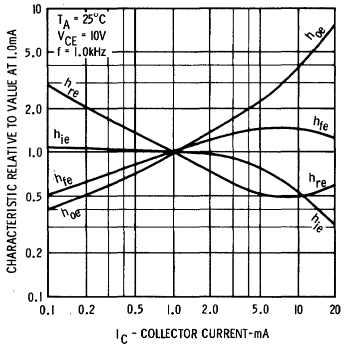
COLLECTOR CUTOFF CURRENTS VERSUS AMBIENT TEMPERATURE



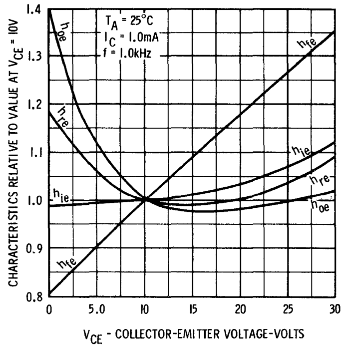
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

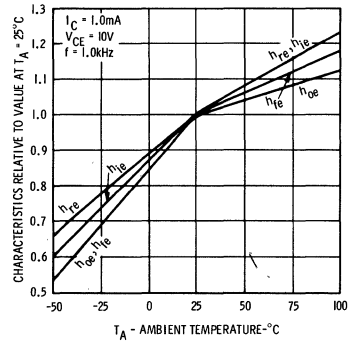
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



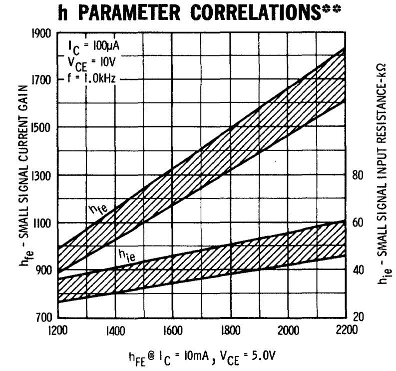
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



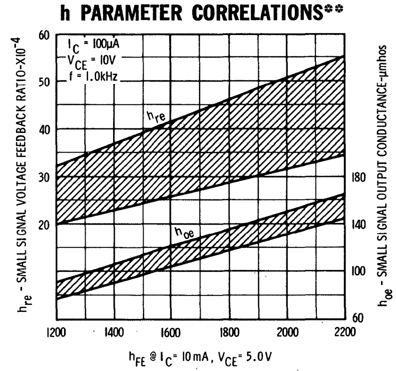
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



h PARAMETER CORRELATIONS**



h PARAMETER CORRELATIONS**



** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

SYMBOL	CHARACTERISTICS	TYP.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance	39	kohms	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{oe}	Output Conductance	120	μmhos	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{re}	Voltage Feedback Ratio	33	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{fe}	Small Signal Current Gain	1630		$I_C = 1.0$ 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 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 150°C and junction to case thermal resistance of 146°C/Watt (derating factor of 6.9 mW/°C); junction to ambient thermal resistance of 480°C/Watt (derating factor of 2.1 mW/°C) for FT107A. 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 5.0 mW/°C) for SE4022.
(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%.

FT107B • SE4021

NPN LOW LEVEL, LOW NOISE AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **LOW 1/f NOISE . . . . NF = 6.0 dB (TYP) AT 10 Hz, 1.0 kΩ**
- **HIGH GAIN . . . . h_{FE} = 450 (MIN) AT 10 μA**
  h_{FE} = 600 (MIN) AT 10 mA
- **LOW SATURATION VOLTAGE . . . $V_{CE(sat)}$ = 0.2 V (MAX) AT 10 mA/0.5 mA**
- **LOW LEAKAGE . . . . I_{CBO} = 2.0 nA (MAX) AT V_{CB} = 30 V**
  I_{CBO} = 50 nA (MAX) AT V_{CB} = 30 V, T_A = 65°C (SE4021)
  I_{CBO} = 1.0 μA (MAX) AT V_{CB} = 30 V, T_A = 125°C (FT107B)

ABSOLUTE MAXIMUM RATINGS (Note 1)

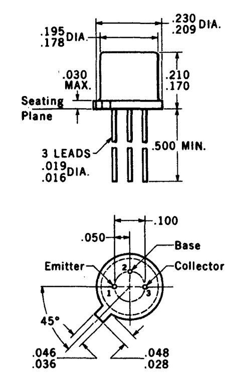
		FT107B	SE4021
Maximum Temperatures			
Storage Temperatures		−65°C to +150°C	−65°C to +125°C
Operating Junction Temperatures		+150°C	+125°C
Lead Temperature (Soldering, 10 seconds time limit)		+300°C	+260°C
Maximum Power Dissipation (Notes 2 and 3)			
Total Dissipation at 25°C Case Temperature		0.86 Watt	0.5 Watt
25°C Ambient Temperature		0.26 Watt	0.2 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	45 Volts	45 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	45 Volts	45 Volts
V_{EBO}	Emitter to Base Voltage	8.0 Volts	8.0 Volts
I_C	Continuous Collector Current	50 mA	50 mA

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		3.5	6.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 1.0 kΩ BW = 400 Hz
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		1.5	4.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 10 kΩ BW = 400 Hz
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		2.5	8.0	dB	I_C = 100 μA V_{CE} = 5.0 V R_S = 100 kΩ BW = 400 Hz
NF	Narrow-Band Noise Figure (f = 100 Hz)		3.5			I_C = 100 μA V_{CE} = 5.0 V R_S = 1.0 kΩ BW = 8.0 Hz
NF	**Narrow-Band Noise Figure (f = 10 Hz)**		**6.0**	(Note 6)	**dB**	**I_C = 100 μA V_{CE} = 5.0 V R_S = 1.0 kΩ BW = 10 Hz**
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		1.5	3.0	dB	I_C = 10 μA V_{CE} = 5.0 V R_S = 10 kΩ BW = 400 Hz
NF	Wide-Band Noise Figure (f = 10 Hz to 10 kHz)		1.5	3.0	dB	I_C = 10 μA V_{CE} = 5.0 V R_S = 10 kΩ BW = 15.7 kHz
h_{FE}	**DC Current Gain**	**450**	735			**I_C = 10 μA V_{CE} = 5.0 V**
h_{FE}	DC Current Gain	500	840			I_C = 100 μA V_{CE} = 5.0 V
h_{FE}	DC Current Gain	550	960			I_C = 1.0 mA V_{CE} = 5.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	**600**	**950**	**1550**		**I_C = 10 mA V_{CE} = 5.0 V**
h_{FE}(−55°C)	DC Current Gain	130				I_C = 10 μA V_{CE} = 5.0 V
h_{FE}(100°C)	DC Pulse Current Gain (FT107B) (Note 5)		1200	2300		I_C = 10 mA V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	1.5	2.6			I_C = 10 mA V_{CE} = 5.0 V

Additional Characteristics on Page 2 Notes on Page 4

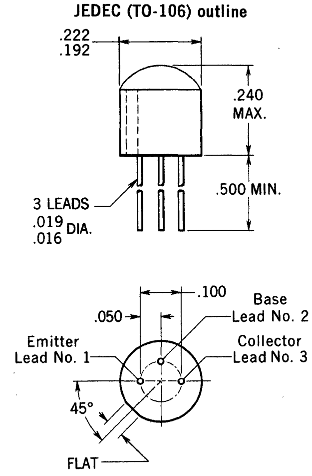
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



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

FT107B

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-106) outline



NOTES: All dimensions in inches
All leads electrically isolated from case
Package weight is 0.31 gram. Package
is electrically non-conductive material

SE4021

*Planar is a patented Fairchild process.

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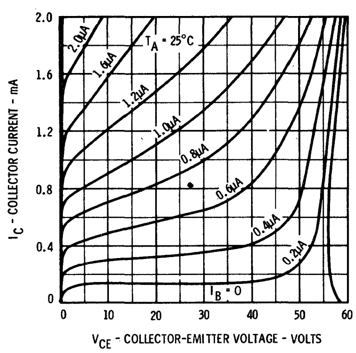
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

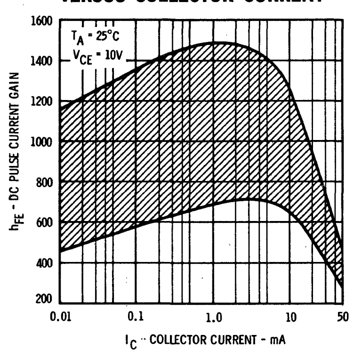
SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{CBO}	**Collector Cutoff Current**		**0.1**	**2.0**	**nA**	**$I_E = 0$**	**$V_{CB} = 30$ V**
I_{CBO}(65°C)	**Collector Cutoff Current (SE4021)**		**1.0**	**50**	**nA**	**$I_E = 0$**	**$V_{CB} = 30$ V**
I_{CBO}(125°C)	**Collector Cutoff Current (FT107B)**		**0.07**	**1.0**	**μA**	**$I_E = 0$**	**$V_{CB} = 30$ V**
I_{EBO}	Emitter Cutoff Current		0.005	1.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{cb}	Collector to Base Capacitance		2.5	4.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{eb}	Emitter to Base Capacitance		3.5	6.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	45			Volts	$I_C = 5.0$ mA	$I_B = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	45			Volts	$I_C = 10\ \mu$A	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0			Volts	$I_C = 0$	$I_E = 10\ \mu$A
$V_{CE(sat)}$	**Collector to Emitter Saturation Voltage** (Note 5)		**0.12**	**0.2**	**Volt**	**$I_C = 10$ mA**	**$I_B = 0.5$ mA**
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.18	0.3	Volt	$I_C = 50$ mA	$I_B = 5.0$ mA
$V_{BE(on)}$	Base to Emitter On Voltage		0.62	0.7	Volt	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

TYPICAL ELECTRICAL CHARACTERISTICS

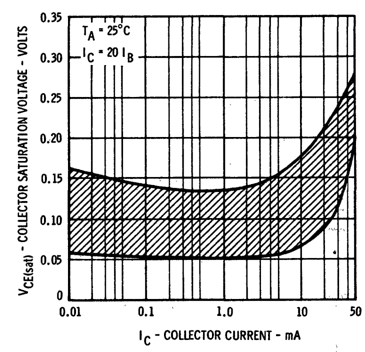
COLLECTOR CHARACTERISTICS* ACTIVE REGION



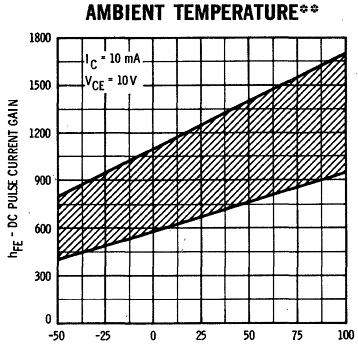
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT**



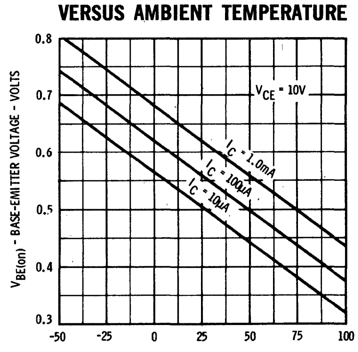
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT**



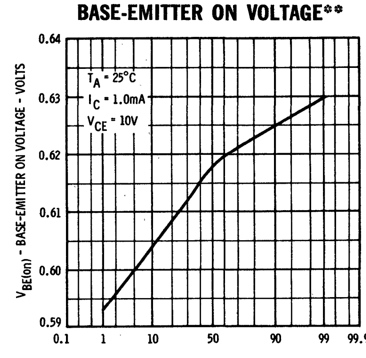
DC PULSE CURRENT GAIN VERSUS AMBIENT TEMPERATURE**



BASE-EMITTER ON VOLTAGE VERSUS AMBIENT TEMPERATURE



DISTRIBUTION OF BASE-EMITTER ON VOLTAGE**

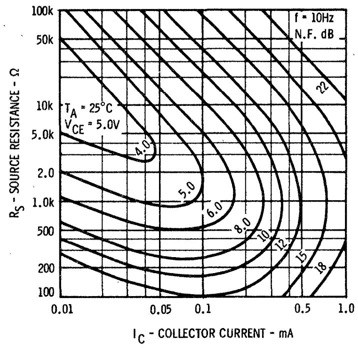


* Single family characteristics on Curve Tracer.

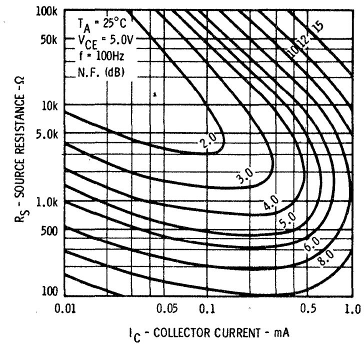
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

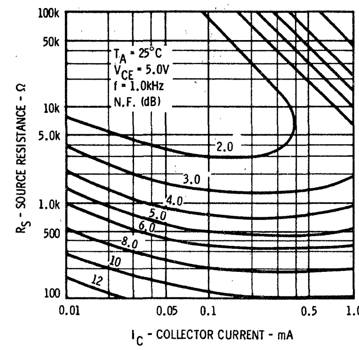
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



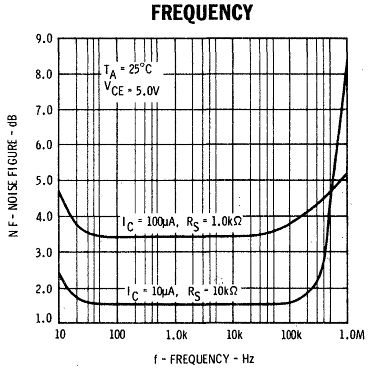
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



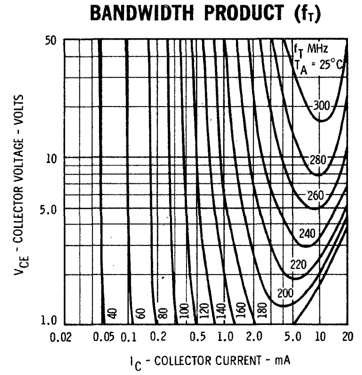
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



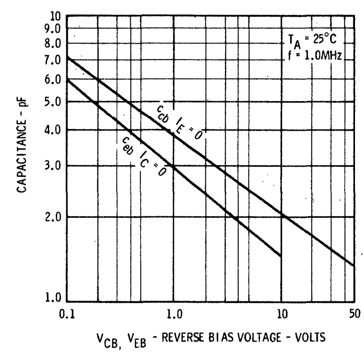
NOISE FIGURE VERSUS FREQUENCY



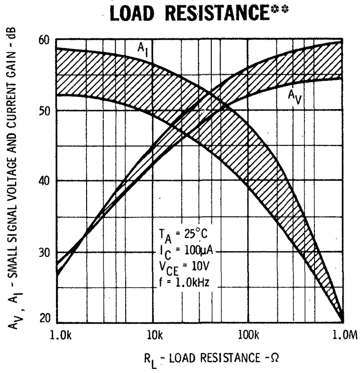
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



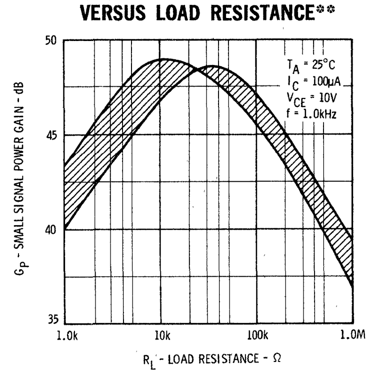
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



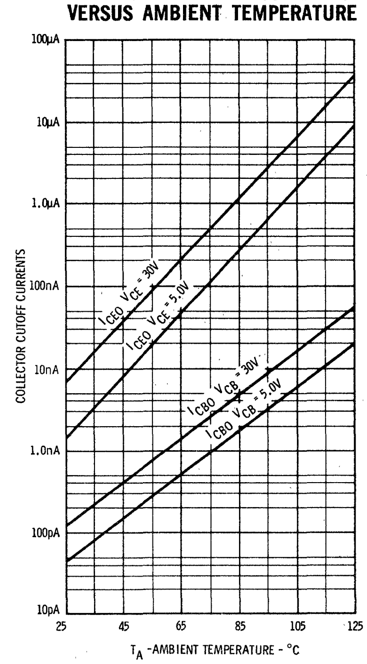
SMALL SIGNAL VOLTAGE AND CURRENT GAIN VERSUS LOAD RESISTANCE**



SMALL SIGNAL POWER GAIN VERSUS LOAD RESISTANCE**



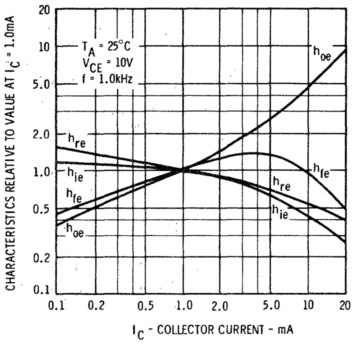
COLLECTOR CUTOFF CURRENTS VERSUS AMBIENT TEMPERATURE



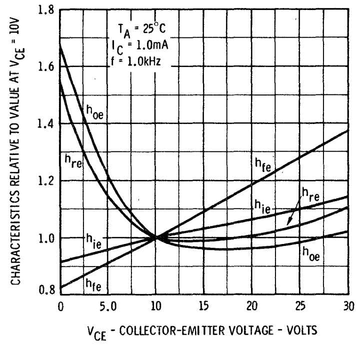
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

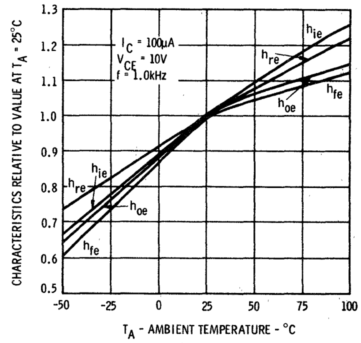
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



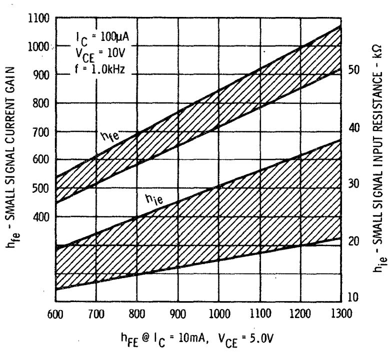
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



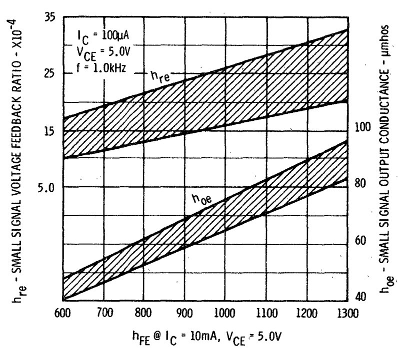
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



h PARAMETER CORRELATIONS**



h PARAMETER CORRELATIONS**



** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

SYMBOL	CHARACTERISTICS	TYP.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance	28	kΩ	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{oe}	Output Conductance	74	µmhos	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{re}	Voltage Feedback Ratio	23	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{fe}	Small Signal Current Gain	1050		$I_C = 1.0$ 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 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 150°C and junction to case thermal resistance of 146°C/Watt (derating factor of 6.9 mW/°C); junction to ambient thermal resistance of 480°C/Watt (derating factor of 2.1 mW/°C) for FT107B. 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) for SE4021.
(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%.
(6) Normally >90% of the units will have NF less than 11 dB.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

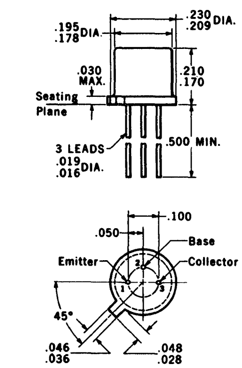
FT107C • SE4020

NPN LOW LEVEL, LOW NOISE AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **LOW 1/f NOISE . . . . NF = 2.5 dB (TYP) AT 100 Hz; 1.0 kΩ**
- **HIGH GAIN . . . . h_{FE} = 100 (MIN) AT 10 μA**
  h_{FE} = 150 (MIN) AT 10 mA
- **LOW SATURATION VOLTAGE . . . $V_{CE(sat)}$ = 0.2 V (MAX) AT 10 mA/0.5 mA**
- **LOW LEAKAGE . . . . I_{CBO} = 2.0 nA (MAX) AT V_{CB} = 45 V**
  I_{CBO} = 50 nA (MAX) AT V_{CB} = 45 V, T_A = 65°C (SE4020)
  I_{CBO} = 1.0 μA (MAX) AT V_{CB} = 45 V, T_A = 125°C (FT107C)

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

FT107C

ABSOLUTE MAXIMUM RATINGS (Note 1)

		FT107C	SE4020
Maximum Temperatures			
Storage Temperatures		−65°C to +150°C	−65°C to +125°C
Operating Junction Temperatures		+150°C	+125°C
Lead Temperature (Soldering, 10 seconds time limit)		+300°C	+260°C
Maximum Power Dissipation (Notes 2 and 3)			
Total Dissipation at 25°C Case Temperature		0.86 Watt	0.5 Watt
25°C Ambient Temperature		0.26 Watt	0.2 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	60 Volts	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	60 Volts	60 Volts
V_{EBO}	Emitter to Base Voltage	8.0 Volts	8.0 Volts
I_C	Continuous Collector Current	50 mA	50 mA

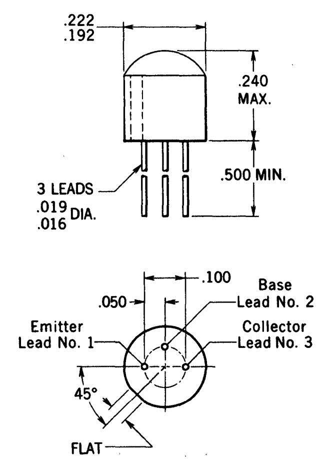
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		2.5	6.0	dB	I_C = 100 μA V_{CE} = 5.0 V; R_S = 1.0 kΩ BW = 400 Hz
NF	Narrow-Band Noise Figure (f = 1.0 kHz)		1.5	3.0	dB	I_C = 10 μA V_{CE} = 5.0 V; R_S = 10 kΩ BW = 400 Hz
NF	**Narrow-Band Noise Figure (f = 100 Hz)**		**2.5**		**dB**	**I_C = 100 μA V_{CE} = 5.0 V; R_S = 1.0 kΩ BW = 8.0 Hz**
NF	Wide-Band Noise Figure (f = 10 Hz to 10 kHz)		1.5	3.0	dB	I_C = 10 μA V_{CE} = 5.0 V; R_S = 10 kΩ BW = 15.7 kHz
h_{FE}	**DC Current Gain**	**100**	**205**			**I_C = 10 μA V_{CE} = 5.0 V**
h_{FE}	DC Current Gain	120	245			I_C = 100 μA V_{CE} = 5.0 V
h_{FE}	DC Current Gain	135	290			I_C = 1.0 mA V_{CE} = 5.0 V
h_{FE}	**DC Pulse Current Gain (Note 5)**	**150**	**310**	**950**		**I_C = 10 mA V_{CE} = 5.0 V**
h_{FE}(−55°C)	DC Current Gain	25				I_C = 10 μA V_{CE} = 5.0 V
h_{FE}(100°C)	DC Pulse Current Gain (FT107C) (Note 5)		400	1450		I_C = 10 mA V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	1.0	2.0			I_C = 10 mA V_{CE} = 5.0 V

Additional Electrical Characteristics on Page 2

Notes on Page 4

PHYSICAL DIMENSIONS
in accordance with JEDEC (TO-106) outline



NOTES: All dimensions in inches
All leads electrically isolated from case
Package weight is 0.31 gram. Package
is electrically non-conductive material

SE4020

*Planar is a patented Fairchild process.

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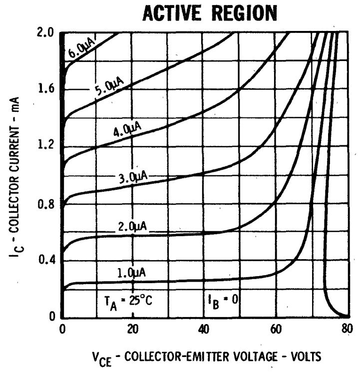
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

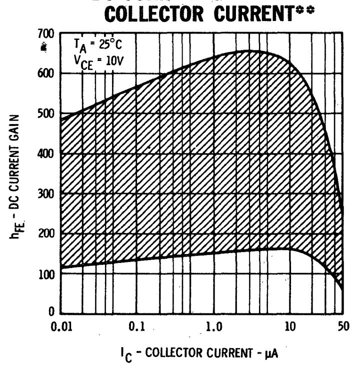
SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{CBO}	**Collector Cutoff Current**		**0.2**	**2.0**	**nA**	**$I_E = 0$**	**$V_{CB} = 45$ V**
I_{CBO}(65°C)	**Collector Cutoff Current** (SE4020)		**3.0**	**50**	nA	**$I_E = 0$**	**$V_{CB} = 45$ V**
I_{CBO}(125°C)	**Collector Cutoff Current** (FT107C)		**0.1**	**1.0**	**μA**	**$I_E = 0$**	**$V_{CB} = 45$ V**
I_{EBO}	Emitter Cutoff Current		0.007	1.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{cb}	Collector to Base Capacitance		2.5	4.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{eb}	Emitter to Base Capacitance		4.0	6.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	60			Volts	$I_C = 5.0$ mA	$I_B = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	60			Volts	$I_C = 10\ \mu$A	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0			Volts	$I_C = 0$	$I_E = 10\ \mu$A
$V_{CE(sat)}$	**Pulsed Collector to Emitter Saturation Voltage** (Note 5)		**0.12**	**0.2**	**Volt**	**$I_C = 10$ mA**	**$I_B = 0.5$ mA**
$V_{CE(sat)}$	Pulsed Collector to Emitter Saturation Voltage (Note 5)		0.17	0.3	Volt	$I_C = 50$ mA	$I_B = 5.0$ mA
$V_{BE(on)}$	Base to Emitter On Voltage		0.64	0.7	Volt	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

TYPICAL ELECTRICAL CHARACTERISTICS

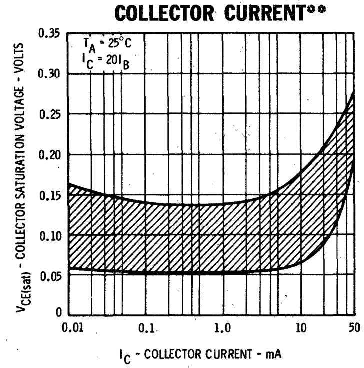
COLLECTOR CHARACTERISTICS* ACTIVE REGION



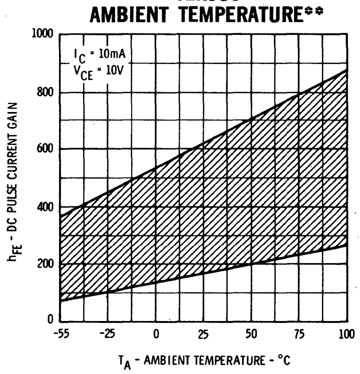
DC CURRENT GAIN VERSUS COLLECTOR CURRENT**



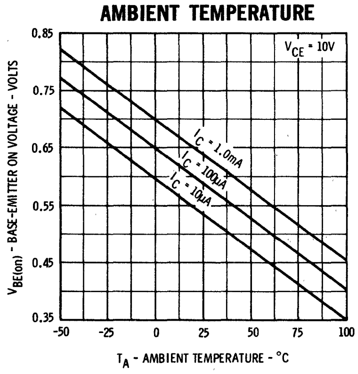
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT**



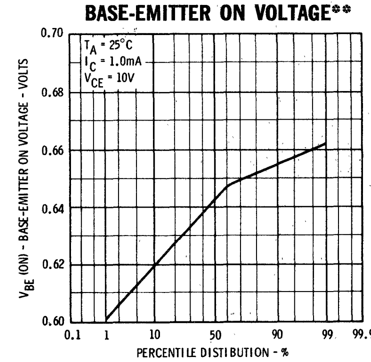
DC PULSE CURRENT GAIN VERSUS AMBIENT TEMPERATURE**



BASE-EMITTER ON VOLTAGE VERSUS AMBIENT TEMPERATURE



DISTRIBUTION OF BASE-EMITTER ON VOLTAGE**

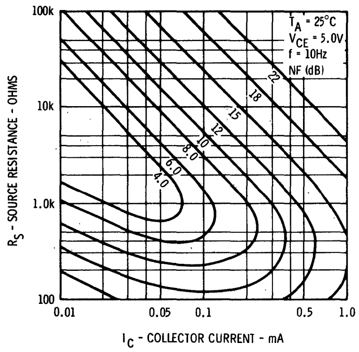


* Single family characteristic on Transistor Curve Tracer.

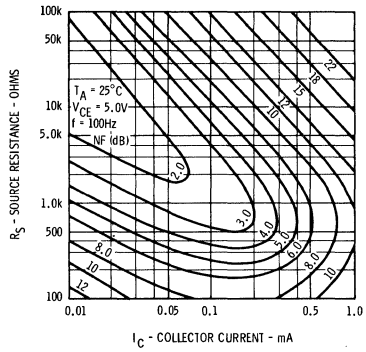
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

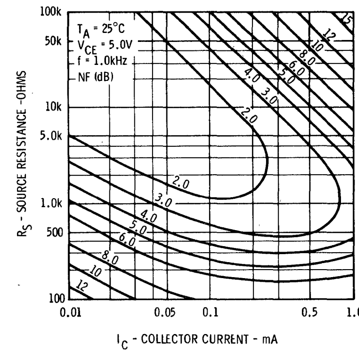
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



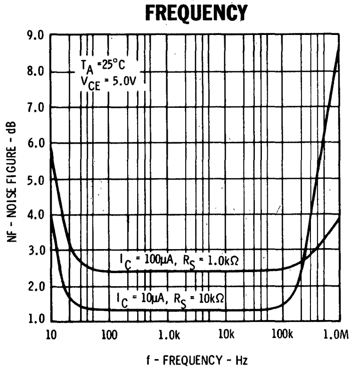
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



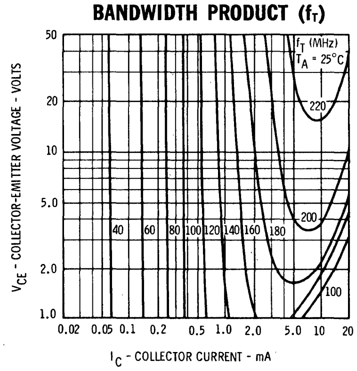
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



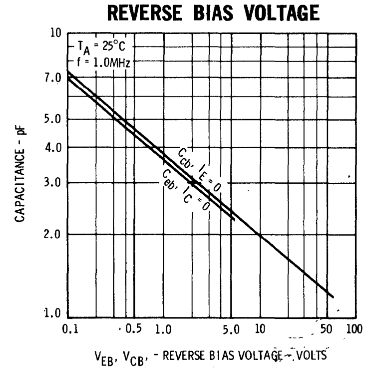
NOISE FIGURE VERSUS FREQUENCY



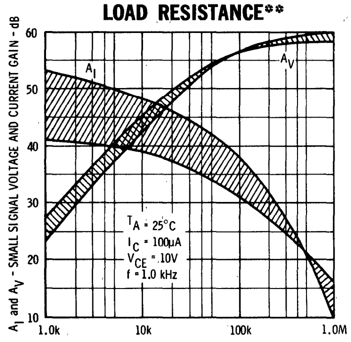
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



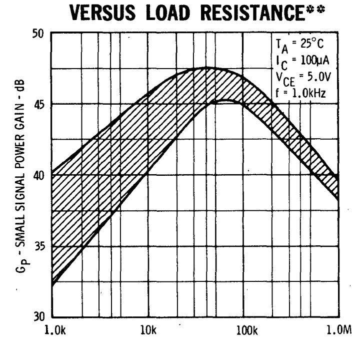
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



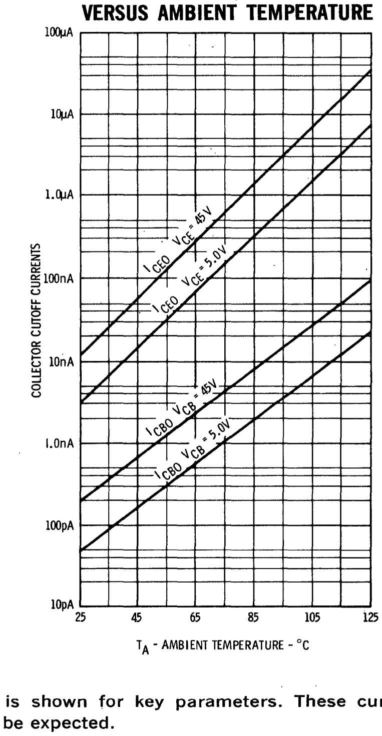
SMALL SIGNAL VOLTAGE AND CURRENT GAIN VERSUS LOAD RESISTANCE**



SMALL SIGNAL POWER GAIN VERSUS LOAD RESISTANCE**



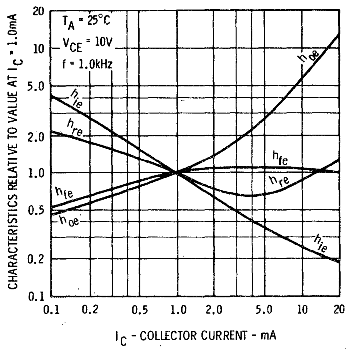
COLLECTOR CUTOFF CURRENTS VERSUS AMBIENT TEMPERATURE



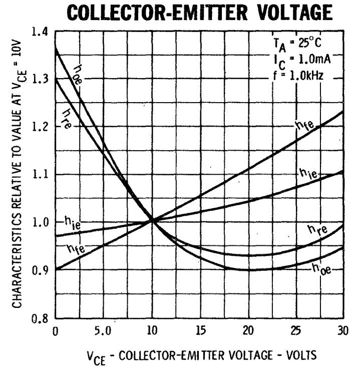
** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

TYPICAL ELECTRICAL CHARACTERISTICS

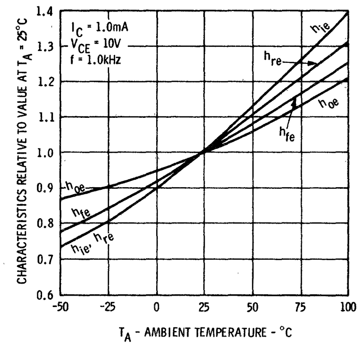
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



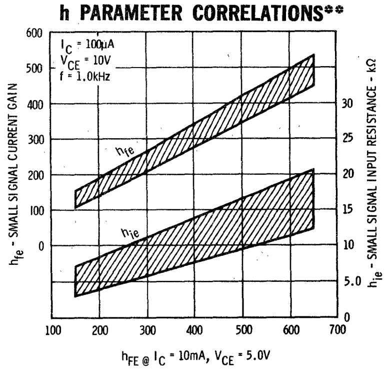
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



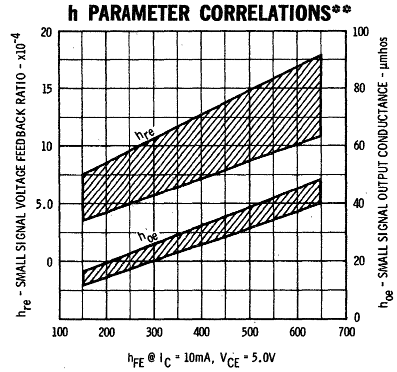
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



h PARAMETER CORRELATIONS**



h PARAMETER CORRELATIONS**



** In recognition of the needs of computer aided design, correlation and distribution information is shown for key parameters. These curves are not guaranteed but represent with a high degree of confidence the distributions and correlations to be expected.

SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

SYMBOL	CHARACTERISTICS	TYP.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance	8.5	kohms	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{oe}	Output Conductance	24	µmhos	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{re}	Voltage Feedback Ratio	7.0	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 10$ V
h_{fe}	Small Signal Current Gain	335		$I_C = 1.0$ 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 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 150°C and junction to case thermal resistance of 146°C/Watt (derating factor of 6.9 mW/°C); junction to ambient thermal resistance of 480°C/Watt (derating factor of 2.1 mW/°C) for FT107C. 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) for SE4020.
(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%.

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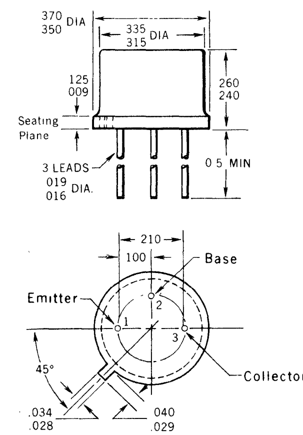
FT123

NPN HIGH-VOLTAGE VIDEO OUTPUT TRANSISTOR

DIFFUSED SILICON PLANAR* TRANSISTOR

- **HIGH VOLTAGE . . . . $LV_{CEO} = 300$ V (MIN)**
- **LOW C_{cb} . . . . 3.0 pF (MAX) AT $V_{CB} = 20$ V**
- **HIGH FREQUENCY . . . . $f_T = 60$ MHz (MIN)**
- **HIGH POWER DISSIPATION . . . $P_D = 1.0$ W AT $T_A = 25°C$**
  $P_D = 5.0$ W AT $T_C = 25°C$

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES All dimensions in inches
Leads are gold plated over nickel flash on steel
Lead No. 3 internally connected to case
Package weight is 0.76 gram

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 second time limit)		+300°C
Maximum Power Dissipation (Notes 2 and 3)		
Total Dissipation at 25°C Case Temperature		**5.0 Watts**
at 25°C Ambient Temperature		**1.0 Watt**
Maximum Voltages		
V_{CBO}	Collector to Base Voltage	300 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	300 Volts
V_{EBO}	Emitter to Base Voltage	8.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
C_{cb}	**Collector to Base Capacitance**		**2.0**	**3.0**	**pF**	**$I_E = 0$**	**$V_{CB} = 20$ V**
h_{fe}	**High Frequency Current Gain (f = 20 MHz)**	**3.0**	**3.5**			**$I_C = 10$ mA**	**$V_{CE} = 20$ V**
h_{FE}	DC Pulse Current Gain (Note 5)	40	50			$I_C = 30$ mA	$V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain (Note 5)	40	70			$I_C = 10$ mA	$V_{CE} = 20$ V
h_{FE}	DC Current Gain	25	50			$I_C = 1.0$ mA	$V_{CE} = 20$ V
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**300**	340		**Volts**	**$I_C = 5.0$ mA** (pulsed)	**$I_B = 0$**
BV_{CBO}	Collector to Base Breakdown Voltage	300	340		Volts	$I_C = 100\ \mu A$	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0	10		Volts	$I_E = 100\ \mu A$	$I_C = 0$
I_{CBO}	Collector Cutoff Current		1.0	200	nA	$I_E = 0$	$V_{CB} = 200$ V
I_{CBO}(125°C)	Collector Cutoff Current		0.25	5.0	μA	$I_E = 0$	$V_{CB} = 200$ V
I_{EBO}	Emitter Cutoff Current		1.0	100	nA	$I_C = 0$	$V_{EB} = 6.0$ V
C_{eb}	Emitter to Base Capacitance		40	45	pF	$I_C = 0$	$V_{EB} = 0.5$ V
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)		0.74	0.8	Volts	$I_C = 20$ mA	$I_B = 2.0$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.50	1.5	Volts	$I_C = 20$ mA	$I_B = 2.0$ mA

Notes on page 2

*Planar is a patented Fairchild process.

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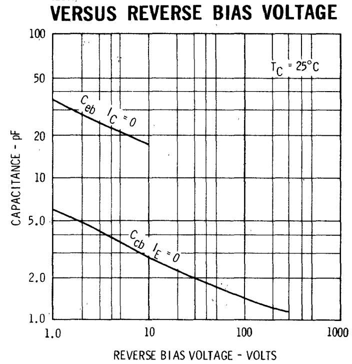
NOTES:

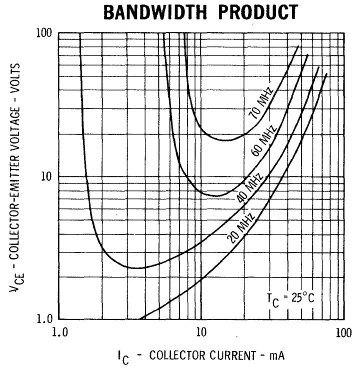
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations. Note Power Dissipation Curve shown below.
(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 35°C/Watt (derating factor of 28.7 mW/°C); junction to ambient thermal resistance of 175°C/Watt (derating factor of 5.72 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%.

ELECTRICAL CHARACTERICTICS

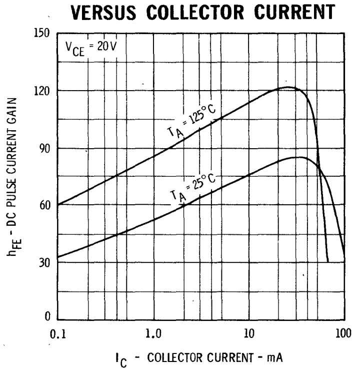
COLLECTOR TO BASE AND EMITTER TO BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



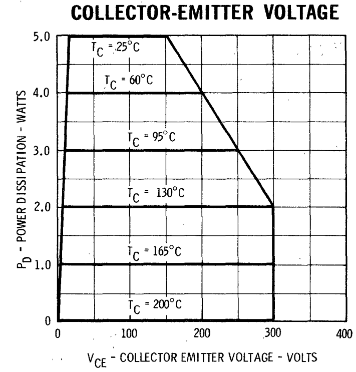
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT



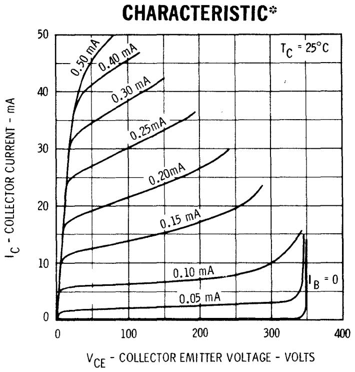
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



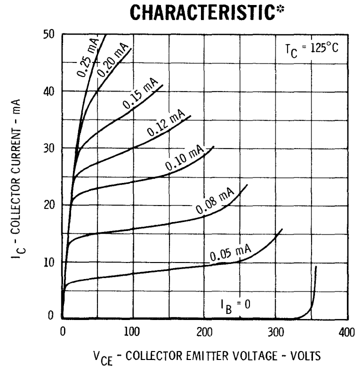
GUARANTEED MAXIMUM DC POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE



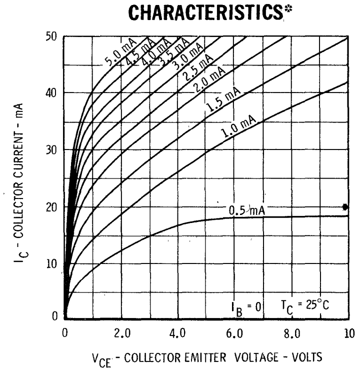
LARGE SIGNAL COLLECTOR CHARACTERISTIC*



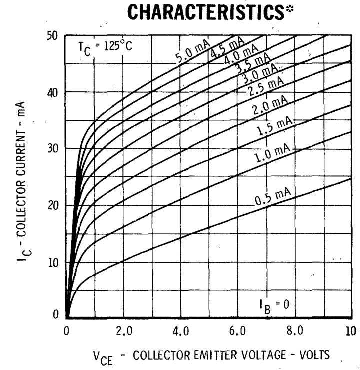
LARGE SIGNAL COLLECTOR CHARACTERISTIC*



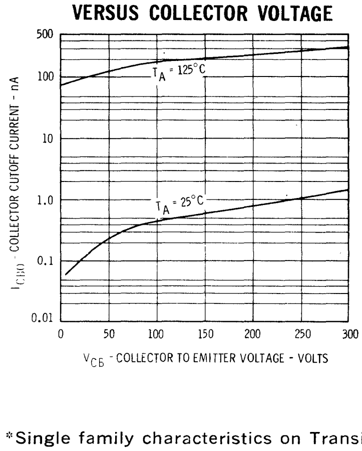
COLLECTOR SATURATION CHARACTERISTICS*



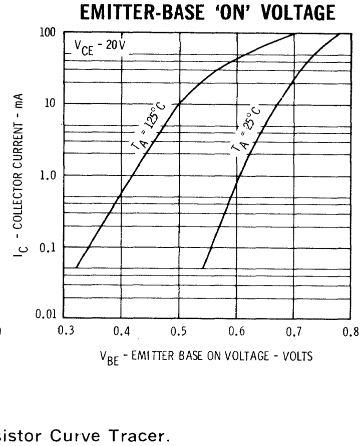
COLLECTOR SATURATION CHARACTERISTICS*



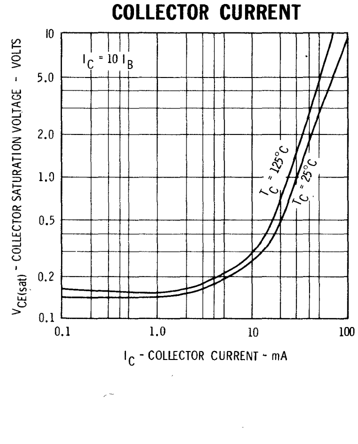
COLLECTOR CUTOFF CURRENT VERSUS COLLECTOR VOLTAGE



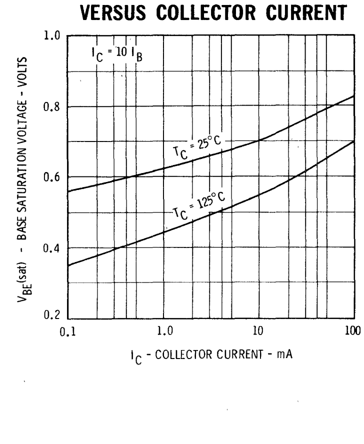
COLLECTOR CURRENT VERSUS EMITTER-BASE 'ON' VOLTAGE



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



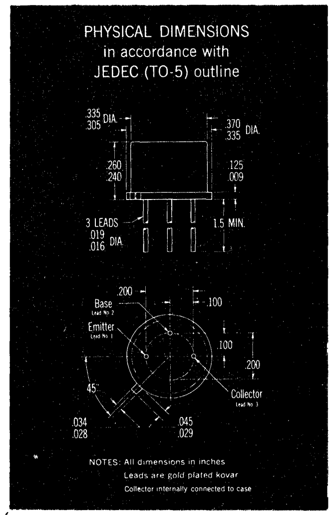
*Single family characteristics on Transistor Curve Tracer.

2N497 • 2N498 • 2N656 • 2N657

NPN GENERAL PURPOSE HIGH VOLTAGE

DIFFUSED SILICON PLANAR*TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3108 OR 2N3114



GENERAL DESCRIPTION - These high voltage NPN double diffused silicon transistors are designed for use in highperformance amplifier, oscillator and switching circuits.

ABSOLUTE MAXIMUM RATINGS (25° C) [Note 1]		2N497/2N656	2N498/2N657
Maximum Temperatures			
Storage Temperature		-65° C to +300° C	-65° C to +300° C
Operating Junction Temperature		+200° C Maximum	+200° C Maximum
Maximum Power Dissipation			
Total Dissipation at Case Temperature	25° C [Note 2 & 3]	4.0 Watts	4.0 Watts
at Ambient Temperature 25° C		0.8 Watt	0.8 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	60 Volts	100 Volts
V_{CEO}	Collector to Emitter Voltage	60 Volts	100 Volts
V_{EBO}	Emitter to Base Voltage	8.0 Volts	8.0 Volts

GUARANTEED ELECTRICAL CHARACTERISTICS (25° C unless otherwise noted)

Symbol	Characteristic	2N497 Min.	2N497 Max.	2N498 Min.	2N498 Max.	2N656 Min.	2N656 Max.	2N657 Min.	2N657 Max.	Units	Test Conditions	
BV_{CBO}	Breakdown Voltage	60		100		60		100		Volts	I_C = 100 μA	I_E = 0
BV_{CEO}	Breakdown Voltage	60		100		60		100		Volts	I_C = 250 μA	I_B = 0
BV_{EBO}	Breakdown Voltage	8.0		8.0		8.0		8.0		Volts	I_E = 250 μA	I_C = 0
I_{CBO}	Collector Cutoff Current		10		10		10		10	μA	I_E = 0	V_{CB} = 30 V
h_{FE}	Current Transfer Ratio	12	36	12	36	30	90	30	90		I_C = 200 mA	V_{CE} = 10 V
h_{IE}	Input Impedance		500		500		500		500	ohms	I_B = 8.0 mA	V_{CE} = 10 V
R_{CS}	Saturation Resistance		25		25		25		25	ohms	I_C = 200 mA	I_B = 40 mA

TYPICAL ELECTRICAL CHARACTERISTICS (25° C unless otherwise noted)

Symbol	Characteristic	2N497-98	2N656-57	Units	Test Conditions	
h_{FE}	DC Current Gain	27	60		I_C = 200 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	20	45		I_C = 100 μA	V_{CE} = 10 V
V_{BE} (sat)	Base Saturation Voltage	1.1	1.1	Volts	I_C = 200 mA	I_B = 40 mA
C_{ob}	Collector Capacitance	13	13	pF	I_E = 0	V_{CB} = 10 V
C_{TE}	Emitter Transition Capacitance	60	60	pF	I_C = 0	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current	0.4	0.4	mμA	I_E = 0	V_{CB} = 90 V
I_{CBO}	Collector Cutoff Current (150° C)	1.5	1.5	μA	I_E = 0	V_{CB} = 90 V
h_{fe}	High Frequency Current Gain f = 20 MHz	2.5	3.5		I_C = 50 mA	V_{CE} = 10 V
I_{EBO}	Emitter Current	0.1	0.1	mμA	I_C = 0	V_{EB} = 5.0 V

* Planar is a patented Fairchild process.

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NOTES:

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

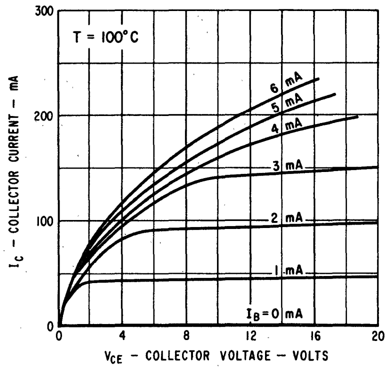
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operation.

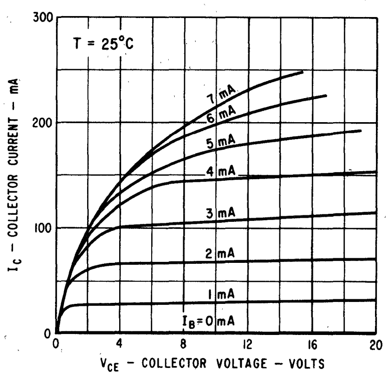
(3) These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 43.8° C/Watt (derating factor of 22.8 mW/° C).

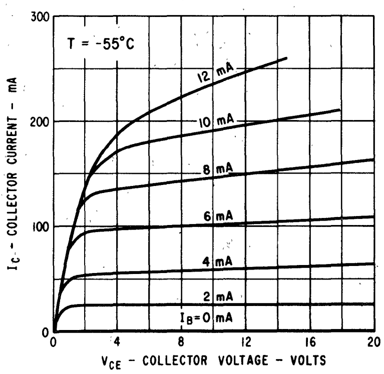
TYPICAL ELECTRICAL CHARACTERISTICS

2N497 AND 2N498

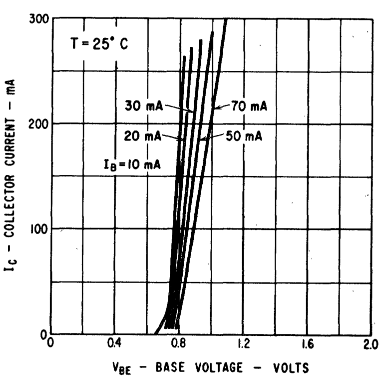
COLLECTOR CHARACTERISTICS





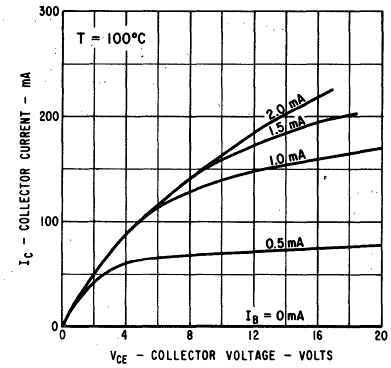


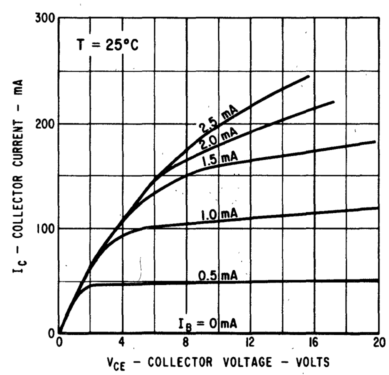
BASE CHARACTERISTICS

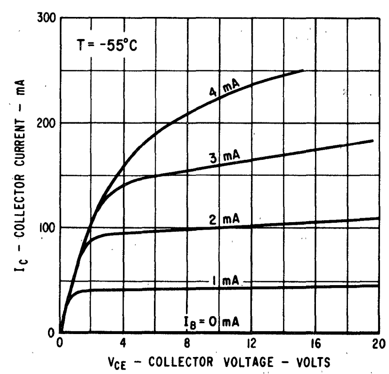


2N656 AND 2N657

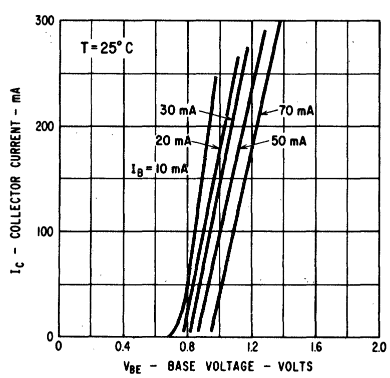
COLLECTOR CHARACTERISTICS





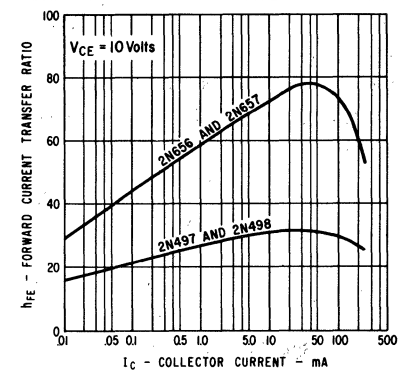


BASE CHARACTERISTICS

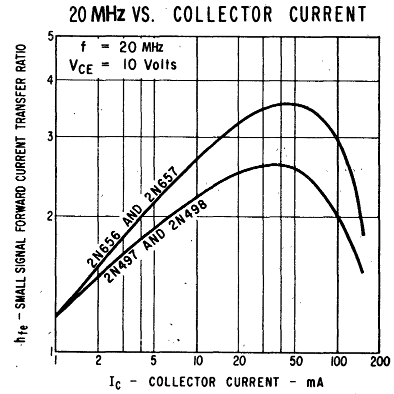


2N497, 2N498, 2N656 AND 2N657

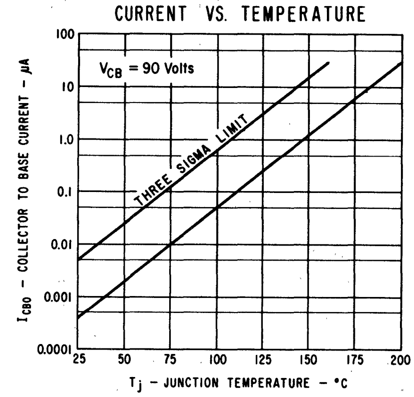
PULSED DC CURRENT GAIN VS. COLLECTOR CURRENT



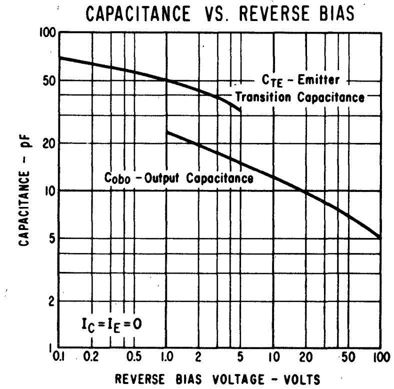
SMALL SIGNAL CURRENT GAIN AT 20 MHz VS. COLLECTOR CURRENT



COLLECTOR-BASE DIODE REVERSE CURRENT VS. TEMPERATURE



COLLECTOR AND EMITTER TRANSITION CAPACITANCE VS. REVERSE BIAS



2N696 • 2N697 • 2N717 • 2N718 • 2N1420

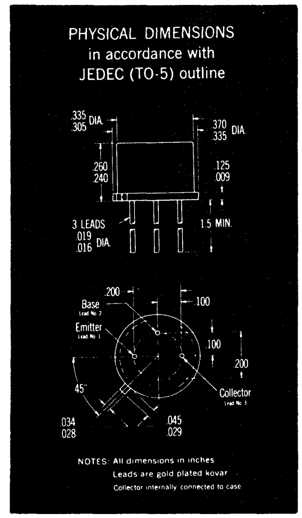
NPN GENERAL PURPOSE TYPE

DIFFUSED SILICON TRANSISTORS

These transistors are designed for high-performance amplifier, oscillator and some switching applications. They perform at frequencies from dc to VHF and over more than 3 decades of current. They have been in wide usage for several years and are designed to meet the environmental requirements of MIL-S-19500.

Superior replacements offering PLANAR reliability and performance are available as the 2N1613, 2N1711 and 2N718A.

Type	Military Designation
2N696	MIL-S-19500/99A (Sig C)
2N697	MIL-S-19500/99A (Sig C)
2N1613	MIL-S-19500/181 (Navy)
2N1711	MIL-S-19500/225 (Navy)

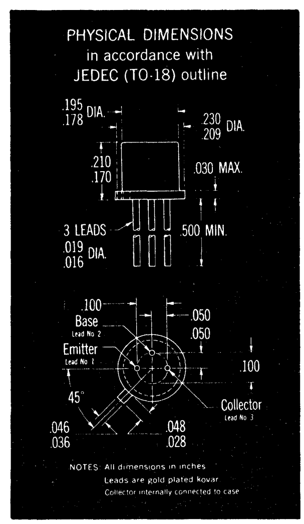


2N696 • 2N697 • 2N1420

ABSOLUTE MAXIMUM RATINGS [Note 1]	**2N696 2N697 2N1420**	**2N717 2N718**
Maximum Temperatures		
Storage Temperature	−65°C to +300°C	−65°C to +300°C
Operating Junction Temperature	175°C Maximum	175°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature [Note 2 & 3]	2.0 Watts	1.5 Watts
at 100°C Case Temperature [Note 2 & 3]	1.0 Watt	0.75 Watt
at 25°C Ambient Temperature	0.6 Watt	0.4 Watt
Maximum Voltages		
V_{CBO} Collector to Base Voltage	60 Volts	60 Volts
V_{CER} Collector to Emitter Voltage ($R_{BE} \leq 10\Omega$) [Note 4]	40 Volts (30V for 2N1420)	40 Volts
V_{EBO} Emitter to Base Voltage	5.0 Volts	5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	2N717 2N696 Min.	Typ.	Max.	2N718 2N697 Min.	Typ.	Max.	2N1420 Min.	Typ.	Max.	UNITS	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain [Note 5]	20	40	60	40	75	120	100		300		$I_C = 150$ mA $V_{CE} = 10$ V
V_{BE} (sat)	Base Saturation Voltage		1.0	1.3		1.0	1.3		1.0	1.3	Volts	$I_C = 150$ mA $I_B = 15$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.7	1.5		0.7	1.5		0.7	1.5	Volts	$I_C = 150$ mA $I_B = 15$ mA
h_{fe}	High Frequency Current Gain f = 20 mc	2.0	3.0		2.5	4.0		2.5	5.0			$I_C = 50$ mA $V_{CE} = 10$ V
C_{ob}	Output Capacitance		17	35		17	35		17	35	pf	$I_E = 0$ $V_{CB} = 10$ V
I_{CBO}	Collector Cutoff Current		0.01	1.0		0.01	1.0		0.01	1.0	μA	$I_E = 0$ $V_{CB} = 30$ V
I_{CBO} (150°C)	Collector Cutoff Current		0.7	100		0.7	100		0.7	100	μA	$I_E = 0$ $V_{CB} = 30$ V



2N717 • 2N718

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 operation.

(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 75°C/watt (derating factor of 13.3 mW/°C) for the 2N696, 2N697 and 2N1420; junction-to-case thermal resistance of 100°C/watt (derating factor of 10mW/°C) for the 2N717 and 2N718.

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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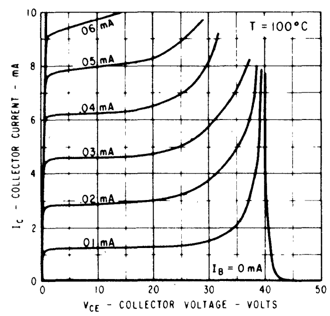
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

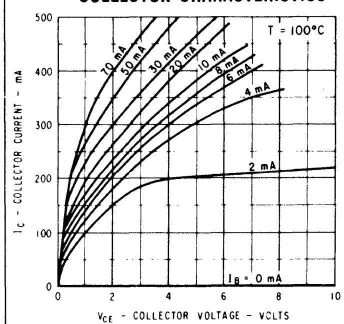
HIGH VOLTAGE

SATURATION REGION

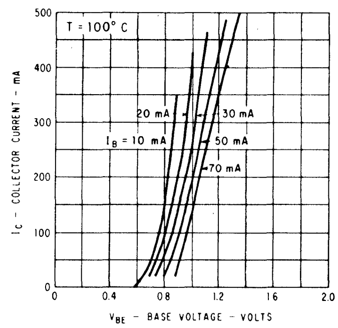
COLLECTOR CHARACTERISTICS



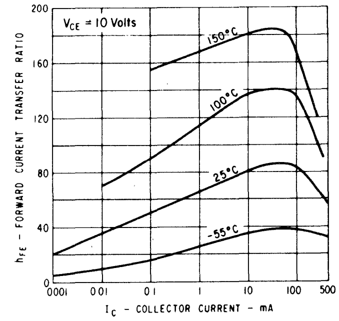
COLLECTOR CHARACTERISTICS



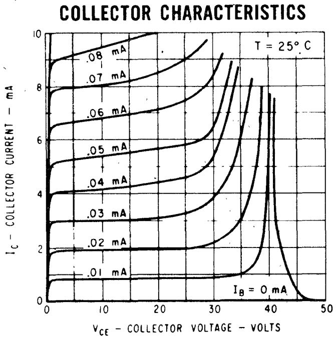
BASE CHARACTERISTICS



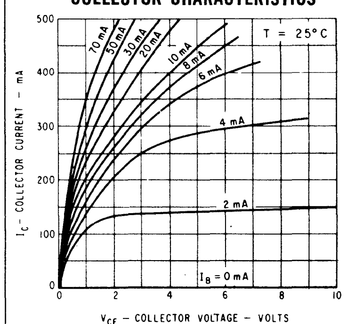
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



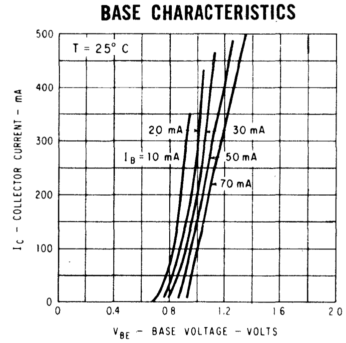
COLLECTOR CHARACTERISTICS



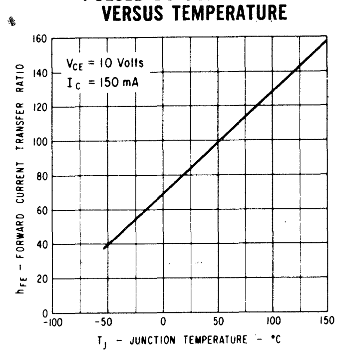
COLLECTOR CHARACTERISTICS



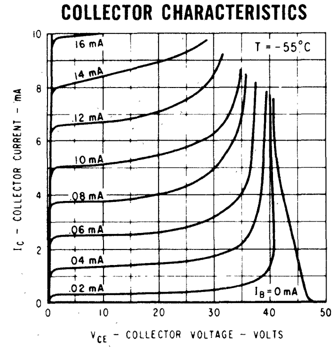
BASE CHARACTERISTICS



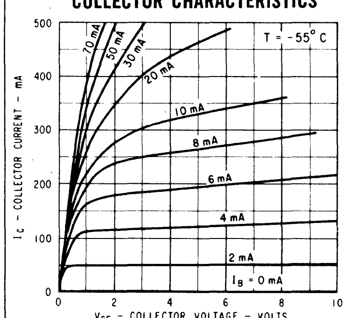
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



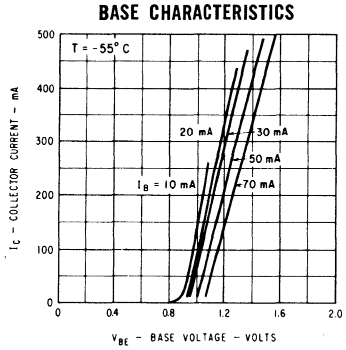
COLLECTOR CHARACTERISTICS



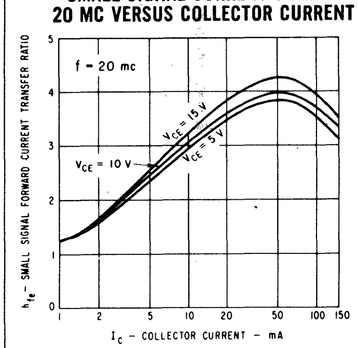
COLLECTOR CHARACTERISTICS



BASE CHARACTERISTICS



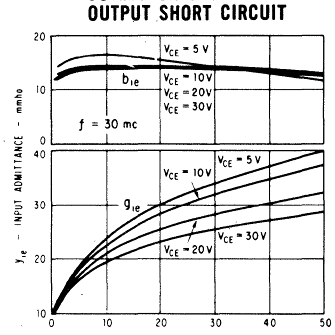
SMALL SIGNAL CURRENT GAIN AT 20 MC VERSUS COLLECTOR CURRENT



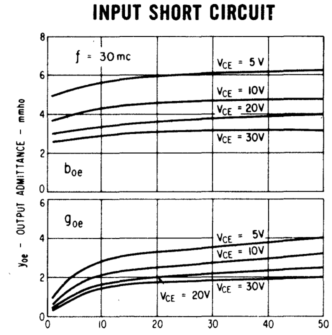
*Single family characteristics on Transistor Curve Tracer.

TYPICAL SMALL SIGNAL COMMON EMITTER 'Y' PARAMETERS

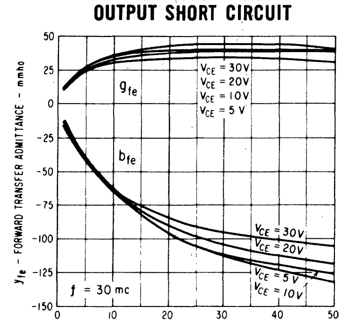
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT—OUTPUT SHORT CIRCUIT



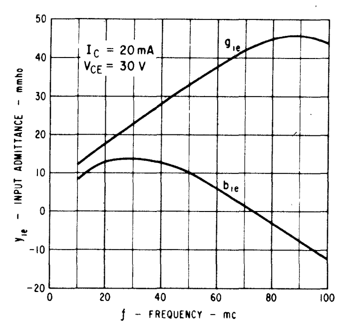
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT—INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT—OUTPUT SHORT CIRCUIT



INPUT ADMITTANCE VERSUS FREQUENCY—OUTPUT SHORT CIRCUIT

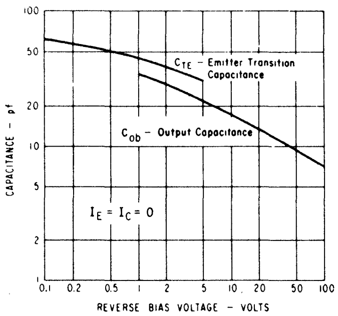


NOTE: The 2N696, 2N717 and 2N1420 are similar to the 2N697 and 2N718 except for values of h_{FE} and h_{fe}.

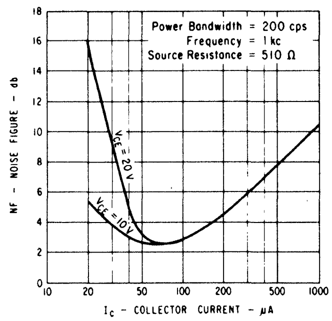
FAIRCHILD TRANSISTORS—TYPES 2N697 AND 2N718

TYPICAL ELECTRICAL CHARACTERISTICS

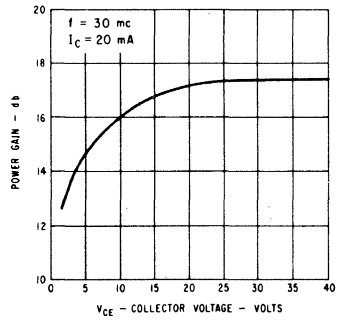
COLLECTOR AND EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



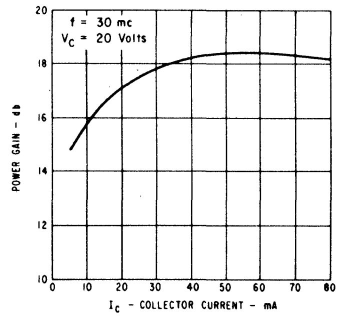
NOISE FIGURE VERSUS COLLECTOR CURRENT



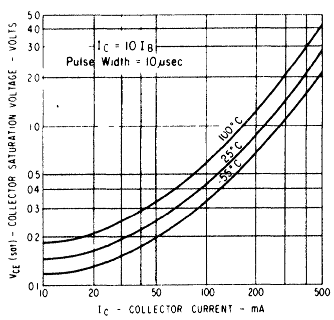
30 MC POWER GAIN VERSUS COLLECTOR VOLTAGE



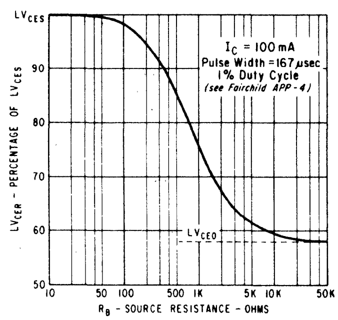
30 MC POWER GAIN VERSUS COLLECTOR CURRENT



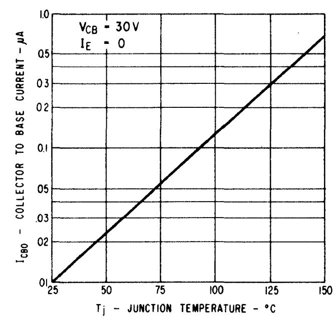
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



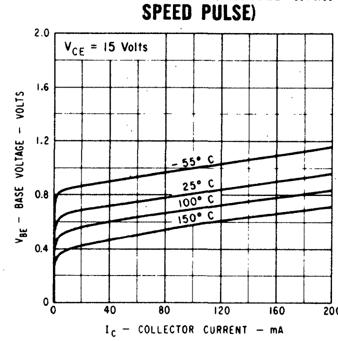
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



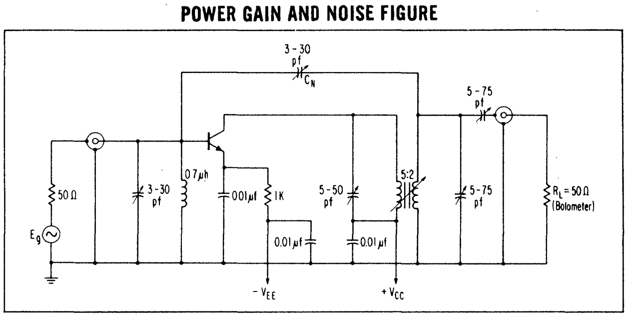
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



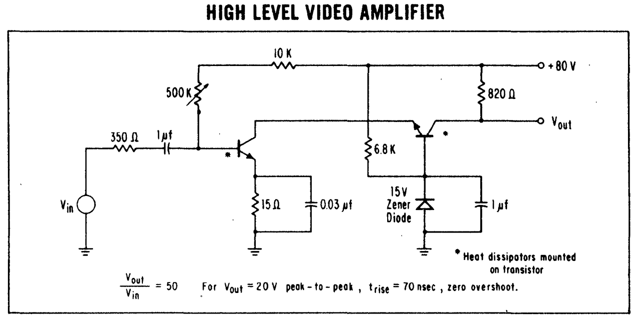
BASE VOLTAGE VERSUS COLLECTOR CURRENT (NON-SATURATED HIGH SPEED PULSE)



TEST AMPLIFIER FOR MEASURING 30MC NEUTRALIZED POWER GAIN AND NOISE FIGURE

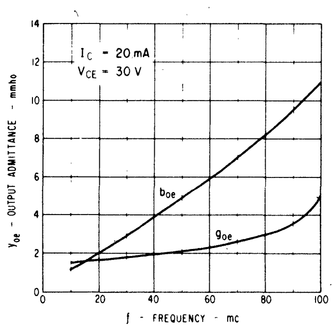


HIGH LEVEL VIDEO AMPLIFIER

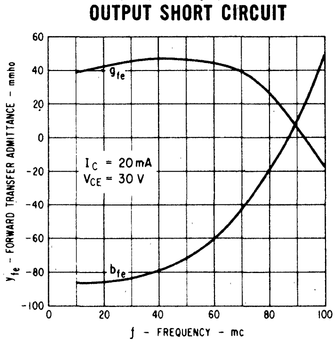


TYPICAL SMALL SIGNAL COMMON EMITTER 'Y' PARAMETERS

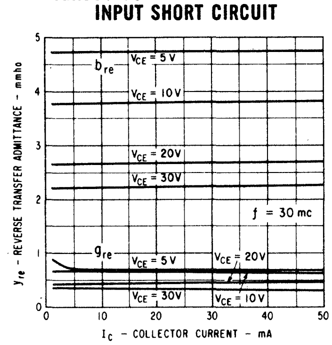
OUTPUT ADMITTANCE VERSUS FREQUENCY—INPUT SHORT CIRCUIT



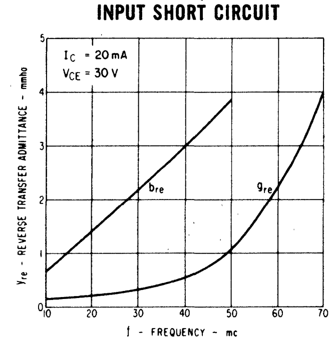
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY—OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT—INPUT SHORT CIRCUIT



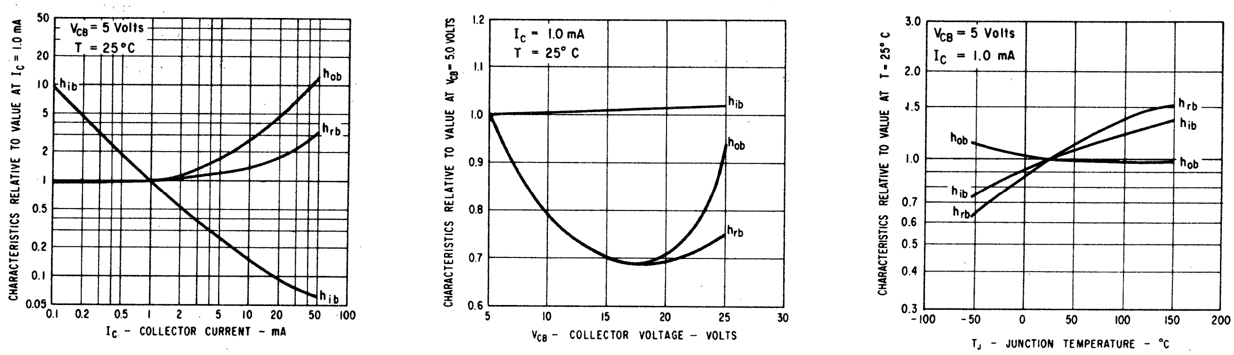
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY—INPUT SHORT CIRCUIT



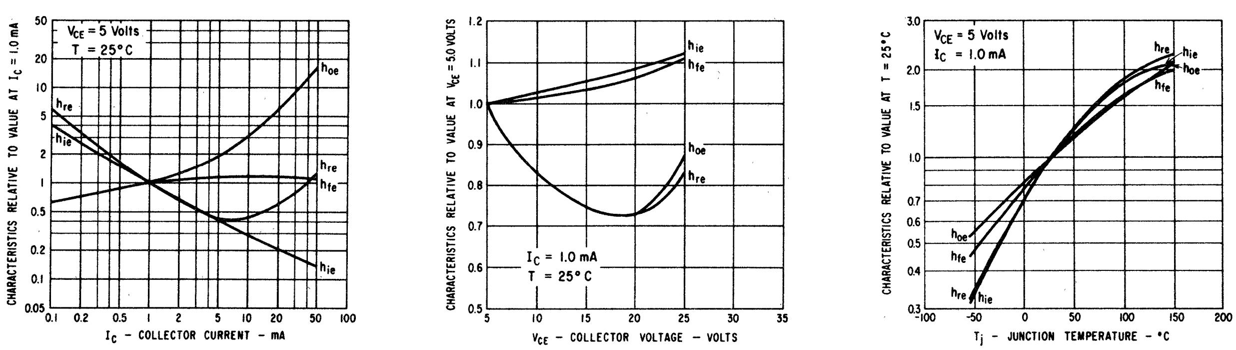
SMALL SIGNAL CHARACTERISTICS (f = 1KC)

SYMBOL	CHARACTERISTICS	Min.	Typ.	Max.	UNITS	TEST CONDITIONS	
h_{ib}	Input Resistance	24	27	34	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
		4.0	6.3	8.0	Ohms	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{rb}	Voltage Feedback Ratio		0.7	3.0	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
			0.8	3.0	$x10^{-4}$	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{fe}	Small Signal Current Gain	30	55	100		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
		35	70	150		$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{ob}	Output Conductance	0.1	0.16	0.5	μmho	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
		0.1	0.19	1.0	μmho	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{ie}	Input Resistance		2.2		K ohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio		3.6		$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance		12.5		μmho	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

TYPICAL COMMON BASE CHARACTERISTICS



TYPICAL COMMON EMITTER CHARACTERISTICS



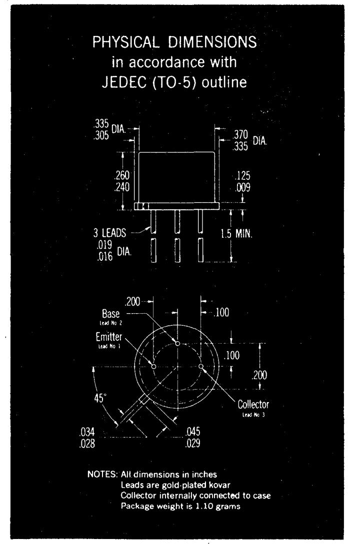
NOTE: All graphs show typical variation with operating point and temperature.

2N698

NPN GENERAL PURPOSE HIGH VOLTAGE TYPE

DIFFUSED SILICON PLANAR* TRANSISTOR

GENERAL DESCRIPTION - NPN double diffused silicon Planar* transistor designed for a wide variety of amplifier, oscillator and switching circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures		
Storage Temperature		-65° C to +300° C
Operating Junction Temperature		+200° C Maximum
Maximum Power Dissipation		
Total Dissipation at Case Temperature	25° C [Note 2 & 3]	3.0 Watts
at Case Temperature	100° C [Note 2 & 3]	1.7 Watts
at Free-Air Temperature	25° C	0.8 Watt
Maximum Voltages		
V_{CBO} Collector to Base Voltage		120 Volts
V_{CER} Collector to Emitter Voltage ($R_{BE} \leq 10\ \Omega$)	[Note 4]	80 Volts
V_{CEO} Collector to Emitter Voltage	[Note 4]	60 Volts
V_{EBO} Emitter to Base Voltage		7.0 Volts

ELECTRICAL CHARACTERISTICS (25° C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain [Note 5]	20	60		I_C = 150 mA V_{CE} = 10 V
V_{BE} (sat)	Base Saturation Voltage		0.9	Volts	I_C = 50 mA I_B = 5.0 mA
V_{CE} (sat)	Collector Saturation Voltage		1.2	Volts	I_C = 50 mA I_B = 5.0 mA
V_{BE} (sat)	Base Saturation Voltage		1.3	Volts	I_C = 150 mA I_B = 15 mA
V_{CE} (sat)	Collector Saturation Voltage		5.0	Volts	I_C = 150 mA I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Output Capacitance		15	pF	I_E = 0 V_{CB} = 10 V
C_{TE}	Emitter Transition Capacitance		85	pF	I_C = 0 V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		5.0	mμA	I_E = 0 V_{CB} = 75 V
I_{CBO} (150° C)	Collector Cutoff Current		15	μA	I_E = 0 V_{CB} = 75 V
BV_{CBO}	Collector to Base Breakdown Voltage	120		Volts	I_C = 100 μA I_E = 0
V_{CER} (sust)	Collector to Emitter Sustaining Voltage [Note 4]	80		Volts	I_C = 100 mA (pulsed) $R_{BE} \leq 10\ \Omega$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 4]	60		Volts	I_C = 30 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0		Volts	I_C = 0 I_E = 100 μA
I_{EBO}	Emitter Cutoff Current		10	mμA	I_C = 0 V_{EB} = 5.0 V

SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{ib}	Input Resistance	20	35	ohms	I_C = 1.0 mA V_{CB} = 5.0 V
			10	ohms	I_C = 5.0 mA V_{CB} = 10 V
h_{rb}	Voltage Feedback Ratio		2.5	$\times 10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
			5.0	$\times 10^{-4}$	I_C = 5.0 mA V_{CB} = 10 V
h_{fe}	Small Signal Current Gain	15			I_C = 1.0 mA V_{CE} = 5.0 V
		25			I_C = 5.0 mA V_{CE} = 10 V
h_{ob}	Output Conductance		0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
			1.0	μmho	I_C = 5.0 mA V_{CB} = 10 V

(See notes on back page)

* Planar is a patented Fairchild process.

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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 operation.

(3) These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 58.3° C/watt (derating factor of 17.2 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse conditions: length = 300 μsec; duty cycle $\leq$ 1%.

2N699 • 2N719 • 2N720

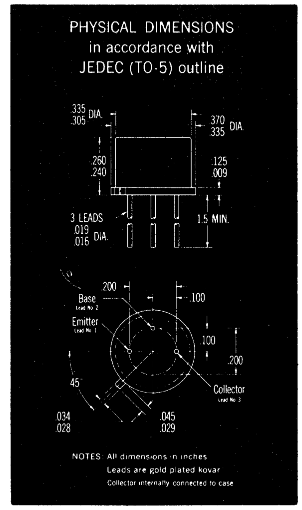
NPN HIGH VOLTAGE TYPES

DIFFUSED SILICON TRANSISTORS

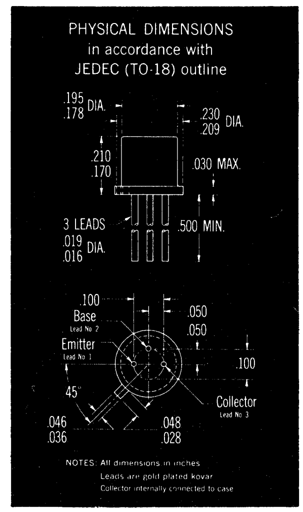
These NPN double-diffused silicon transistors are designed for use in high performance amplifier, oscillator and switching circuits. They provide greater voltage swings in oscillator and amplifier circuits due to their 120 volt collector-to-base voltage rating.

Each transistor is designed to meet the environmental requirements of MIL-S-19500.

The PLANAR versions of these units are 2N699B, 2N1893 and 2N720A.



2N699



2N719 2N720

ABSOLUTE MAXIMUM RATINGS [Note 1]	2N699	2N719 2N720
Maximum Temperatures		
Storage Temperature	−65°C to +300°C	−65°C to +300°C
Operating Junction Temperature	175°C Maximum	175°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature [Note 2 & 3]	2.0 Watts	1.5 Watts
at 100°C Case Temperature [Note 2 & 3]	1.0 Watt	0.75 Watt
at 25°C Ambient Temperature	0.6 Watt	0.4 Watt
Maximum Voltages		
V_{CBO} Collector to Base Voltage	120 Volts	120 Volts
V_{CER} Collector to Emitter Voltage ($R \leq 10\Omega$) [Note 4]	80 Volts	80 Volts
V_{EBO} Emitter to Base Voltage	5.0 Volts	5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTIC	2N699 2N720 MIN.	TYP.	MAX.	2N719 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain [Note 5]	40	80	120	20	40	60		$I_C = 150mA$ $V_{CE} = 10V$
V_{BE} (sat)	Base Saturation Voltage		0.92	1.3		0.92	1.3	Volts	$I_C = 150mA$ $I_B = 15mA$
V_{CE} (sat)	Collector Saturation Voltage		2.5	5.0		2.5	5.0	Volts	$I_C = 150mA$ $I_B = 15mA$
C_{ob}	Output Capacitance		12	20		12	20	pf	$I_E = 0$ $V_{CB} = 10V$
h_{fe}	High Frequency Current Gain f = 20 mc	2.5	4.0		2.0				$I_C = 50mA$ $V_{CE} = 10V$
I_{CBO}	Collector Cutoff Current			2.0			2.0	μA	$I_E = 0$ $V_{CB} = 60V$
I_{CBO} (150°C)	Collector Cutoff Current		1.5	200		1.5	200	μA	$I_E = 0$ $V_{CB} = 60V$
I_{EBO}	Emitter Cutoff Current			100†				μA	$I_C = 0$ $V_{EB} = 2.0V$

† 2N699 only.

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 175°C and junction-to-case thermal resistance of 100°C/watt (derating factor of 10mW/°C) for the 2N719 and 2N720; junction-to-case thermal resistance of 75°C/watt (derating factor of 13.3 mW/°C) for the 2N699.
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

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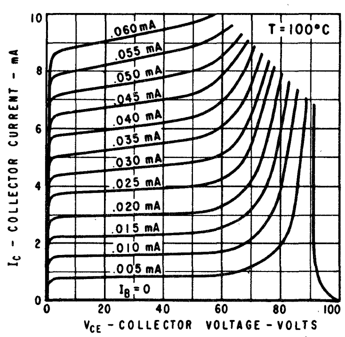
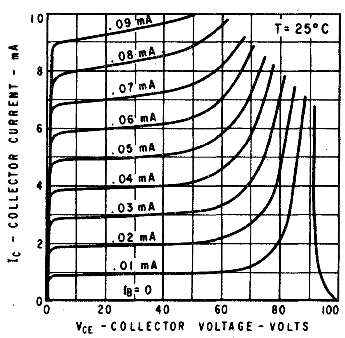
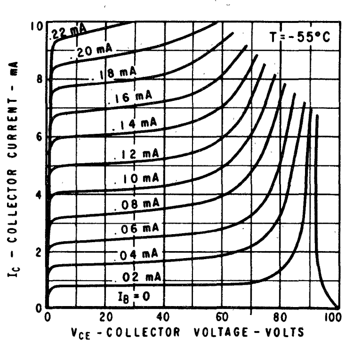
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

HIGH VOLTAGE

COLLECTOR CHARACTERISTICS

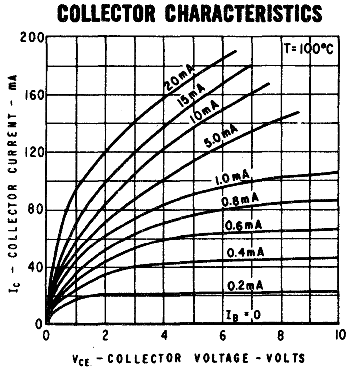


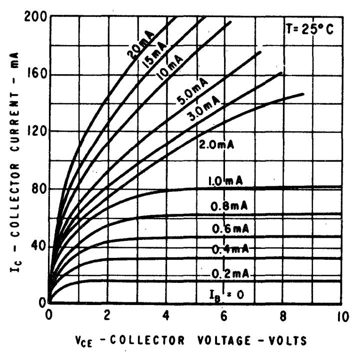


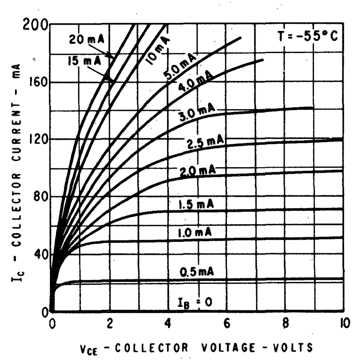


SATURATION REGION

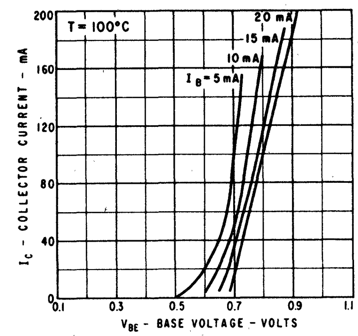
COLLECTOR CHARACTERISTICS

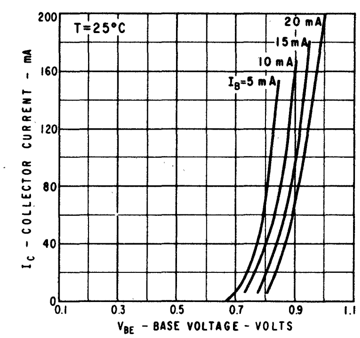


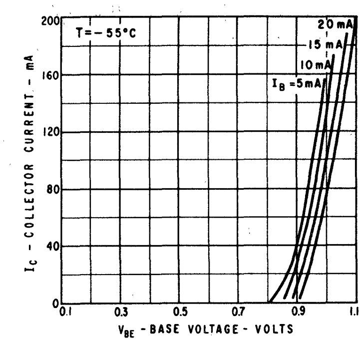




BASE CHARACTERISTICS

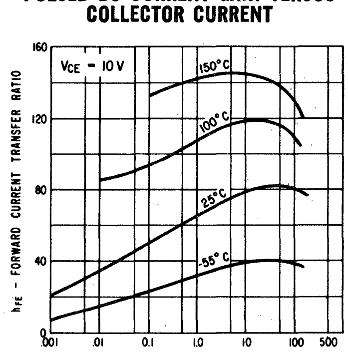




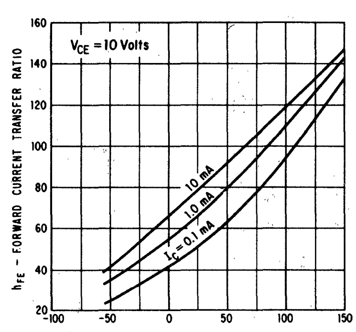


TYPICAL ELECTERICAL CHARACTERISTICS

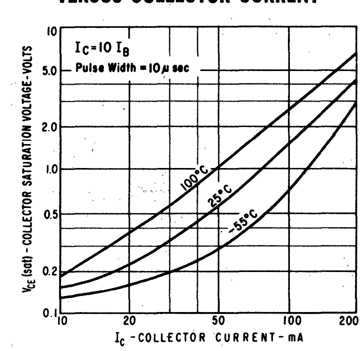
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VERSUS TEMPERATURE

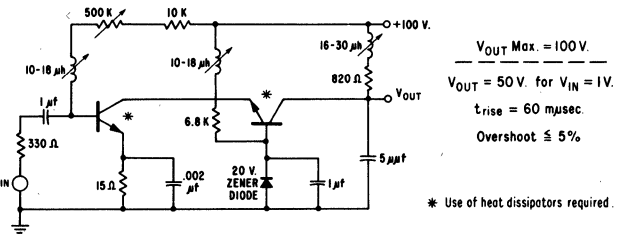


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

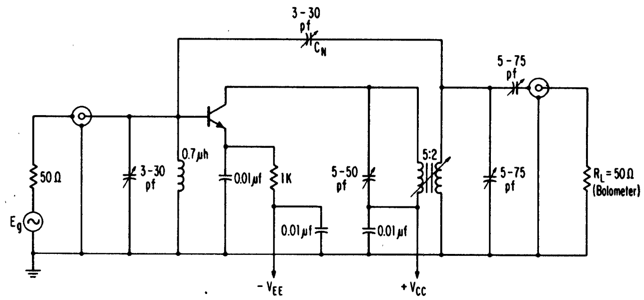


TYPICAL HF AND VHF CHARACTERISTICS

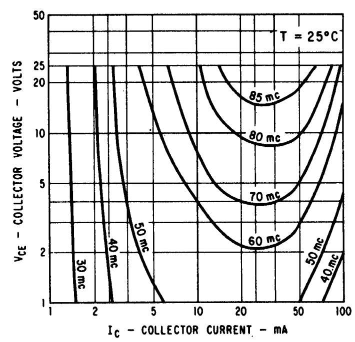
HIGH VOLTAGE OUTPUT VIDEO AMPLIFIER



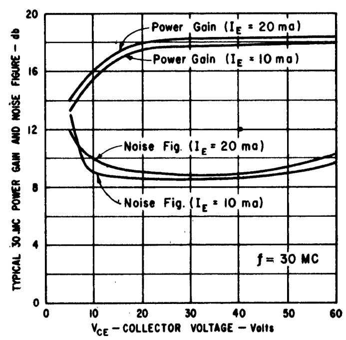
TEST AMPLIFIER FOR MEASURING 30 MC NEUTRALIZED POWER GAIN AND NOISE FIGURE



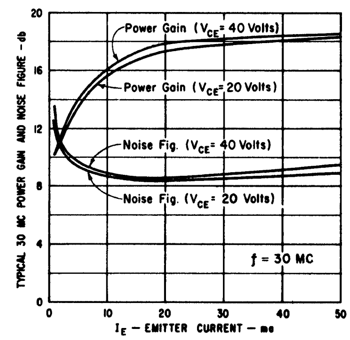
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



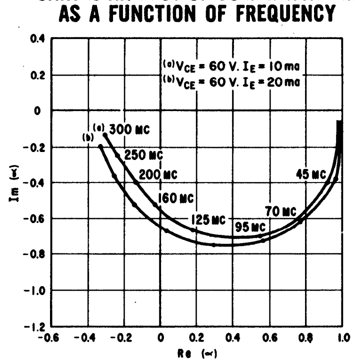
30 MC POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR VOLTAGE



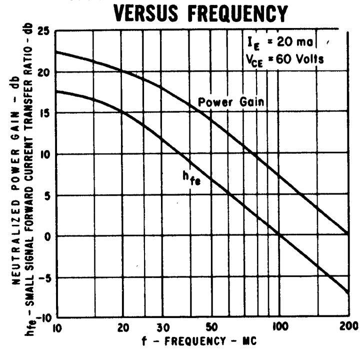
30 MC POWER GAIN AND NOISE FIGURE VERSUS EMITTER CURRENT



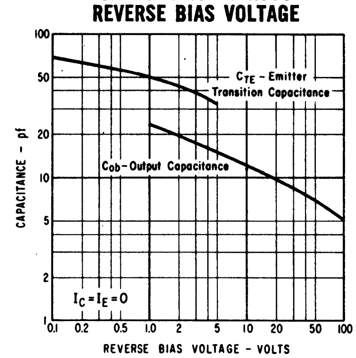
CARTESIAN PLOT OF COMPLEX ALPHA AS A FUNCTION OF FREQUENCY



NEUTRALIZED POWER GAIN AND SMALL SIGNAL CURRENT GAIN VERSUS FREQUENCY

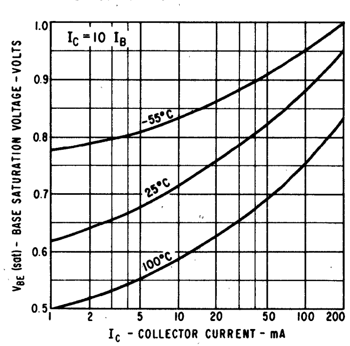


INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

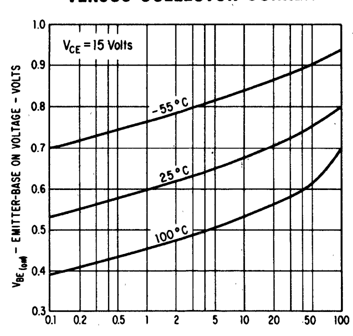


TYPICAL ELECTRICAL CHARACTERISTICS

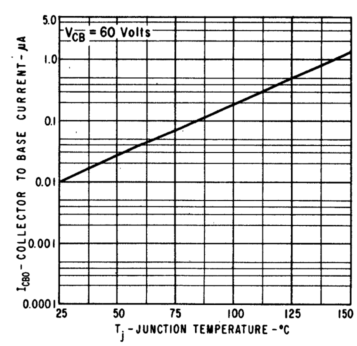
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT



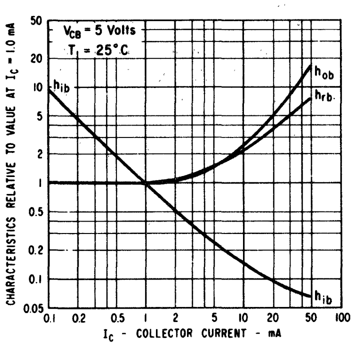
COLLECTOR-BASE DIODE REVERSE CURRENT VS. TEMPERATURE

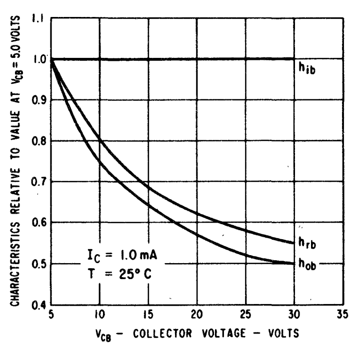


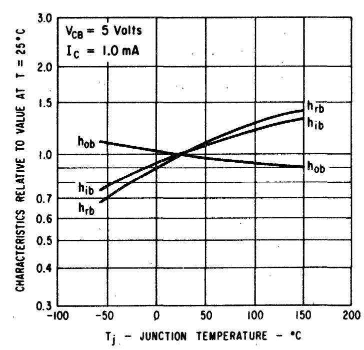
SMALL SIGNAL CHARACTERISTICS (f=1kc)

SYMBOL	CHARACTERISTICS	2N699 2N720 MIN.	2N699 2N720 TYP.	2N699 2N720 MAX	2N719 MIN.	2N719 TYP.	2N719 MAX	UNITS	TEST CONDITIONS	
h_{ib}	Input Resistance	20	27	30	20	27	35	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
			6.3	10		6.3		Ohms	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{ob}	Output Conductance	0.1	0.12	0.5	0.1	0.12	0.5	μmho	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
			0.13	1.0		0.13	1.0	μmho	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{rb}	Voltage Feedback Ratio		0.4	2.5		0.25	5.0	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
			0.5	3.0		0.4		$x10^{-4}$	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{fe}	Small Signal Current Gain	35	60	100	15	35			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
		45	75		25	45			$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{ie}	Input Resistance		750			600		Ohms	$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{oe}	Output Conductance		16			25		μmho	$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{re}	Voltage Feedback Ratio		1.05			0.9		$x10^{-4}$	$I_C = 5.0$ mA	$V_{CE} = 10$ V

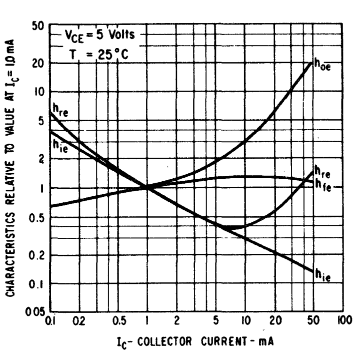
TYPICAL COMMON BASE CHARACTERISTICS

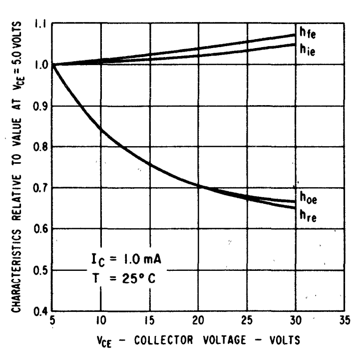


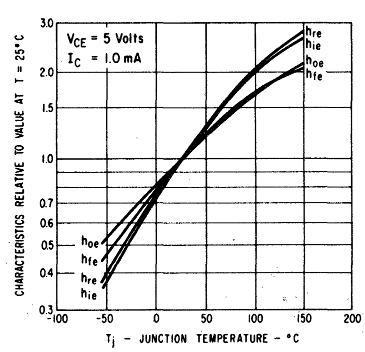




TYPICAL COMMON EMITTER CHARACTERISTICS







FAIRCHILD
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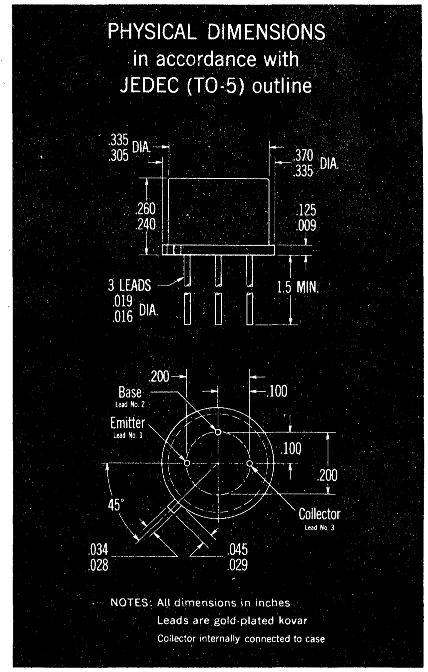
2N699B • 2N1893

NPN GENERAL PURPOSE HIGH VOLTAGE TYPE

DIFFUSED SILICON PLANAR TRANSISTORS

GENERAL DESCRIPTION The 2N699B • 2N1893 are High-Voltage, NPN Double-Diffused Silicon Planar Transistors designed for use in high-performance amplifier, oscillator and switching circuits. The 2N699B is rated at 5.0 watts and the 2N1893 at 3.0 watts.

These transistors provide greater voltage swings in oscillator and amplifier circuits and more protection in inductive switching circuits due to their 120 volt collector-to-base voltage rating. Both transistors are designed to meet the environmental requirements of MIL-S-19500.



ABSOLUTE MAXIMUM RATINGS

		2N699 B	2N1893
Maximum Temperatures			
Storage Temperature		-65°C to +300°C	-65°C to +300°C
Operating Junction Temperature		200°C Maximum	200°C Maximum
Lead Temperature (Soldering, No Time Limit)		300°C Maximum	300°C Maximum
Maximum Power Dissipation (Notes 2 and 3)			
Total Dissipation at 25°C Case Temperature		5.0 Watts	3.0 Watts
at 100°C Case Temperature		2.8 Watts	1.7 Watts
at 25°C Ambient Temperature		0.87 Watt	0.8 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	120 Volts	120 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\,\Omega$) (Note 4)	100 Volts	100 Volts
V_{CEO}	Collector to Emitter (Note 4)	80 Volts	80 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts

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

Symbol	†FACT Subgroup	Characteristic	2N699B Min.	2N699B Typ.	2N699B Max.	2N1893 Min.	2N1893 Typ.	2N1893 Max.	Units	Test Conditions
$*h_{FE}$	1a	DC Pulse Current Gain (Note 5)	40	80	120	40	80	120		I_C = 150 mA V_{CE} = 10 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	35	80		35	80			I_C = 10 mA V_{CE} = 10 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 5)	20	40		20	40			I_C = 10 mA V_{CE} = 10 V
h_{FE}	4	DC Current Gain	20	50		20	50			I_C = 0.1 mA V_{CE} = 10 V
$*V_{BE}$(sat)	1a	Base Saturation Voltage		0.82	1.0		0.82	0.9	Volts	I_C = 50 mA I_B = 5.0 mA
$*V_{CE}$(sat)	1a	Collector Saturation Voltage		0.5	1.2		0.5	1.2	Volts	I_C = 50 mA I_B = 5.0 mA
V_{BE}(sat)	4	Base Saturation Voltage		0.96	1.3		0.96	1.3	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	4	Collector Saturation Voltage		2.0	5.0		2.0	5.0	Volts	I_C = 150 mA I_B = 15 mA
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	3.0	3.5		2.5	3.5			I_C = 50 mA V_{CE} = 10 V

†NOTE: These numerals apply to the Fairchild FACT Program.
*NOTE: FACT program End-Point Measurement Parameter.

Additional Electrical Characteristics on page 4

NOTES:

(1) These ratings are limiting values above which the serviceability of any 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 35°C/Watt (derating factor of 28.6 mW/°C) for the 2N699B; for the 2N1893 58.3°C/Watt (derating factor of 17.2 mW/°C). Junction-to-ambient thermal resistance of 201°C/Watt (derating factor of 4.97 mW/°C) for 2N699B; for the 2N1893 219°C/Watt (derating factor of 4.56 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

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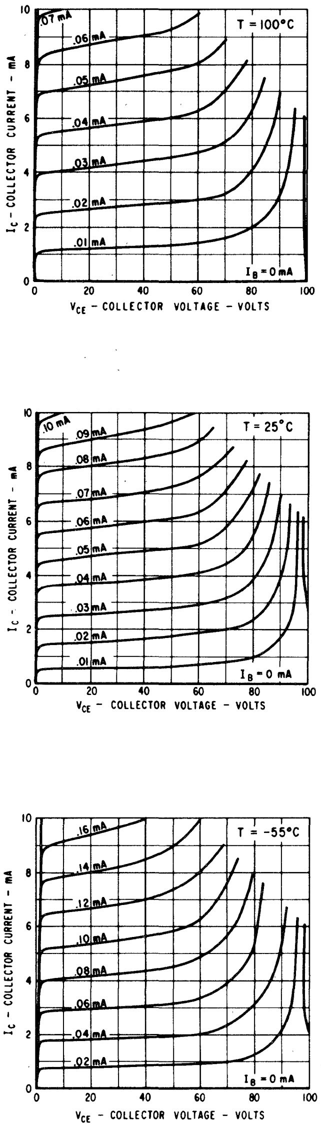
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

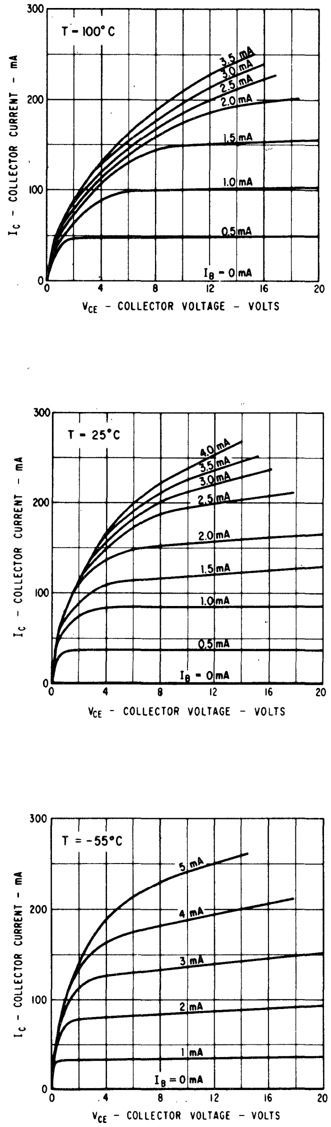
HIGH VOLTAGE

COLLECTOR CHARACTERISTICS

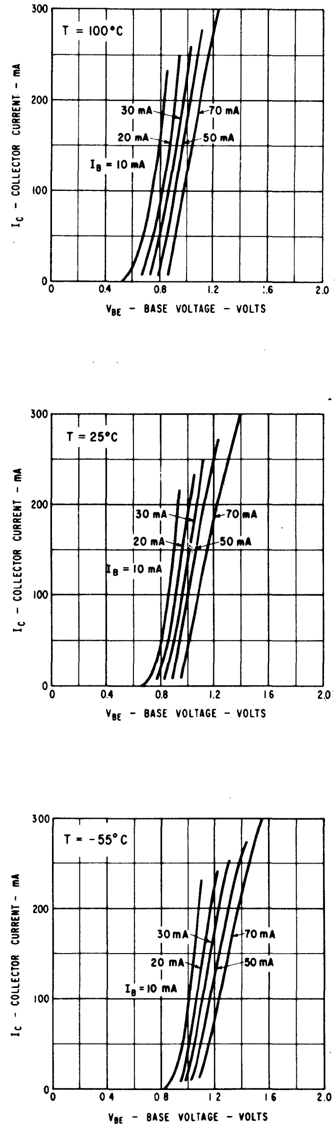


SATURATION REGION

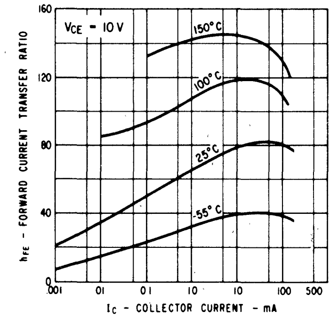
COLLECTOR CHARACTERISTICS



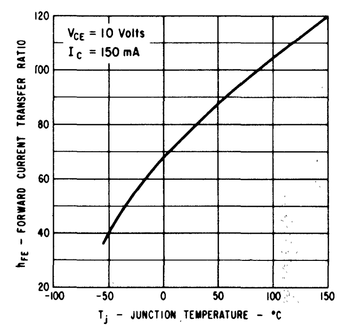
BASE CHARACTERISTICS



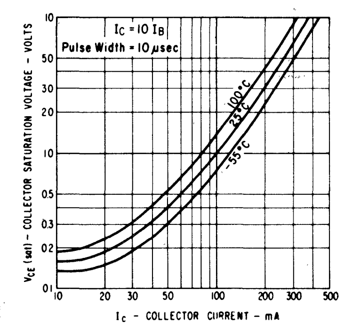
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VERSUS TEMPERATURE



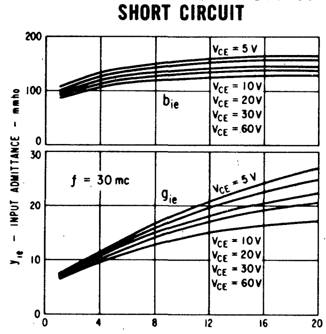
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



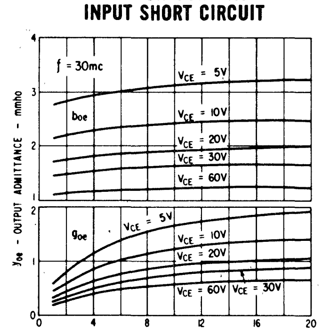
*Single family characteristics on Transistor Curve Tracer.

TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

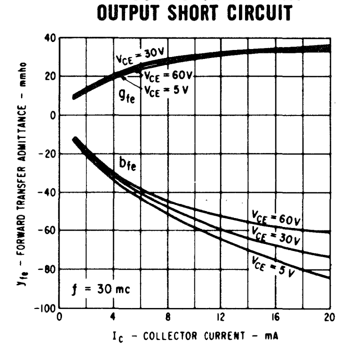
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



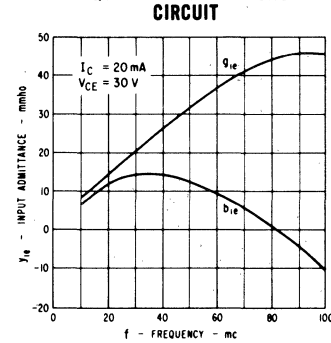
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT

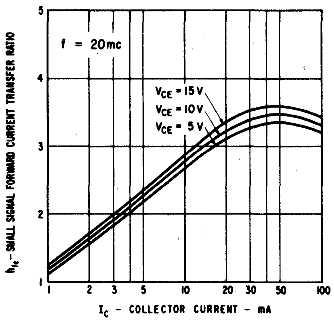


INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT

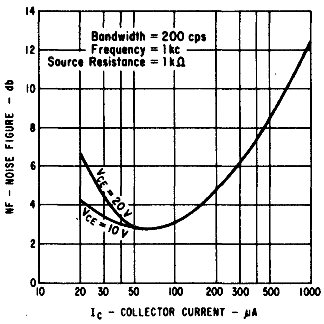


TYPICAL ELECTRICAL CHARACTERISTICS

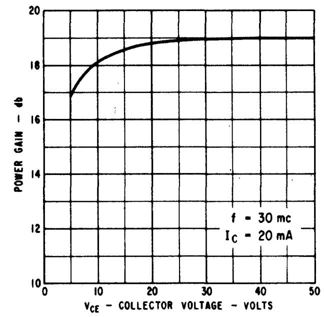
SMALL SIGNAL CURRENT GAIN AT 20 MC VERSUS COLLECTOR CURRENT



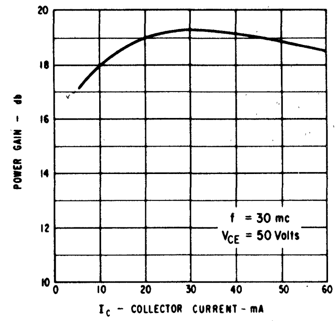
NOISE FIGURE VERSUS COLLECTOR CURRENT



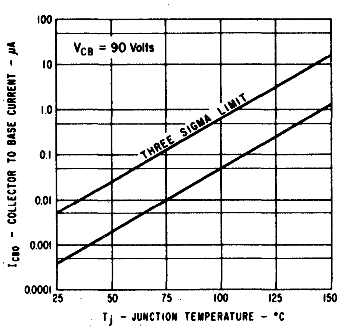
30 MC POWER GAIN VERSUS COLLECTOR VOLTAGE



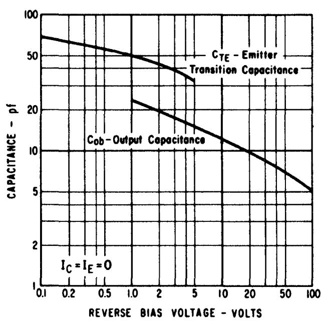
30 MC POWER GAIN VERSUS COLLECTOR CURRENT



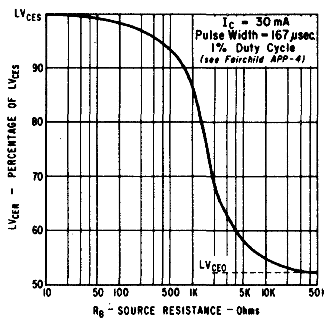
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



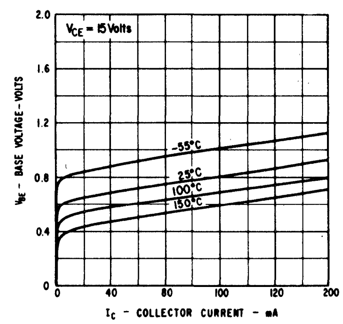
COLLECTOR AND EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



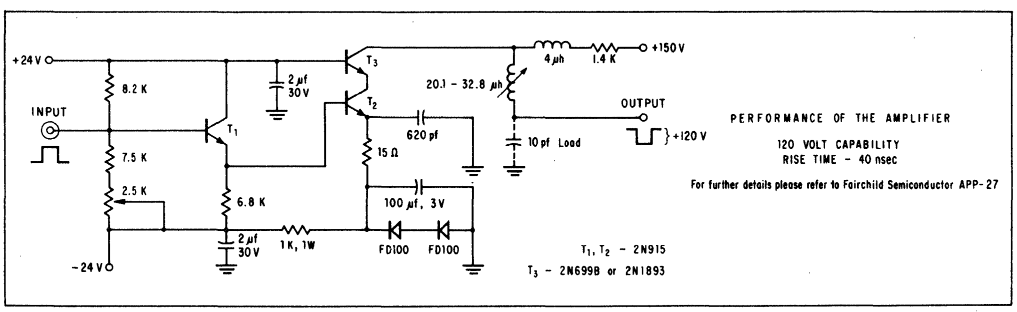
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



BASE VOLTAGE VERSUS COLLECTOR CURRENT (NON-SATURATED HIGH SPEED PULSE)

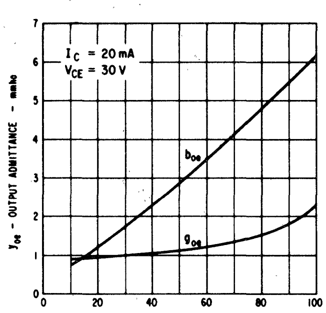


DIRECT-COUPLED VIDEO AMPLIFIER

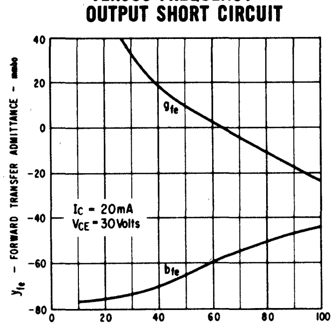


TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

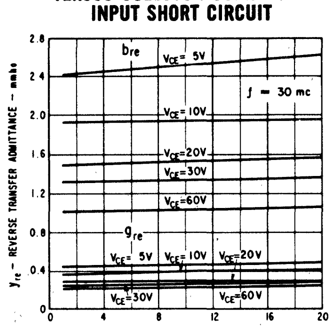
OUTPUT ADMITTANCE VERSUS FREQUENCY—INPUT SHORT CIRCUIT



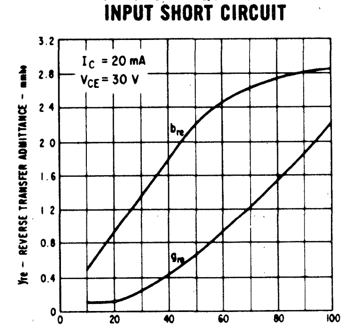
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY—OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLCTOR CURRENT—INPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY—INPUT SHORT CIRCUIT



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

Symbol	†FACT Subgroup	Characteristic	2N699B Min.	2N699B Typ.	2N699B Max.	2N1893 Min.	2N1893 Typ.	2N1893 Max.	Units	Test Conditions	
C_{obo}	4	Output Capacitance		13	15		13	15	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	4	Emitter Transition Capacitance		55	85		55	85	pf	I_C = 0	V_{EB} = 0.5 V
*I_{CBO}	1b	Collector Cutoff Current		0.3	10		0.3	10	nA	I_E = 0	V_{CB} = 90 V
I_{CBO}(150°C)	4	Collector Cutoff Current		1.5	15		1.5	15	μA	I_E = 0	V_{CB} = 90 V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	120			120			Volts	I_C = 100 μA	I_E = 0
V_{CER}(sust)	4	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	100			100			Volts	I_C = 100 mA (pulsed)	$R_{BE} \leq$ 10 Ω
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	80			80			Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	7.0			7.0			Volts	I_C = 0	I_E = 100 μA
*I_{EBO}	1b	Emitter Current		0.05	10		0.05	10	nA	I_C = 0	V_{EB} = 5.0 V

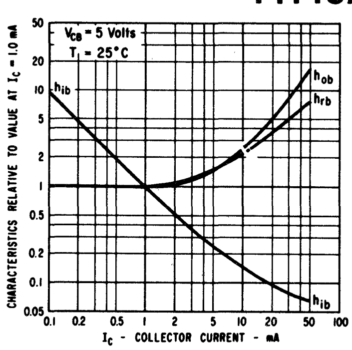
†NOTE: These numerals apply to the Fairchild FACT Program.
*NOTE: FACT program End-Point Measurement Parameter.

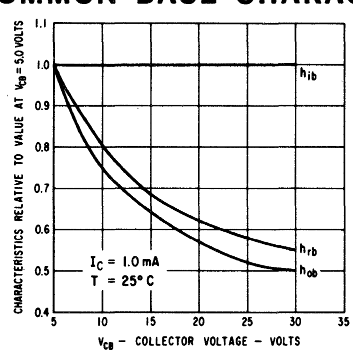
SMALL SIGNAL CHARACTERISTICS (f = 1 KC)

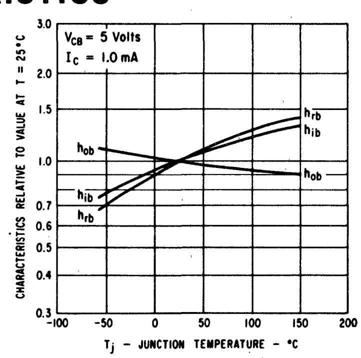
Symbol	†FACT Subgroup	Characteristic	2N699B Min.	2N699B Typ.	2N699B Max.	2N1893 Min.	2N1893 Typ.	2N1893 Max.	Units	Test Conditions	
h_{ib}	4	Input Resistance	20	27	30	20	27	30	Ohms	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{ib}	4	Input Resistance	4.0	6.4	8.0	4.0	6.4	8.0	Ohms	I_C = 5.0 mA	V_{CB} = 10 V
h_{rb}	4	Voltage Feedback Ratio		0.5	1.25		0.5	1.25	$x10^{-4}$	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{rb}	4	Voltage Feedback Ratio		0.6	1.50		1.6	1.50	$x10^{-4}$	I_C = 5.0 mA	V_{CB} = 10 V
h_{fe}	4	Small Signal Current Gain	35	70	100	30	70	100		I_C = 1.0 mA	V_{CE} = 5.0 V
h_{fe}	4	Small Signal Current Gain	45	85		45	85			I_C = 5.0 mA	V_{CE} = 10 V
h_{ob}	4	Output Conductance	0.1	0.12	0.5		0.12	0.5	μmho	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{ob}	4	Output Conductance		0.14	0.5		0.14	0.5	μmho	I_C = 5.0 mA	V_{CB} = 10 V
h_{ie}	4	Input Resistance		2.8			2.8		Kohms	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{re}	4	Voltage Feedback Ratio		3.5			3.5		$x10^{-4}$	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{oe}	4	Output Conductance		11			11		μmho	I_C = 1.0 mA	V_{CE} = 5.0 V

†NOTE: These numerals apply to the Fairchild FACT Program.

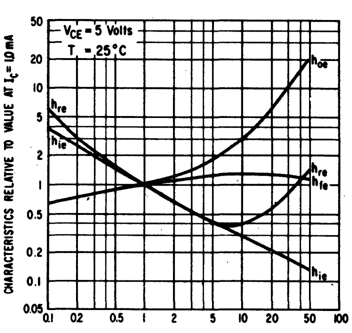
TYPICAL COMMON BASE CHARACTERISTICS

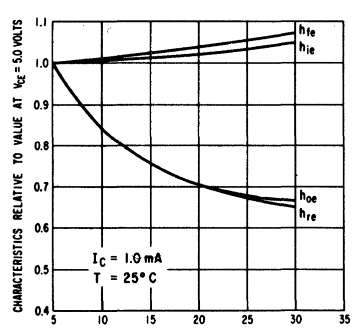


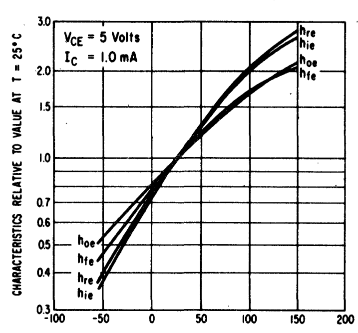




TYPICAL COMMON EMITTER CHARACTERISTICS







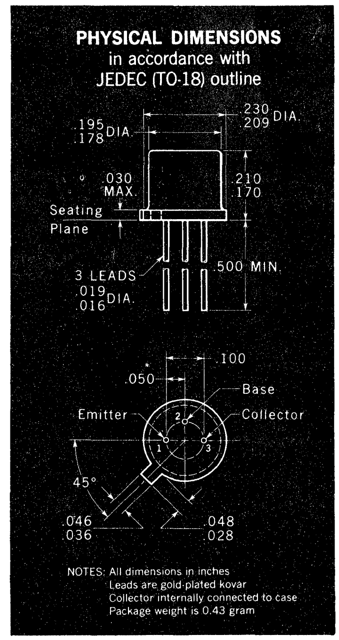
2N703

NPN HIGH-SPEED, HIGH-CURRENT SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N916

GENERAL DESCRIPTION - The Fairchild 2N703 is an NPN silicon PLANAR transistor designed primarily for low power, non-saturating switching applications and high frequency amplifier and oscillator circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature		-65°C to +175°C
Operating Junction Temperature		175°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.6 Watt
at 25°C Ambient Temperature	(Notes 2 and 3)	0.3 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		25 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	25 Volts
V_{EBO}	Emitter to Base Voltage		5.0 Volts
I_C	Collector Current		50 mA

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

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain [Note 5]	40	100		I_C = 10 mA	V_{CE} = 5.0 V
h_{FE}(-55°C)	DC Current Gain [Note 5]	20			I_C = 10 mA	V_{CE} = 5.0 V
V_{CE}(sat)	Collector Saturation Voltage [Note 5]		0.5	Volts	I_C = 10 mA	I_B = 0.5 mA
V_{BE}	Base to Emitter Voltage	0.7	0.95	Volts	I_C = 10 mA	V_{CE} = 5.0 V
I_{CBO}	Collector Cutoff Current		0.5	μA	V_{CB} = 10 V	I_E = 0
I_{CBO}(150°C)	Collector Cutoff Current		50	μA	V_{CB} = 10 V	I_E = 0
I_{CEO}	Collector Cutoff Current		10	μA	V_{CE} = 20 V	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	25		Volts	I_{CBO} = 5.0 μA	I_E = 0
BV_{CEO}	Collector to Emitter Breakdown Voltage	25		Volts	I_{CEO} = 2.0 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	I_{EBO} = 10 μA	I_C = 0
C_{ob}	Output Capacitance (f = 1.0 mc)		6.0	pf	V_{CB} = 5.0 V	I_E = 0
f_T	Gain Bandwidth Product	70		mc	V_{CE} = 5.0 V	I_E = -10 mA

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 175°C and junction-to-case thermal resistance of 250°C/Watt (derating factor of 4.0 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. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≈ 2%.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

2N706

NPN HIGH SPEED SATURATED SWITCH

SILICON PLANAR* TRANSISTOR

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 second time limit)	300°C Maximum

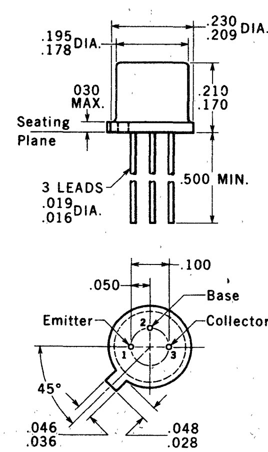
Maximum Voltages

V_{CBO}	Collector to Base Voltage	25 V
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\ \Omega$) (Note 2)	20 V
V_{EBO}	Emitter to Base Voltage	3 V

Maximum Power Dissipation

Total Dissipation at Case Temperature 25°C (Note 3)	1.0 Watt
at Case Temperature 100°C	0.5 Watt
at Free Air Temperature 25°C	0.3 Watt

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 0.44 gram

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 4)	20				$I_C = 10$ mA	$V_{CE} = 1.0$ V
$V_{BE(sat)}$	Base Saturation Voltage		0.75	0.9	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{CE(sat)}$	Collector Saturation Voltage		0.3	0.6	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
h_{fe}	Small Signal Current Gain (f = 100 MHz)	2.0	4.0			$I_C = 10$ mA	$V_{CE} = 15$ V
C_{obo}	Collector Capacitance		5.0	6.0	pF	$I_E = 0$	$V_{CB} = 10$ V
I_{CBO}	Collector Cutoff Current		0.005	0.05	μA	$V_{CB} = 15$ V	$I_E = 0$
I_{CBO}(150°C)	Collector Cutoff Current		3.5	30	μA	$V_{CB} = 15$ V	$I_E = 0$
τ_s	Charge Storage Time Constant (See Fairchild 2N708 Data Sheet for exact circuit)		16	60	ns	$I_C = 10$ mA $I_{B1} = I_{B2} = 10$ mA	$V_{CC} = 10$ V $R_L = 1$ kΩ

*Planar is a patented Fairchild process.

NOTES:

(1) The maximum ratings are limiting absolute values above which life or satisfactory performance may be impaired.
(2) 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) These ratings give maximum junction temperature of 175°C and junction to case thermal resistance of 150°C/watt (derating factor of 6.7 mW/°C).
(4) Pulse conditions: Length = 300 μs; duty cycle ≤ 1%.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

2N708

NPN HIGH-FREQUENCY AND LOW-STORAGE

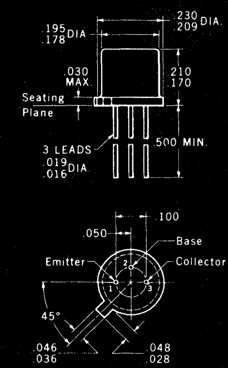
DIFFUSED SILICON PLANAR* TRANSISTOR

The 2N708 is an NPN silicon transistor designed specifically as a high-speed saturated logic switch to replace the 2N706 (A, B), 2N753 mesa series. In addition the 2N708 is oriented toward Satellite and Conventional small-signal, RF, and all digital type circuits.

The Fairchild PLANAR structure extends the range of useful current gain down to the microampere region. Other features are lower leakage current, increased maximum ratings, reduced storage time, higher beta, and lower saturation voltage relative to its predecessors.

Typical three sigma limits for B E T A and S A T U R A T E D V_{CE} are included to completely characterize the 2N708 as a switch, thus promoting design over a wide family of operating conditions. These transistors are designed to meet the environmental requirements of MIL-S-19500.

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 +300°C
Operating Junction Temperature			200°C Maximum
Lead Temperature (Soldering, No Time Limit)			300°C Maximum
Maximum Power Dissipation			
Total Dissipation at Case Temperature	25°C	[Note 2 & 3]	1.2 Watts
at Case Temperature	100°C	[Note 2 & 3]	.68 Watt
at Ambient Temperature	25°C	[Note 2 & 3]	.36 Watt
Maximum Voltages			
V_{CBO} Collector to Base Voltage			40 Volts
V_{CER} Collector to Emitter Voltage ($R_{BE} \leq 10\ \Omega$)		[Note 4]	20 Volts
V_{CEO} Collector to Emitter Voltage		[Note 4]	15 Volts
V_{EBO} Emitter to Base Voltage			5.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	30	120		$I_C = 10$ mA	$V_{CE} = 1.0$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	15			$I_C = 10$ mA	$V_{CE} = 1.0$ V
h_{FE}	DC Current Gain	15			$I_C = 0.5$ mA	$V_{CE} = 1.0$ V
V_{BE} (sat)	Base Saturation Voltage	.72	.80	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		.40	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE} (sat)	Base Saturation Voltage (−55°C)		.90	Volts	$I_C = 7.0$ mA	$I_B = 0.7$ mA
V_{CE} (sat)	Collector Saturation Voltage (−55°C to +125°C)		.40	Volts	$I_C = 7.0$ mA	$I_B = 0.7$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0			$I_C = 10$ mA	$V_{CE} = 10$ V
C_{ob}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 10$ V
r_b'	Base Spreading Resistance [Note 6] (f = 300 MHz)		50	ohms	$I_C = 10$ mA	$V_{CE} = 10$ V
I_{CBO}	Collector Cutoff Current		25	mμA	$I_E = 0$	$V_{CB} = 20$ V
I_{CBO} (150°C)	Collector Cutoff Current		15	μA	$I_E = 0$	$V_{CB} = 20$ V
BV_{CBO}	Collector to Base Breakdown Voltage	40		Volts	$I_C = 1.0\ \mu$A	$I_E = 0$
V_{CER} (sust)	Collector to Emitter Sustaining Voltage [Note 4 & 5]	20		Volts	$I_C = 30$ mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 4 & 5]	15		Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	$I_C = 0$	$I_E = 10\ \mu$A
I_{EBO}	Emitter Cutoff Current		0.1	μA	$I_C = 0$	$V_{EB} = 4.0$ V
I_{CEX} (125°C)	Collector-Emitter Cutoff Current		10	μA	$V_{CE} = 20$V	$V_{BE} = .25$ V
τ_s	Charge Storage Time Constant [Note 7] [See circuit of page 3]		25	nsec	$I_C = I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA	
t_{on}	Turn On Time [See circuit on page 4]		40	nsec	$I_C \approx 10$ mA, $I_{B1} \approx 3.0$ mA, $V_{BE} = -2.0$ V	
t_{off}	Turn Off Time [See circuit on page 4]		75	nsec	$I_C \approx 10$ mA, $I_{B1} \approx 3.0$ mA, $I_{B2} \approx -1.0$ mA	

* Planar is a patented Fairchild process.

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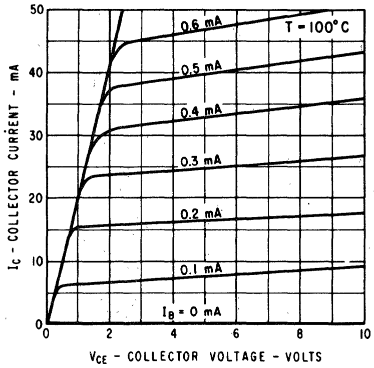
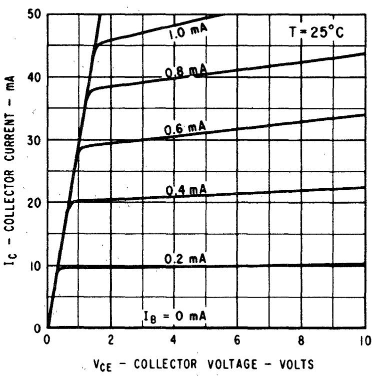
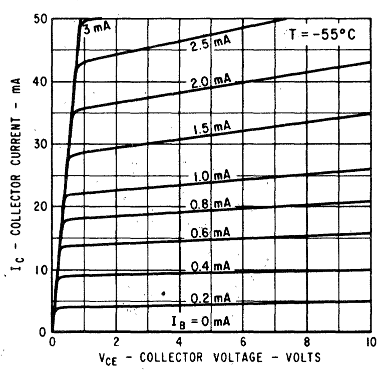
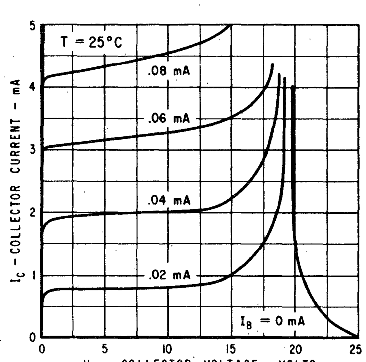
TYPICAL ELECTRICAL CHARACTERISTICS

TYPICAL COLLECTOR CHARACTERISTICS*

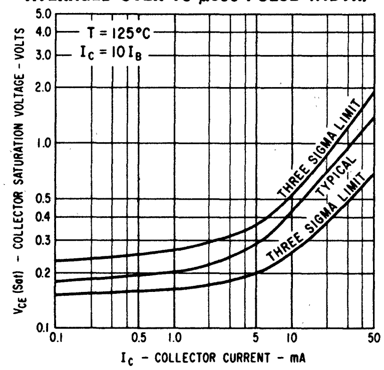


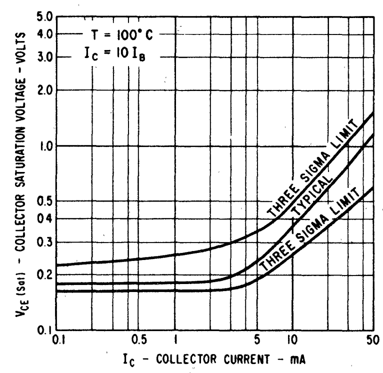


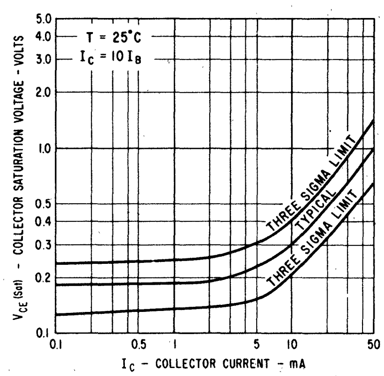




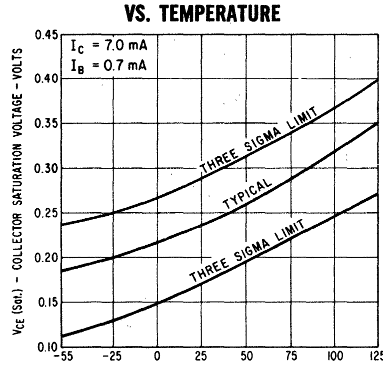
COLLECTOR SATURATION VOLTAGE CHARACTERISTICS (VOLTAGE AVERAGED OVER 10 μsec PULSE WIDTH)



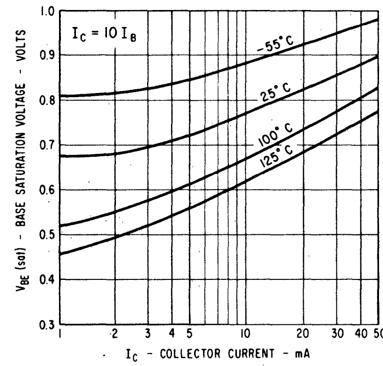




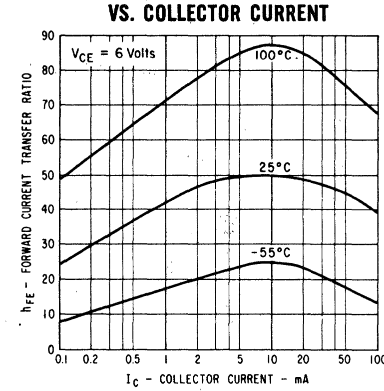
COLLECTOR SATURATION VOLTAGE VS. TEMPERATURE



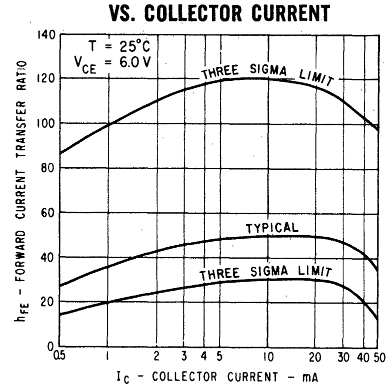
BASE SATURATION VOLTAGE VS. COLLECTOR CURRENT



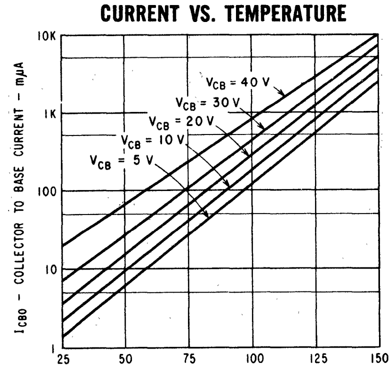
PULSED DC CURRENT GAIN VS. COLLECTOR CURRENT



PULSED DC CURRENT GAIN VS. COLLECTOR CURRENT



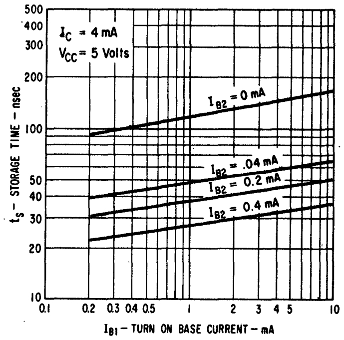
COLLECTOR-BASE DIODE REVERSE CURRENT VS. TEMPERATURE

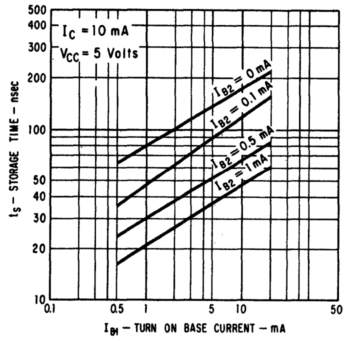


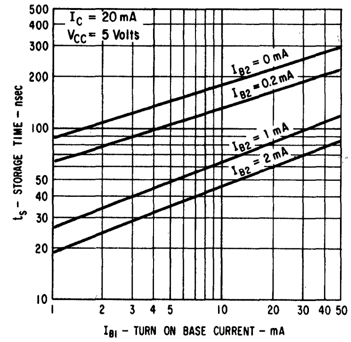
*** Single family characteristics on Transistor Curve Tracer.**

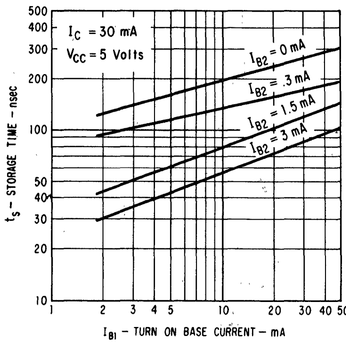
SATURATED SWITCHING CHARACTERISTICS-TYPICAL DELAY, RISE, STORAGE AND FALL TIMES

STORAGE TIME VS. TURN ON BASE CURRENT

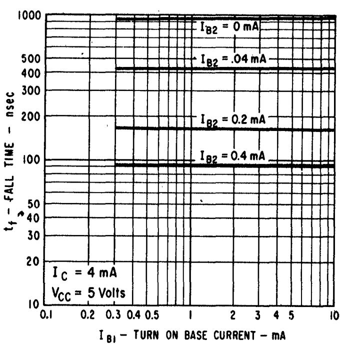


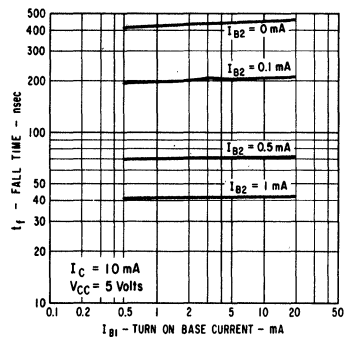


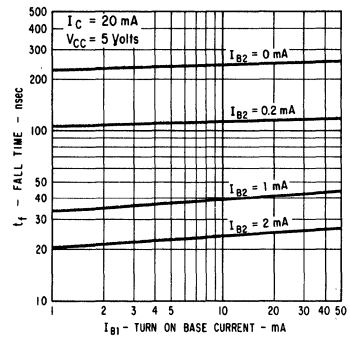


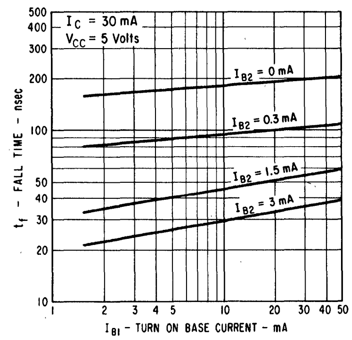


FALL TIME VS. TURN ON BASE CURRENT

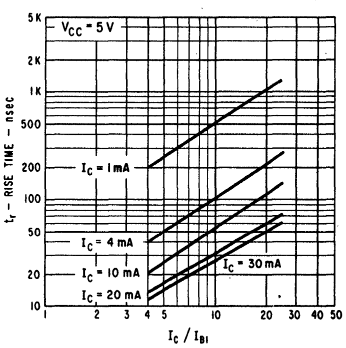




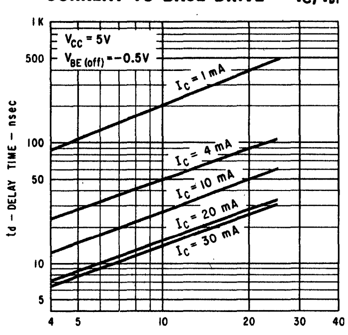




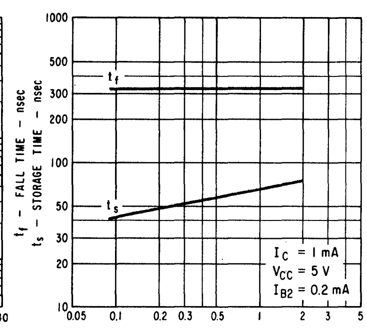
RISE TIME VS. RATIO OF COLLECTOR CURRENT TO BASE DRIVE — I_C/I_{B1}



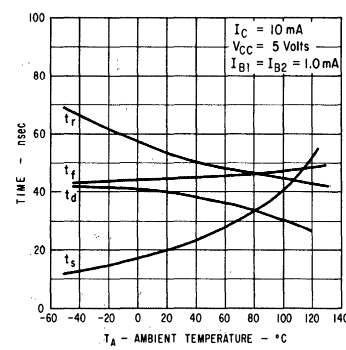
DELAY TIME VS. RATIO OF COLLECTOR CURRENT TO BASE DRIVE — I_C/I_{B1}



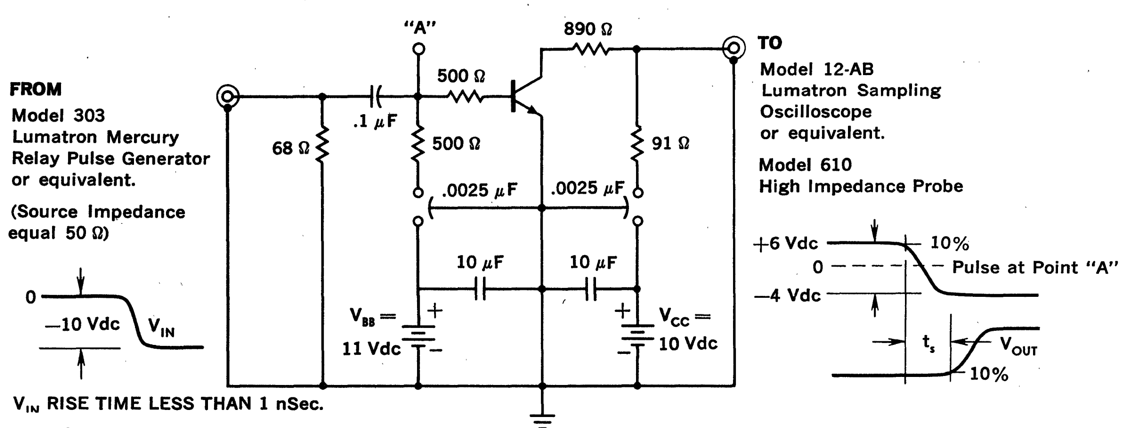
STORAGE AND FALL TIMES VS. TURN ON BASE CURRENT



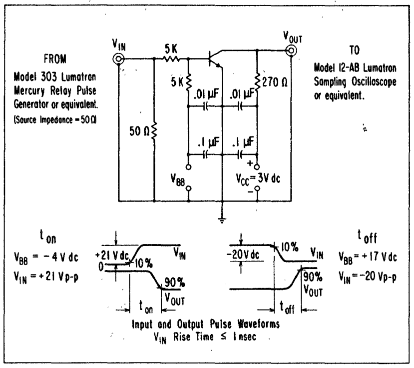
SWITCHING TIMES VS. TEMPERATURE



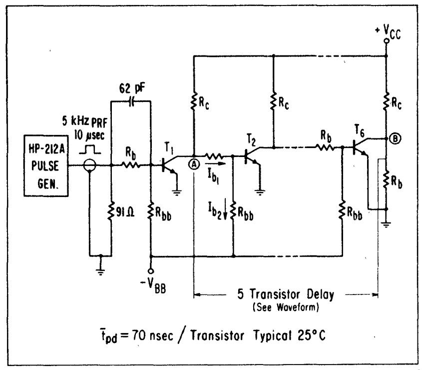
CHARGE STORAGE TIME CONSTANT TEST CIRCUIT AND WAVEFORMS



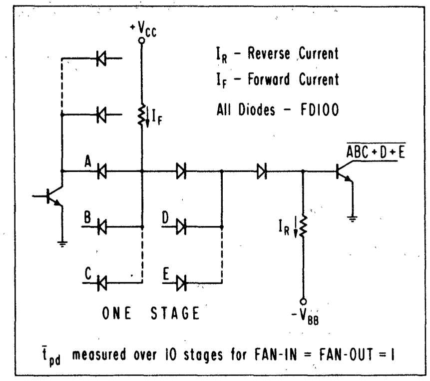
T_{on} AND T_{off} TEST CIRCUIT



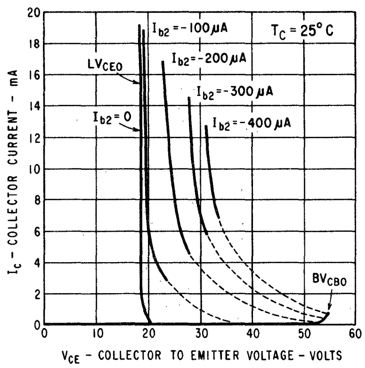
TRL PROPAGATION DELAY MEASUREMENT CIRCUIT



LOW-POWER AND-OR-NOT LOGIC CIRCUIT

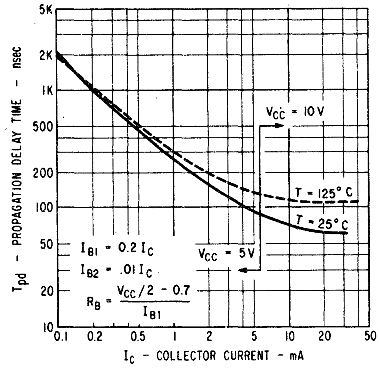


COLLECTOR BREAKDOWN CHARACTERISTICS VS. REVERSE BASE CURRENT



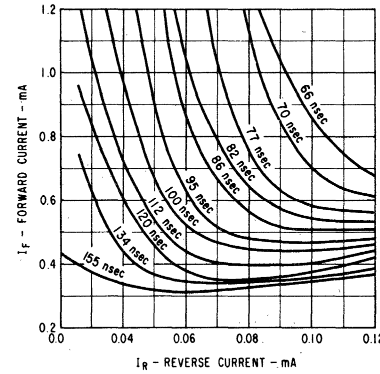
TRL PROPAGATION DELAY TIME VS. COLLECTOR CURRENT

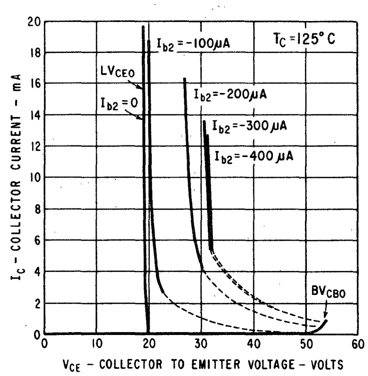
[Measured in the circuit above]



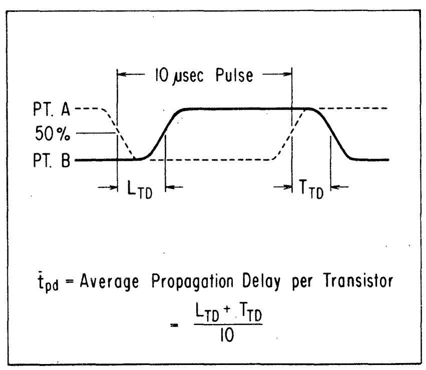
CONSTANT CONTOURS OF PROPAGATION DELAY (t_{pd})

[Measured in the circuit above]

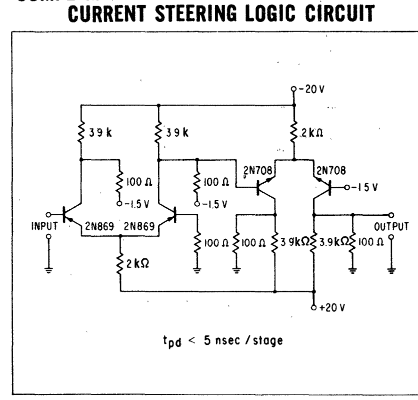




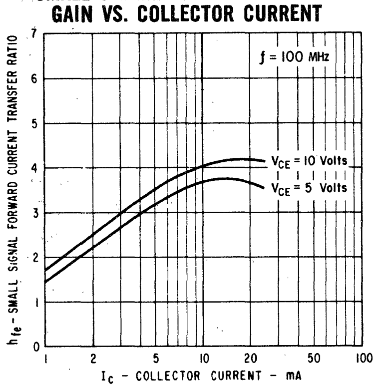
DEFINITION OF PROPAGATION DELAY



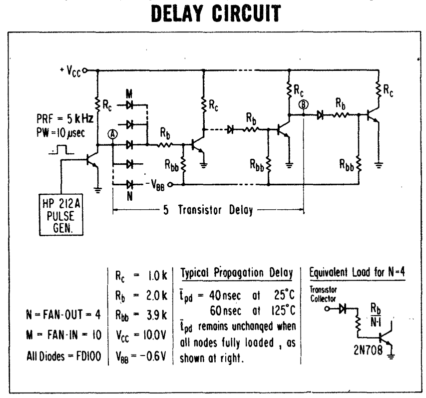
COMPLEMENTARY HIGH-SPEED NON-SATURATED CURRENT STEERING LOGIC CIRCUIT



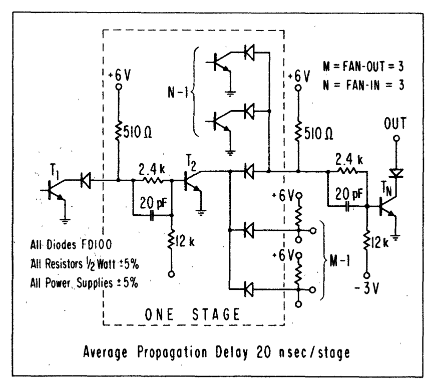
SMALL SIGNAL FORWARD CURRENT GAIN VS. COLLECTOR CURRENT



DIODE TRANSISTOR LOGIC PROPAGATION DELAY CIRCUIT



HIGH-SPEED LOW-LEVEL NAND CIRCUIT



NOTES:

(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operation.
(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) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) $r_b' = h_{ie}$ (Real Part) — Measured with GR #1607-A Bridge.
(7) Measured on Sampling Scope. PW ≤ 400 nsec.

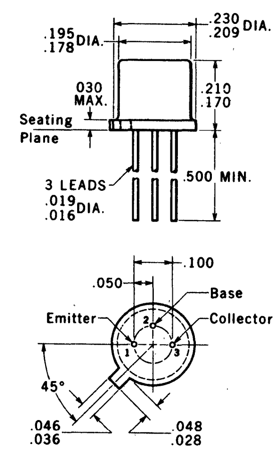
2N709 • FT709

HIGH SPEED SATURATED SWITCHES

FAIRCHILD NPN DIFFUSED SILICON PLANAR* TRANSISTORS

- **ULTRA HIGH SPEED . . . . $\tau_S = 6.0$ ns (MAX), 3.0 ns (TYP) AT 5.0 mA**
  $t_{on} = 12$ ns (MAX) AT 10 mA
  $t_{off} = 12$ ns (MAX) AT 10 mA
- **HIGH FREQUENCY . . . . . $f_T = 600$ MHz (MIN), 800 MHz (TYP) AT 10 mA**
- **LOW CAPACITANCE . . . . $C_{obo} = 3.0$ pF (MAX) AT 5.0 V**
  $C_{ibo} = 2.0$ pF (MAX) AT 0.5 V
- **BREAKDOWN VOLTAGE . . . $LV_{CEO} = 6.0$ V (MIN)**
- **SATURATED BETA GUARANTEES FROM 1.0 mA TO 30 mA**
- **SIX V_{CE}(sat) GUARANTEES WITH THREE AT +125°C**

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 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, no time limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 100°C Case Temperature (Notes 2 and 3)	0.5 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.3 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	15 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	6.0 Volts
V_{EBO}	Emitter to Base Voltage	4.0 Volts

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

SYMBOL	CHARACTERISTICS	2N709 MIN.	2N709 TYP.	2N709 MAX.	FT709 MIN.	FT709 TYP.	FT709 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**				**30**	**70**	**125**		**$I_C = 10$ mA**	**$V_{CE} = 0.4$ V**
h_{FE}	DC Current Gain	20	55	120					$I_C = 10$ mA	$V_{CE} = 0.5$ V
h_{FE}	**DC Current Gain**				**20**				**$I_C = 1.0$ mA**	**$V_{CE} = 0.4$ V**
h_{FE}	**DC Current Gain**				**20**				**$I_C = 30$ mA**	**$V_{CE} = 0.4$ V**
h_{FE}	DC Current Gain	15							$I_C = 30$ mA	$V_{CE} = 1.0$ V
h_{FE}(−55°C)	**DC Current Gain**				**12**				**$I_C = 10$ mA**	**$V_{CE} = 0.4$ V**
h_{FE}(−55°C)	DC Current Gain	10							$I_C = 10$ mA	$V_{CE} = 0.5$ V
V_{BE}(sat)	Base Saturation Voltage	0.70	0.78	0.85				Volts	$I_C = 3.0$ mA	$I_B = 0.15$ mA
V_{BE}(sat)	Base Saturation Voltage				0.68	0.73	0.85	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{BE}(sat)	Base Saturation Voltage				0.75	0.83	0.95	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE}(sat)	Base Saturation Voltage					0.92	1.3	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{CE}(sat)	Collector Saturation Voltage					0.18	0.25	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{CE}(sat)	**Collector Saturation Voltage**					**0.18**	**0.25**	**Volts**	**$I_C = 10$ mA**	**$I_B = 1.0$ mA**
V_{CE}(sat)	**Collector Saturation Voltage**		**0.21**	**0.30**				**Volts**	**$I_C = 3.0$ mA**	**$I_B = 0.15$ mA**
V_{CE}(sat)	**Collector Saturation Voltage (125°C)**					**0.20**	**0.32**	**Volts**	**$I_C = 1.0$ mA**	**$I_B = 0.1$ mA**
V_{CE}(sat)	**Collector Saturation Voltage**					**0.22**	**0.38**	**Volts**	**$I_C = 30$ mA**	**$I_B = 3.0$ mA**
V_{CE}(sat)	**Collector Saturation Voltage (125°C)**					**0.20**	**0.42**	**Volts**	**$I_C = 10$ mA**	**$I_B = 1.0$ mA**
V_{CE}(sat)	**Collector Saturation Voltage (125°C)**					**0.23**	**0.45**	**Volts**	**$I_C = 30$ mA**	**$I_B = 3.0$ mA**
C_{obo}	**Output Capacitance**		**2.5**	**3.0**		**2.3**	**3.0**	**pF**	**$I_E = 0$**	**$V_{CB} = 5.0$ V**
C_{ibo}	**Input Capacitance**		**1.4**	**2.0**		**1.8**	**2.0**	**pF**	**$I_C = 0$**	**$V_{EB} = 0.5$ V**
I_{CBO}	Collector Cutoff Current		5.0	50		4.0	50	nA	$I_E = 0$	$V_{CB} = 5.0$ V
I_{CBO}(125°C)	Collector Cutoff Current		1.0	5.0		1.0	5.0	μA	$I_E = 0$	$V_{CB} = 5.0$ V

Additional Electrical Characteristics on page 4
Notes on page 4

*Planar is a patented Fairchild process.

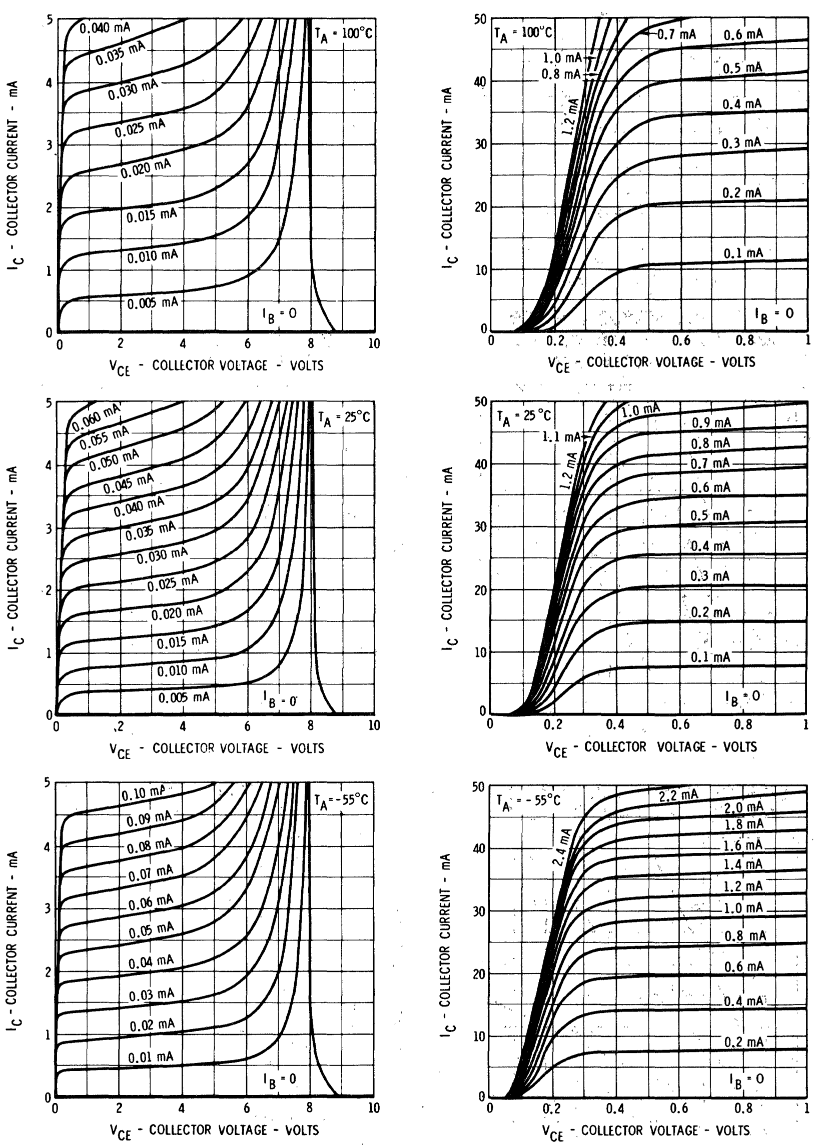
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

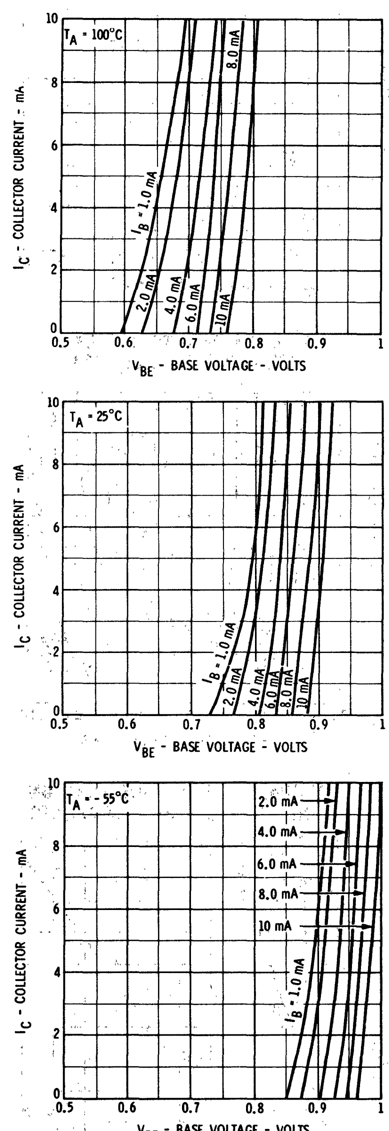
SYMBOL	CHARACTERISTICS	2N709 MIN.	2N709 TYP.	2N709 MAX.	FT709 MIN.	FT709 TYP.	FT709 MAX.	UNITS	TEST CONDITIONS	
BV_{CBO}	Collector to Base Breakdown Voltage	15			15			Volts	$I_C = 10\ \mu A$	$I_E = 0$
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	6.0			**6.0**			**Volts**	**$I_C = 10$ mA** (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0			4.0			Volts	$I_E = 10\ \mu A$	$I_C = 0$
τ_s	**Charge Storage Time Constant** (Notes 6 and 7)		3.0	6.0		**3.0**	**6.0**	ns	**$I_C = I_{B1} \approx 5.0$ mA**	**$I_{B2} \approx -5.0$ mA**
t_{on}	**Turn On Time** (Note 7)		8.0	15		**6.0**	**12**	**ns**	**$I_C \approx 10$ mA**	**$I_{B1} \approx 2.0$ mA**
t_{off}	**Turn Off Time** (Note 7)		8.0	15		**6.0**	**12**	**ns**	**$I_C \approx 10$ mA**	**$I_{B1} \approx 1.0$ mA**, **$I_{B2} \approx -1.0$ mA**
f_T	Gain-Bandwidth Product (f = 100 MHz)	600	800					MHz	$I_C = 5.0$ mA	$V_{CE} = 4.0$ V
f_T	**Gain-Bandwidth Product (f = 100 MHz)**				**600**	**800**		**MHz**	**$I_C = 10$ mA**	**$V_{CE} = 4.0$ V**

TYPICAL ELECTRICAL CHARACTERISTICS

COLLECTOR CHARACTERISTICS*



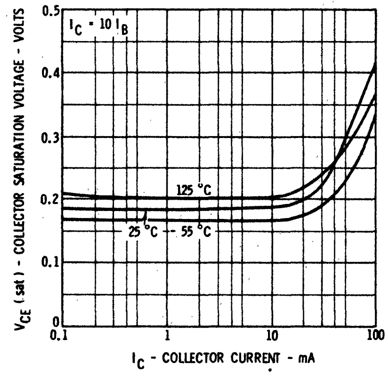
BASE CHARACTERISTICS*



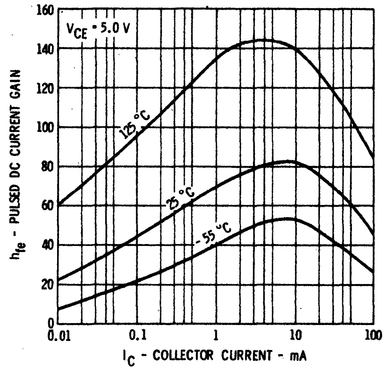
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

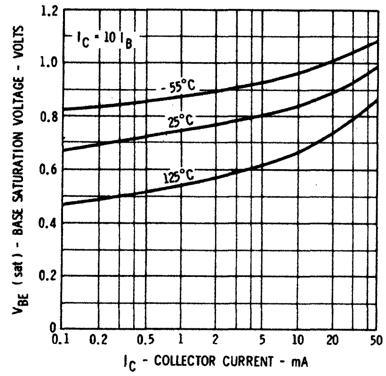
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



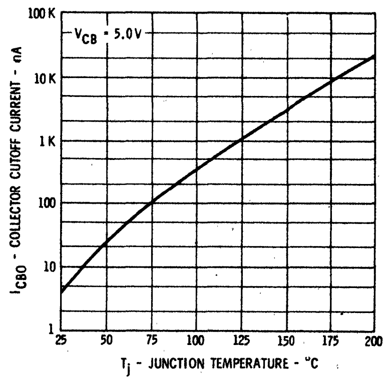
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



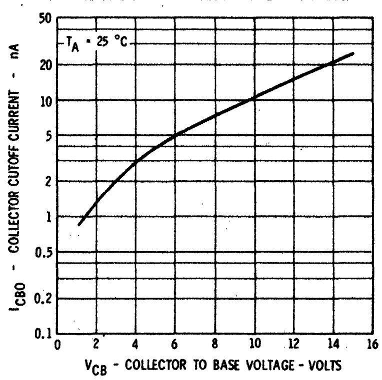
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



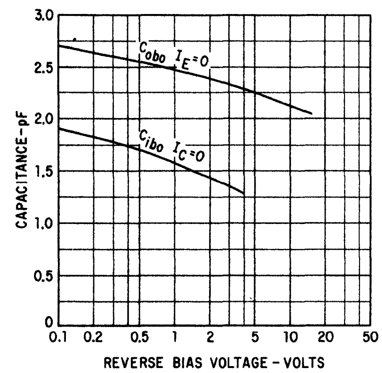
COLLECTOR CUTOFF CURRENT VERSUS JUNCTION TEMPERATURE



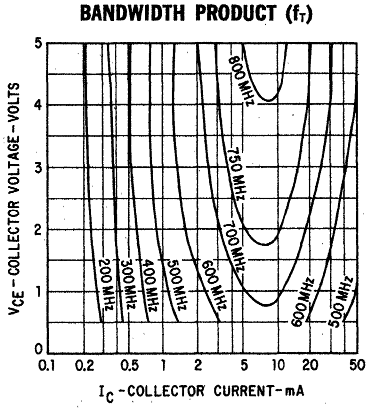
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



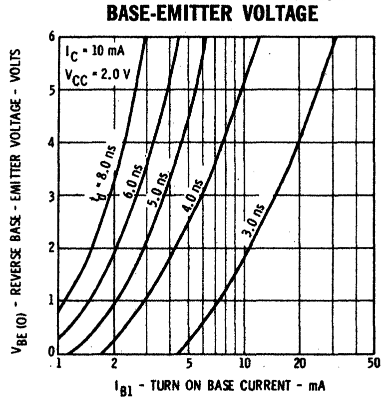
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



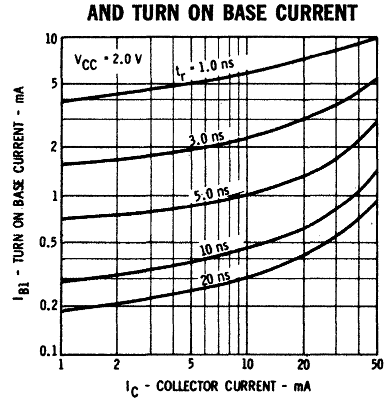
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



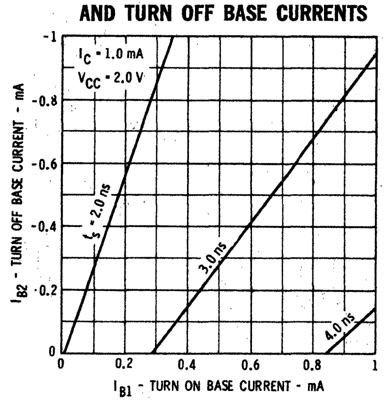
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE-EMITTER VOLTAGE



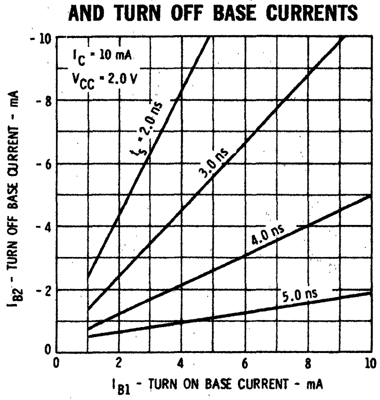
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



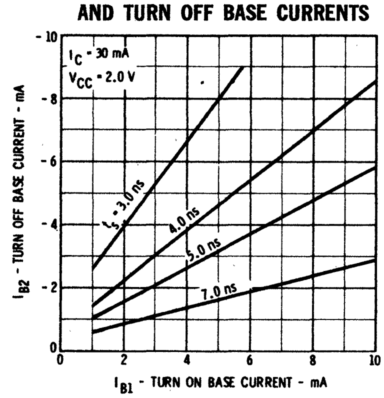
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



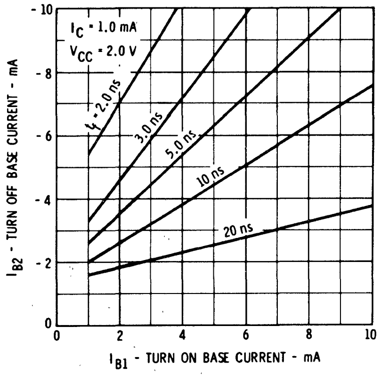
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



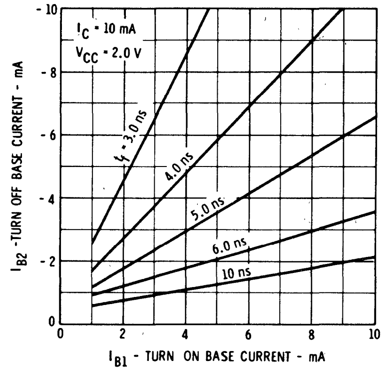
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



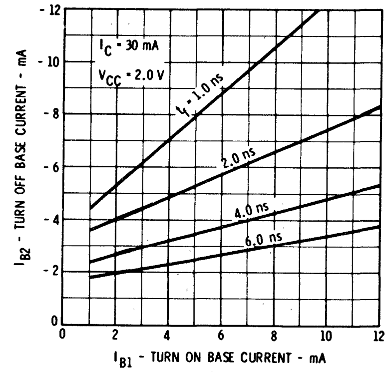
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



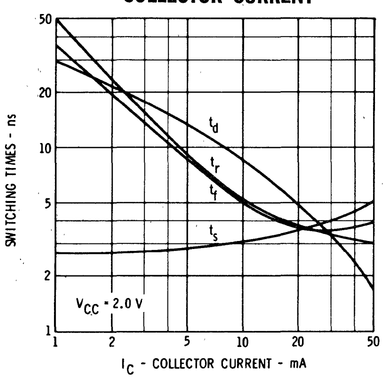
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



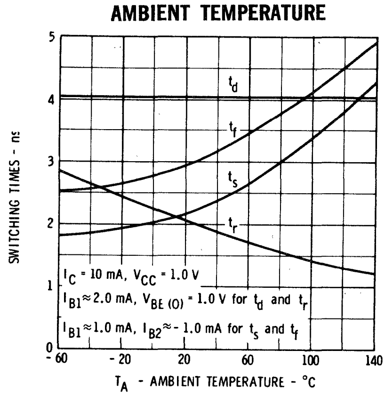
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



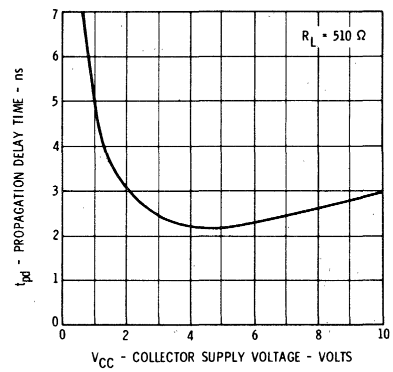
SWITCHING TIMES VERSUS COLLECTOR CURRENT



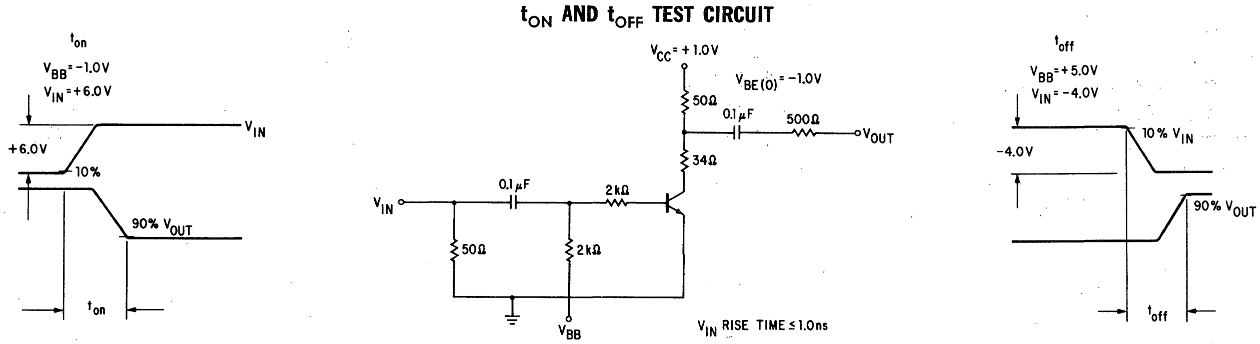
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



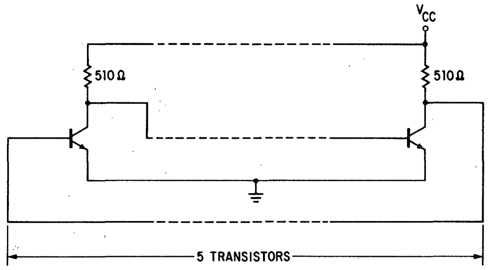
PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



t_{ON} AND t_{OFF} TEST CIRCUIT

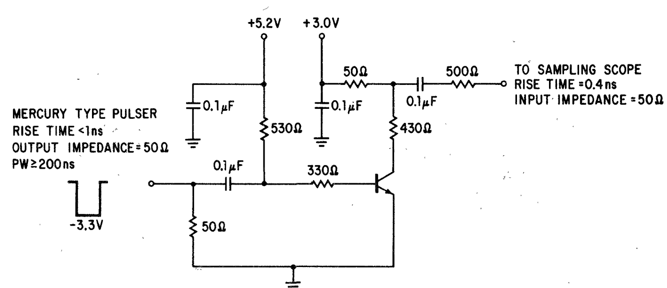


FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



$$t_{pd} = \frac{1}{10 f_{osc}}$$

CHARGE STORAGE TIME CONSTANT 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 operation.
(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 200°C/Watt (derating factor of 5.0 mW/°C at temperatures above 100°C. Power rating is constant at temperatures below 100°C). Junction to ambient thermal resistance of 583°C/Watt (derating factor of 1.71 mW/°C)
(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) Measured on Sampling Scope. PW ≥ 200 ns.
(7) See test circuit for exact values of I_C, I_{B1}, and I_{B2}.

2N718A • 2N1613 • 2N956 • 2N1711

NPN UNIVERSAL AMPLIFIERS AND SWITCHES

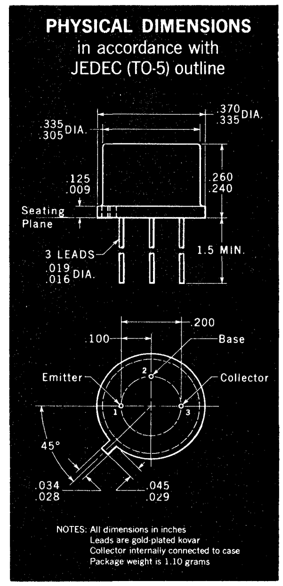
DIFFUSED SILICON PLANAR* TRANSISTORS

The 2N718A**, 2N956, 2N1613** and 2N1711 are NPN double-diffused silicon PLANAR* transistors designed for use in high performance amplifier, oscillator and switching circuits. The 2N956 and 2N1711 are also used to advantage in amplifiers where low noise is an important factor.

These transistors provide useful current gain from the microampere region up to 500 milliamperes and have the many desirable advantages of the PLANAR structure and diffusion techniques. Each transistor is designed to meet the environmental requirements of MIL-S-19500.

These transistors reflect all of the process improvements resulting from the Autonetics Minute Man reliability program for NPN silicon Planar transistors.

** See MIL-S-19500/181A (NAVY) USN 2N718A and USN 2N1613.



2N1613 2N1711

ABSOLUTE MAXIMUM RATINGS [Note 1]

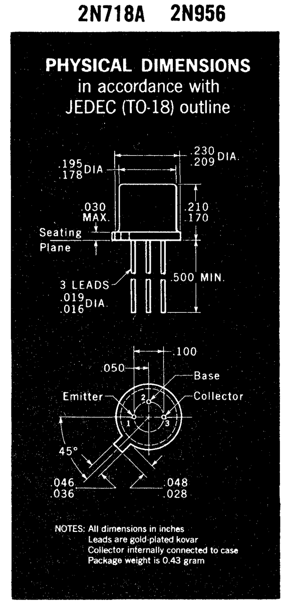
Maximum Temperatures			
Storage Temperature			−65°C to +300°C
Operating Junction Temperature			200°C Maximum
		2N718A 2N956	**2N1613 2N1711**
Maximum Power Dissipation			
Total Dissipation at Case Temperature	25°C [Note 2 & 3]	1.8 Watts	3.0 Watts
at Case Temperature	100°C [Note 2 & 3]	1.0 Watt	1.7 Watts
at Ambient Temperature	25°C [Note 2 & 3]	0.5 Watt	0.8 Watt
Maximum Voltages			
V_{CBO} Collector to Base Voltage			75 Volts
V_{CER} Collector to Emitter Voltage	($R_{BE} \leq 10\,\Omega$) [Note 4]		50 Volts
V_{EBO} Emitter to Base Voltage			7.0 Volts

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	2N718A 2N1613 Min.	Typ.	Max.	2N956 2N1711 Min.	Typ.	Max.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	40	80	120	100	130	300		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain [Note 5]	35	80		75	130			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain [Note 5]	20	55		40	75			I_C = 500 mA	V_{CE} = 10 V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	20	35		35	65			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	20	50		35	80			I_C = 0.1 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain		35		20	60			I_C = 0.01 mA	V_{CE} = 10 V
V_{BE} (sat)	Base Saturation Voltage [Pulsed, Note 5]		0.95	1.3		0.95	1.3	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE} (sat)	Collector Saturation Voltage [Pulsed, Note 5]		0.6	1.5		0.5	1.5	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	4.0		3.5	5.0			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance		18	25		18	25	pF	I_E = 0	V_{CB} = 10 V
C_{TE}	Emitter Transition Capacitance		50	80		50	80	pF	I_C = 0	V_{EB} = 0.5 V
NF	Noise Figure [Note 6]		6.0	12		3.5	8.0	dB	I_C = 0.3 mA	V_{CE} = 10 V
I_{CBO}	Collector Cutoff Current		0.3	10		0.3	10	mμA	I_E = 0	V_{CB} = 60 V
I_{CBO} (150°C)	Collector Cutoff Current		0.4	10		0.4	10	μA	I_E = 0	V_{CB} = 60 V
BV_{CBO}	Collector to Base Breakdown Voltage	75			75			Volts	I_C = 0.1 mA	I_E = 0
V_{CER} (sust)	Collector to Emitter Sustaining Voltage [Note 4 and 5]	50			50			Volts	I_C = 100 mA (pulsed)	$R_{BE} \leq 10\,\Omega$
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			7.0			Volts	I_C = 0	I_E = 0.1 mA
I_{EBO}	Emitter Current		0.05	10		0.05	5.0	mμA	I_C = 0	V_{EB} = 5.0 V

(See notes on back page)

2N718A 2N956



* Planar is a patented Fairchild process.

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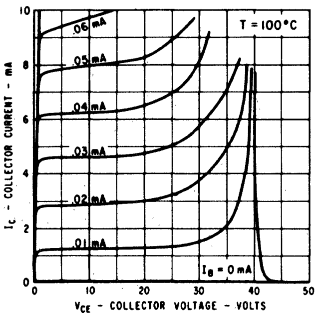
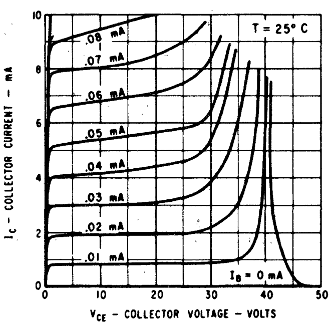
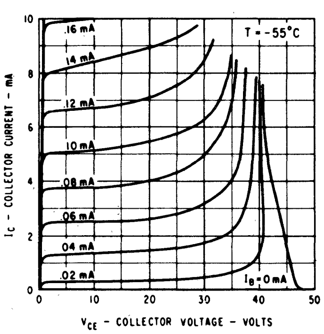
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL ELECTRICAL CHARACTERISTICS

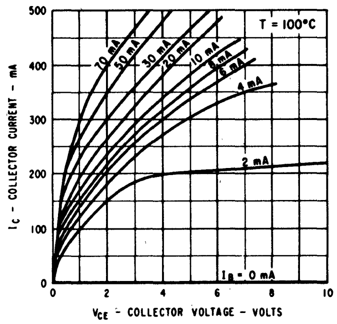
ACTIVE REGION COLLECTOR CHARACTERISTICS*

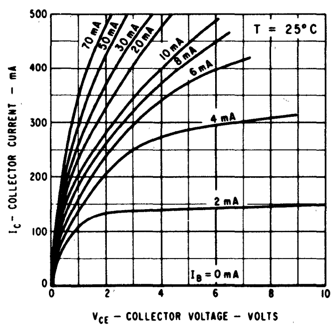


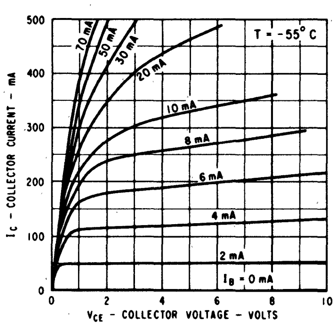




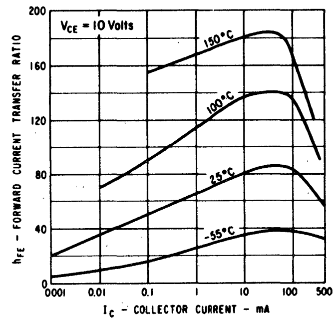
SATURATION REGION COLLECTOR CHARACTERISTICS*



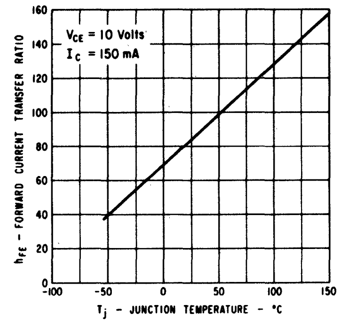




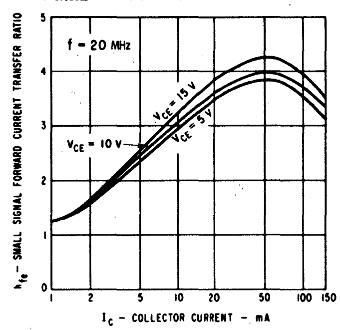
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



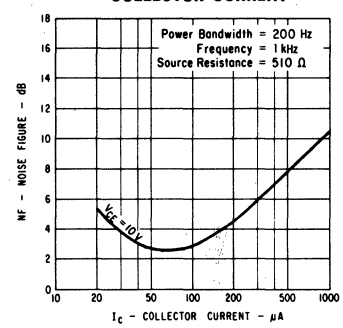
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



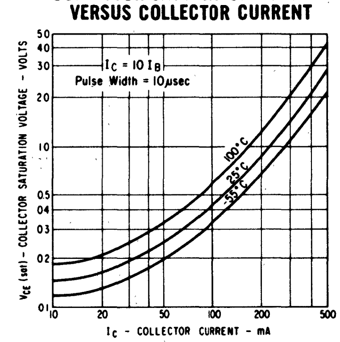
SMALL SIGNAL CURRENT GAIN AT 20 MHz VERSUS COLLECTOR CURRENT



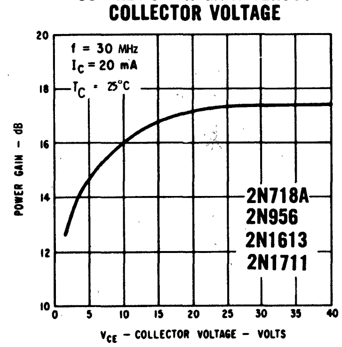
NOISE FIGURE VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

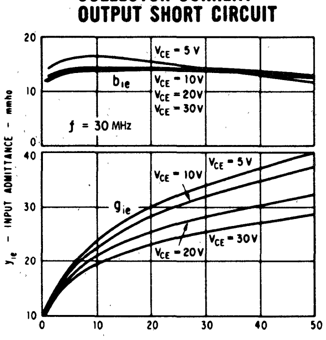


30 MHz POWER GAIN VERSUS COLLECTOR VOLTAGE

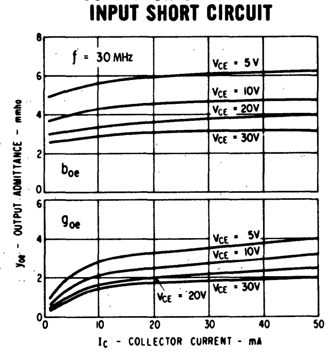


TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

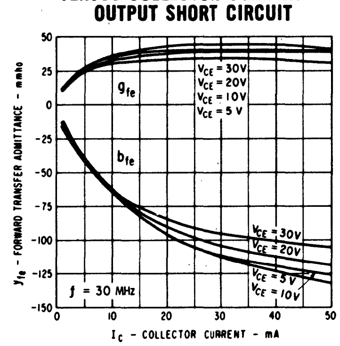
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



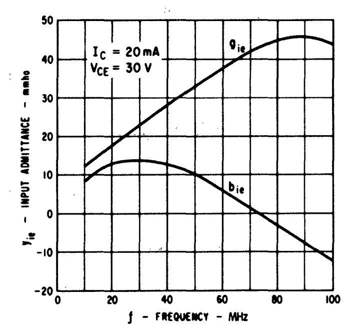
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT

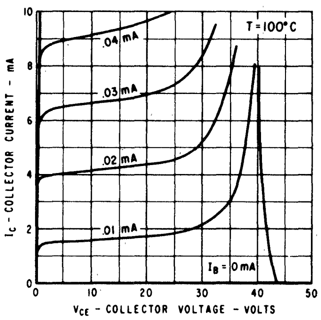


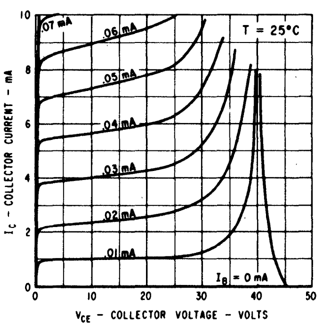
INPUT ADMITTANCE VERSUS FREQUENCY—OUTPUT SHORT CIRCUIT

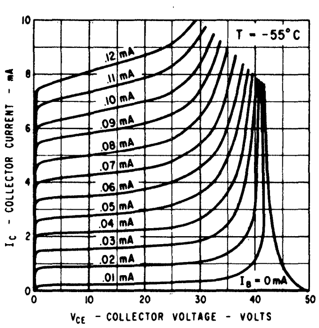


TYPICAL ELECTRICAL CHARACTERISTICS

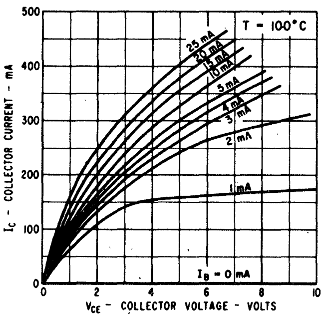
ACTIVE REGION COLLECTOR CHARACTERISTICS*

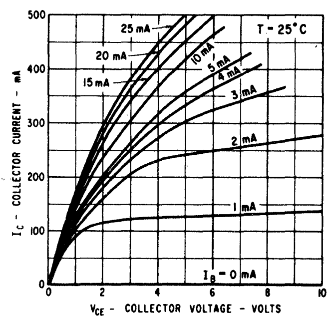


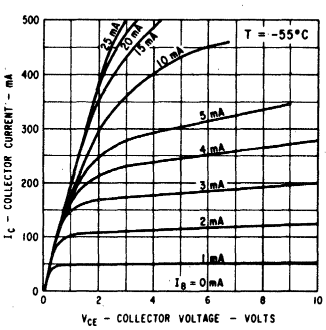




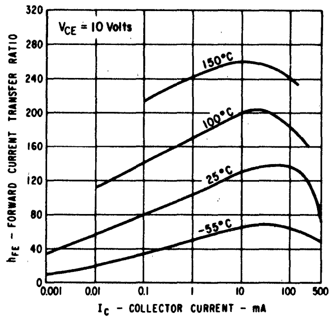
SATURATION REGION COLLECTOR CHARACTERISTICS*



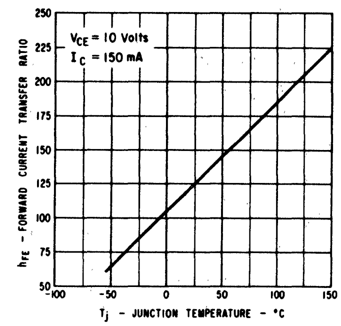




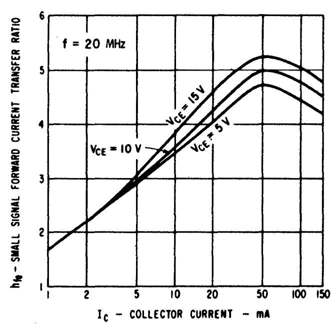
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



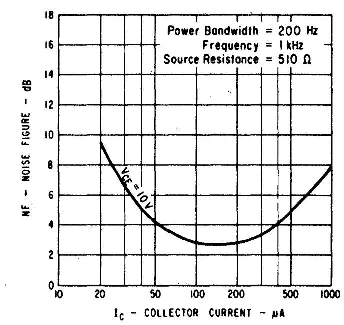
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



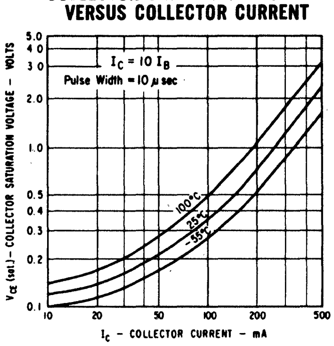
SMALL SIGNAL CURRENT GAIN AT 20 MHz VERSUS COLLECTOR CURRENT



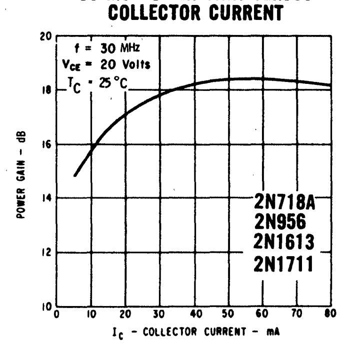
NOISE FIGURE VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

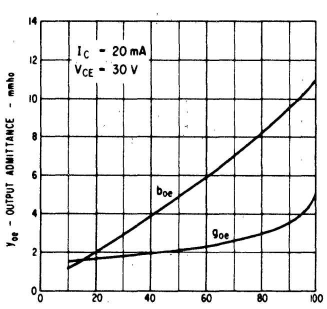


30 MC POWER GAIN VERSUS COLLECTOR CURRENT

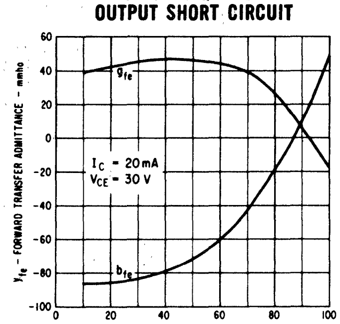


TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

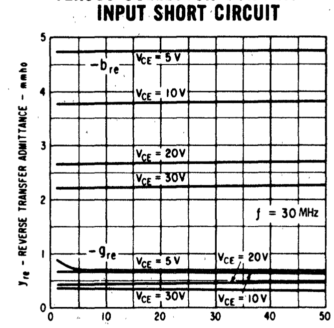
OUTPUT ADMITTANCE VERSUS FREQUENCY—INPUT SHORT CIRCUIT



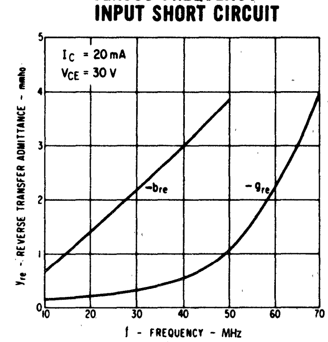
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT

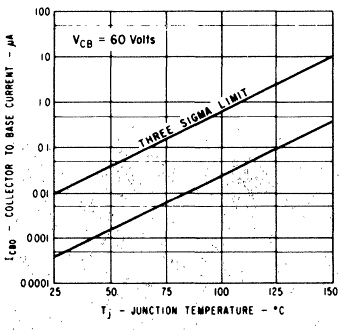


REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT

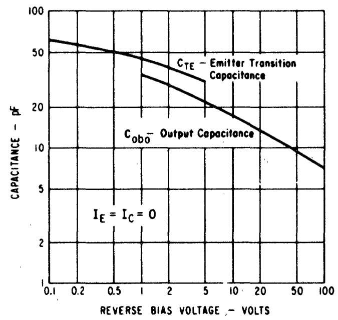


TYPICAL ELECTRICAL CHARACTERISTICS

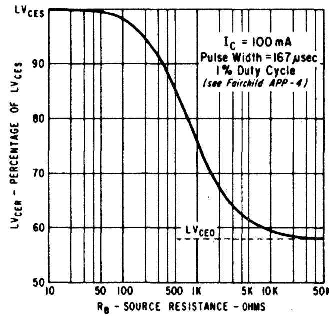
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

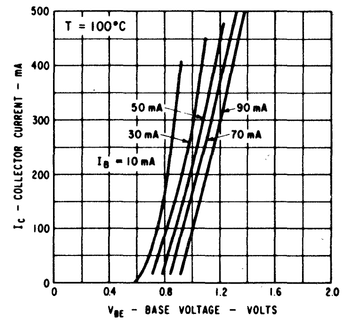


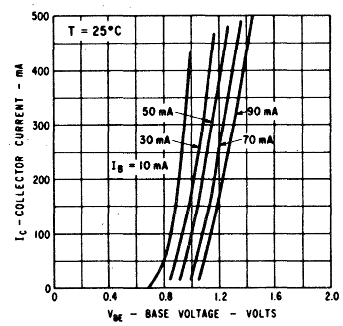
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE

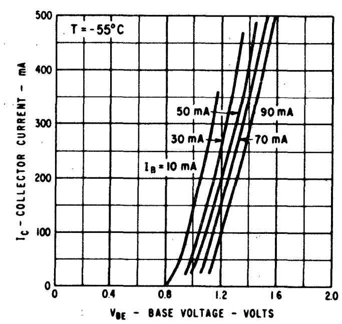


SATURATION REGION

BASE CHARACTERISTICS*

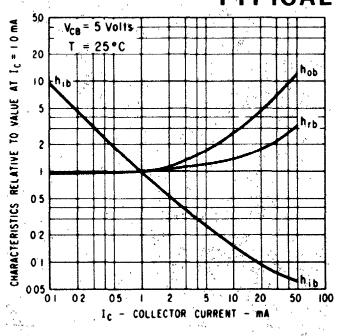


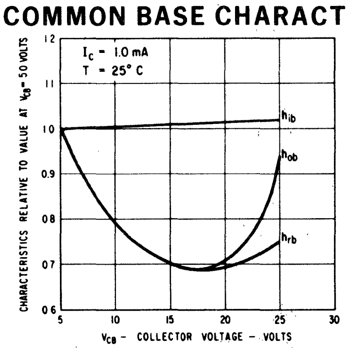


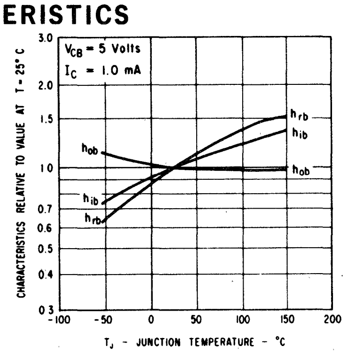


* Single family characteristics on Transistor Curve Tracer.

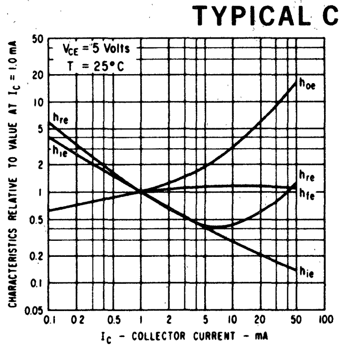
TYPICAL COMMON BASE CHARACTERISTICS

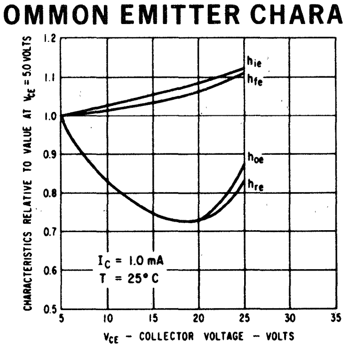


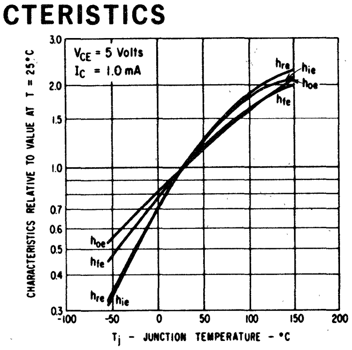




TYPICAL COMMON EMITTER CHARACTERISTICS







SMALL SIGNAL CHARACTERISTICS (f=1 kHz)

SYMBOL	CHARACTERISTICS	2N718A—2N1613 Min. Typ. Max.	2N956—2N1711 Min. Typ. Max.	UNITS	TEST CONDITIONS
h_{ib}	Input Resistance	24 27 34	24 27 34	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
		4.0 6.3 8.0	4.0 6.3 8.0	Ohms	I_C = 5.0 mA V_{CB} = 10 V
h_{rb}	Voltage Feedback Ratio	0.7 3.0	1.2 5.0	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
		0.8 3.0	1.2 5.0	$x10^{-4}$	I_C = 5.0 mA V_{CB} = 10 V
h_{fe}	Small Signal Current Gain	30 55 100	50 115 200		I_C = 1.0 mA V_{CE} = 5.0 V
		35 70 150	70 135 300		I_C = 5.0 mA V_{CE} = 10 V
h_{ob}	Output Conductance	0.1 0.16 0.5	0.1 0.16 0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
		0.1 0.19 1.0	0.1 0.19 1.0	μmho	I_C = 5.0 mA V_{CB} = 10 V
h_{ie}	Input Resistance	2.2	4.4	k ohms	I_C = 1.0 mA V_{CE} = 5.0 V
h_{re}	Voltage Feedback Ratio	3.6	7.3	$x10^{-4}$	I_C = 1.0 mA V_{CE} = 5.0 V
h_{oe}	Output Conductance	12.5	23.8	μmho	I_C = 1.0 mA V_{CE} = 5.0 V

NOTES:

(1) These ratings are limiting values above which the serviceability of any 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 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N1613 and 2N1711; for the 2N718A and 2N956 97.2°C/Watt (derating factor of 10.3 mW/°C). Junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the 2N1613 and 2N1711; for the 2N718A and 2N956 350°C/Watt (derating factor of 2.86 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length = 300 μsec; duty cycle $\leq$ 2%.

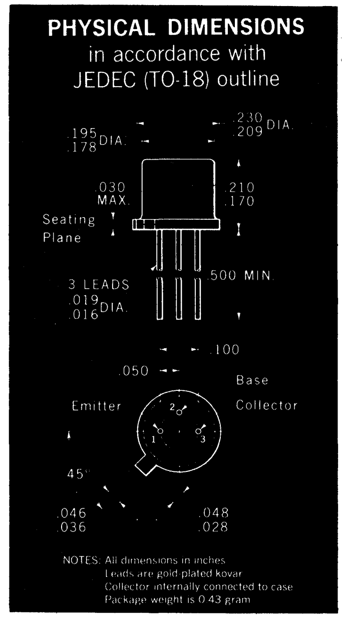
(6) f = 1000 Hz ; R_G = 510 Ω; 1.0 Hz bandwidth.

2N719A

NPN GENERAL PURPOSE HIGH VOLTAGE TYPE

DIFFUSED SILICON PLANAR TRANSISTOR

GENERAL DESCRIPTION - NPN double diffused silicon transistor designed for a wide variety of amplifier and high speed switching applications.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature		-65°C to +300°C
Operating Junction Temperature		+200°C Maximum

Maximum Power Dissipation

Total Dissipation at Case Temperature	25°C [Note 2 & 3]	1.8 Watts
at Case Temperature	100°C [Note 2 & 3]	1.0 Watt
at Ambient Temperature 25°C		0.5 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	120 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\ \Omega$) [Note 4]	80 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	60 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts

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

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	20	60		I_C = 150 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage		0.9	Volts	I_C = 50 mA	I_B = 5.0 mA
V_{CE}(sat)	Collector Saturation Voltage		1.2	Volts	I_C = 50 mA	I_B = 5.0 mA
V_{BE}(sat)	Base Saturation Voltage		1.3	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage		5.0	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain f = 20 mc	2.0			I_C = 50 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance		15	pf	I_E = 0	V_{CB} = 10 V
C_{ib}	Input Capacitance		85	pf	I_C = 0	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		10	mμA	I_E = 0	V_{CB} = 75 V
I_{CBO}(150°C)	Collector Cutoff Current		15	μA	I_E = 0	V_{CB} = 75 V
BV_{CBO}	Collector Breakdown Voltage	120		Volts	I_C = 100 μA	I_E = 0
V_{CER}(sust)	Collector to Emitter [Note 4] Sustaining Voltage	80		Volts	I_C = 100 mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO}(sust)	Collector to Emitter [Note 4] Sustaining Voltage	60		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter Breakdown Voltage	7.0		Volts	I_C = 0	I_E = 100 μA
I_{EBO}	Emitter Cutoff Current		10	mμA	I_C = 0	V_{EB} = 5.0 V

(See notes on back page)

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

SMALL SIGNAL CHARACTERISTICS (f = 1 Kc)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{fe}	Current Gain	15			I_C = 1.0 mA V_{CE} = 5.0 V
		25			I_C = 5.0 mA V_{CE} = 10 V
h_{ib}	Input Resistance	20	35	Ω	I_C = 1.0 mA V_{CB} = 5.0 V
			10	Ω	I_C = 5.0 mA V_{CB} = 10 V
h_{rb}	Voltage Feedback Ratio		2.5	$x\,10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
			5.0	$x\,10^{-4}$	I_C = 5.0 mA V_{CB} = 10 V
h_{ob}	Output Conductance	0.1	0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
			1.0	μmho	I_C = 5.0 mA V_{CB} = 10 V

NOTES:

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

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

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 97.3°C/watt (derating factor of 10.3 mw/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

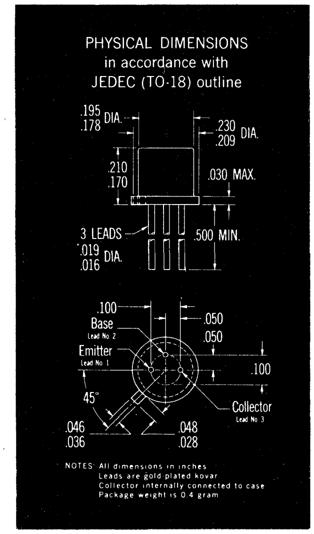
(5) Pulse conditions: length = 300 μsec; duty cycle ≤ 1%.

2N720A

NPN HIGH-VOLTAGE GENERAL PURPOSE

DIFFUSED SILICON PLANAR*TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3108



GENERAL DESCRIPTION - NPN double diffused silicon general purpose transistor for a wide variety of amplifier and high speed switching applications.

ABSOLUTE MAXIMUM RATINGS (25°C) (Note 1)

Maximum Temperatures			
Storage Temperatures			-65°C to +300°C
Operating Junction Temperature			+200°C Maximum
Maximum Power Dissipation			
Total Dissipation at 25°C Case Temperature		(Notes 2 & 3)	1.8 Watts
at 100°C Case Temperature		(Notes 2 & 3)	1.0 Watt
at 25°C Ambient Temperature			0.5 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage		120 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\,\Omega$)	(Note 4)	100 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	80 Volts
V_{EBO}	Emitter to Base Voltage		7 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristics		Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 5)	40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	35			I_C = 10 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain	(Note 5)	20			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain		20			I_C = 0.1 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage			0.9	Volts	I_C = 50 mA	I_B = 5 mA
V_{CE}(sat)	Collector Saturation Voltage			1.2	Volts	I_C = 50 mA	I_B = 5 mA
V_{BE}(sat)	Base Saturation Voltage			1.3	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage			5.0	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.5			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance			15	pF	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance			85	pF	I_C = 0	V_{EB} = 0.5 V
I_{cbo}	Collector Cutoff Current	(Note 6)		10	mμA	I_E = 0	V_{CB} = 90 V
I_{cbo}(150°C)	Collector Cutoff Current	(Note 7)		15	μA	I_E = 0	V_{CB} = 90 V
BV_{CBO}	Collector Breakdown Voltage		120		Volts	I_C = 100 μA	I_E = 0
V_{CER}(sust)	Collector to Emitter Sustaining Voltage	(Note 4)	100		Volts	I_C = 100 mA (pulsed)	$R_{BE} \leq$ 10 Ω
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage	(Note 4)	80		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter Breakdown Voltage		7		Volts	I_C = 0	I_E = 100 μA
I_{EBO}	Emitter Cutoff Current			10	mμA	I_C = 0	V_{BE} = 5 V

(See notes on back page)

* Planar is a patented Fairchild process.

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SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{fe}	Current Gain	30	100		I_E = 1 mA V_{CE} = 5 V
		45			I_E = 5 mA V_{CE} = 10 V
h_{ib}	Input Resistance	20	30	Ω	I_E = 1 mA V_{CB} = 5 V
		4	8	Ω	I_E = 5 mA V_{CB} = 10 V
h_{rb}	Voltage Feedback Ratio		1.25	$x10^{-4}$	I_E = 1 mA V_{CB} = 5 V
			1.50	$x10^{-4}$	I_E = 5 mA V_{CB} = 10 V
h_{ob}	Output Conductance		0.5	μmho	I_E = 1 mA V_{CB} = 5 V
			0.5	μmho	I_E = 5 mA V_{CB} = 10 V

NOTES:

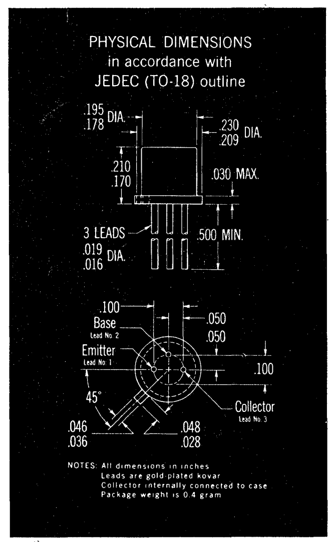
1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operation.
3. These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 97.3°C/Watt (derating factor of 10.3 mW/°C).
4. Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
5. Pulse conditions: length = 300 μsec; duty cycle ≤1%.
6. The 90th percentile shall be no greater than 1 mμA.
7. The 90th percentile shall be no greater than 5 μA.

2N721 • 2N722 • 2N1131 • 2N1132

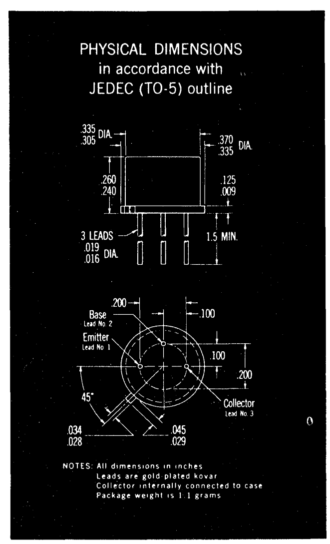
PNP GENERAL PURPOSE TYPE

DIFFUSED SILICON TRANSISTORS

These devices are PNP silicon transistors designed for use in high performance amplifiers, oscillators and some switching circuits. They perform at frequencies from DC to VHF. These transistors are designed to meet the environmental requirements of MIL-S-19500. These devices are available in accordance with the standard Fairchild FACT program.



2N721 • 2N722



2N1131 • 2N1132

ABSOLUTE MAXIMUM RATINGS (25°C) [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+300°C**
Operating Junction Temperature	**175°C** Maximum
Lead Temperature (Soldering, No Time Limit)	**300°C** Maximum

Maximum Power Dissipation

	2N721 2N722	2N1131 2N1132
Total Dissipation at **25°C** Case Temperature [Notes 2 & 3]	**1.5** Watts	**2.0** Watts
at **100°C** Case Temperature [Notes 2 & 3]	**0.75** Watt	**1.0** Watt
at **25°C** Ambient Temperature [Notes 2 & 3]	**0.40** Watt	**0.6** Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	**−50** Volts
V_{CER}	Collector to Emitter Voltage $R_{BE} \leq 10\ \Omega$ [Note 4]	**−50** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**−35** Volts
V_{EBO}	Emitter to Base Voltage	**−5.0** Volts

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

Symbol	FACT† SUBGROUP	Characteristic	2N721 2N1131 Min.	Typ.	Max.	2N722 2N1132 Min.	Typ.	Max.	Units	Test Conditions	
* h_{FE}	1a	DC Pulse Current Gain [Note 5]	**20**	**26**	**45**	**30**	**45**	**90**		$I_C = 150$ mA	$V_{CE} = -10$ V
* V_{BE} (sat)	1a	Base Saturation Voltage		**−0.9**	**−1.3**		**−0.95**	**−1.3**	Volts	$I_C = 150$ mA	$I_B = 15$ mA
* V_{CE} (sat)	1a	Collector Saturation Voltage		**−1.0**	**−1.5**		**−1.0**	**−1.5**	Volts	$I_C = 150$ mA	$I_B = 15$ mA
h_{fe}	4	High Frequency Current Gain (f = 20 mc)	**2.5**	**3.5**		**3.0**	**4.5**			$I_C = 50$ mA	$V_{CE} = -10$ V
* I_{CBO}	1b	Collector Cutoff Current		**0.01**	**1.0**		**0.01**	**1.0**	μA	$I_E = 0$	$V_{CB} = -30$ V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

Additional Electrical Characteristics on page 2.

NOTES:

(1) These ratings art 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 175°C and junction-to-case thermal resistance of 100°C/Watt for the 2N721 and 2N722 (derating factor of 10 mW/°C); for the 2N1131 and 2N1132, 75°C/Watt (derating factor of 13.3 mW/°C). Junction-to-ambient thermal resistance of 375°C/Watt (derating factor of 2.7 mW/°C) for the 2N721 and 2N722 ; for the 2N1131 and 2N1132, 250°C/Watt (derating factor 4.0 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

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

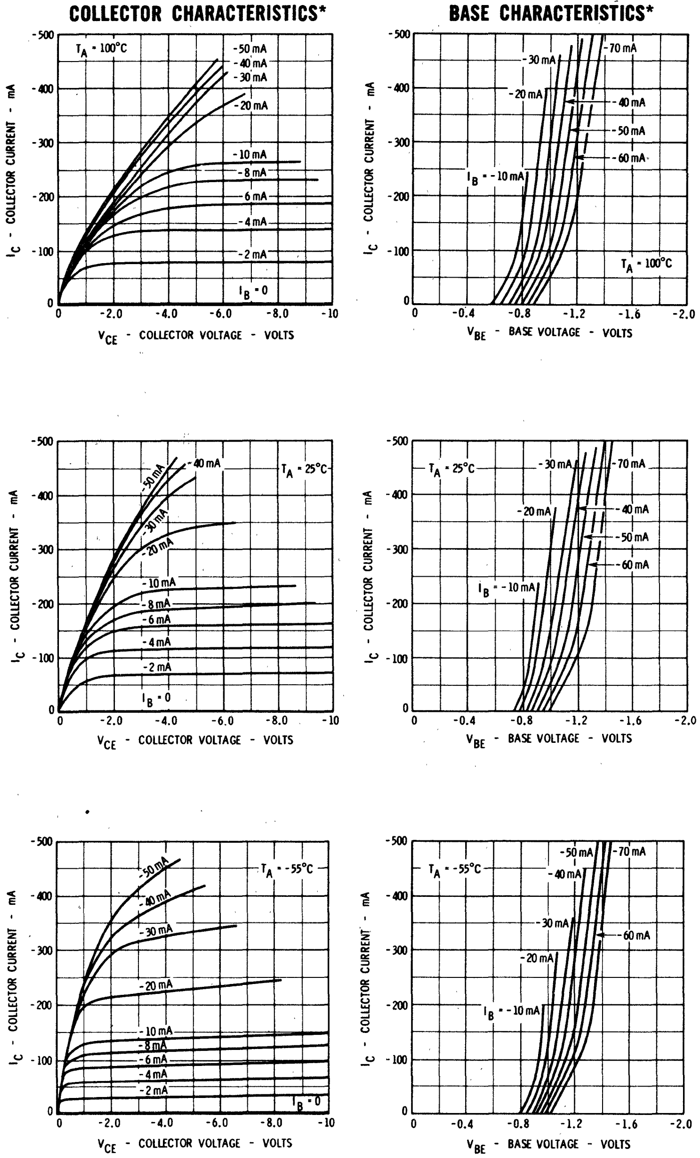
Symbol	FACT † SUBGROUP	Characteristic	Min.	Typ.	Max.	Units	TEST CONDITIONS	
h_{FE}	4	DC Pulse Current Gain [Note 5]	15	26			$I_C = 5.0$ mA	$V_{CE} = -10$ V
C_{ob}	4	Output Capacitance		31	45	pf	$I_E = 0$	$V_{CB} = -10$ V
I_{CBO} (150°C)	4	Collector Cutoff Current		2.0	100	μA	$I_E = 0$	$V_{CB} = -30$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	−50			Volts	$I_C = 100\mu A$	$I_E = 0$
V_{CER} (sust)	4	Collector to Emitter Sustaining Voltage	−50			Volts	$I_C = 100$mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO} (sust)	1a	Collector to Emitter Sustaining Voltage	−35			Volts	$I_C = 100$mA (pulsed)	$I_B = 0$
BV_{EBO}	1a	Emitter to Base Voltage	−5.0			Volts	$I_C = 0$	$I_E = 100\mu A$
* I_{EBO}	1b	Emitter Cutoff Current		0.1	100	μA	$I_C = 0$	$V_{EB} = -2.0$ V
C_{TE}	4	Emitter Transition Capacitance (For 2N721 only)		57	100	pf	$I_C = 0$	$V_{EB} = -0.5$ V
C_{TE}	4	Emitter Transition Capacitance (For 2N1131 only)		57	80	pf	$I_C = 0$	$V_{EB} = -0.5$ V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

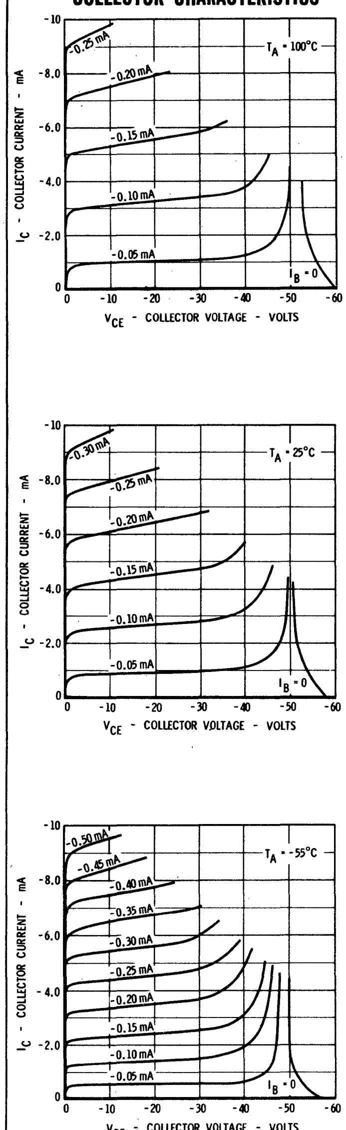
SATURATION REGION

COLLECTOR CHARACTERISTICS* — BASE CHARACTERISTICS*

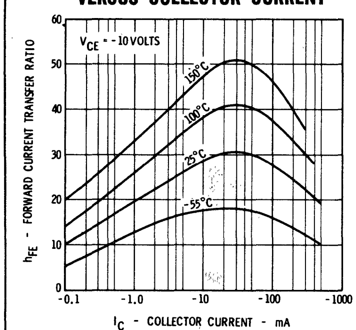


HIGH VOLTAGE

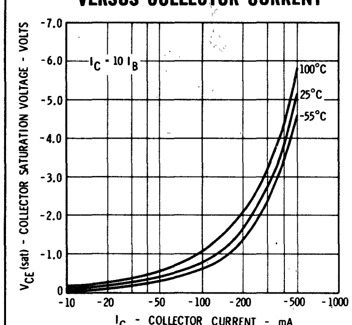
COLLECTOR CHARACTERISTICS*



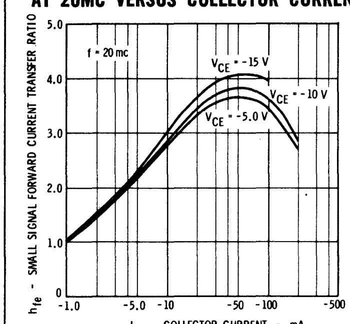
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



SMALL SIGNAL CURRENT GAIN AT 20MC VERSUS COLLECTOR CURRENT



* Single family characteristics on Transistor Curve Tracer.

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

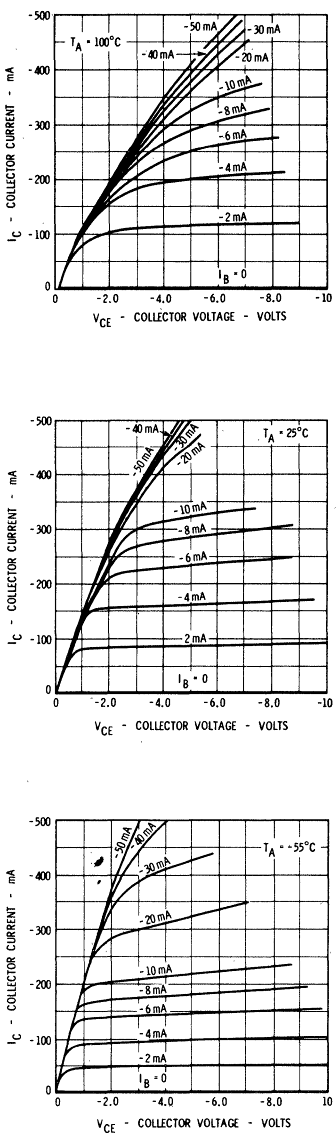
Symbol	FACT † SUBGROUP	Characteristic	Min.	Typ.	Max.	Units	TEST CONDITIONS	
h_{FE}	4	DC Pulse Current Gain [Note 5]	25	55			$I_C = 5.0$ mA	$V_{CE} = -10$ V
C_{ob}	4	Output Capacitance		31	45	pf	$I_E = 0$	$V_{CB} = -10$ V
I_{CBO} (150°C)	4	Collector Cutoff Current		2.0	100	μA	$I_E = 0$	$V_{CB} = -30$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	−50			Volts	$I_C = 100\mu A$	$I_E = 0$
V_{CER} (sust)	4	Collector to Emitter Sustaining Voltage	−50			Volts	$I_C = 100$mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO} (sust)	1a	Collector to Emitter Sustaining Voltage	−35			Volts	$I_C = 100$mA (pulsed)	$I_B = 0$
BV_{EBO}	1a	Emitter to Base Voltage	−5.0			Volts	$I_C = 0$	$I_E = 100\mu A$
*I_{EBO}	1b	Emitter Cutoff Current		0.1	100	μA	$I_C = 0$	$V_{EB} = -2.0$ V
C_{TE}	4	Emitter Transition Capacitance (For 2N722 only)		57	100	pf	$I_C = 0$	$V_{EB} = -0.5$ V
C_{TE}	4	Emitter Transition Capacitance (For 2N1132 only)		57	80	pf	$I_C = 0$	$V_{EB} = -0.5$ V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

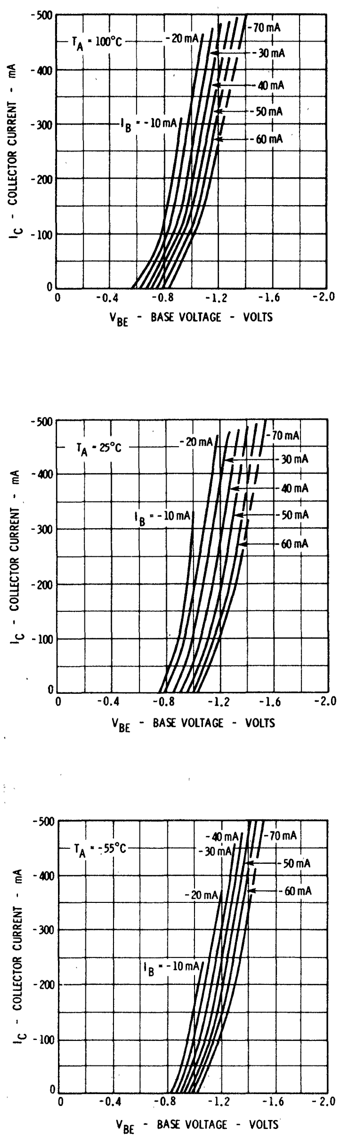
TYPICAL ELECTRICAL CHARACTERISTICS

SATURATION REGION

COLLECTOR CHARACTERISTICS*

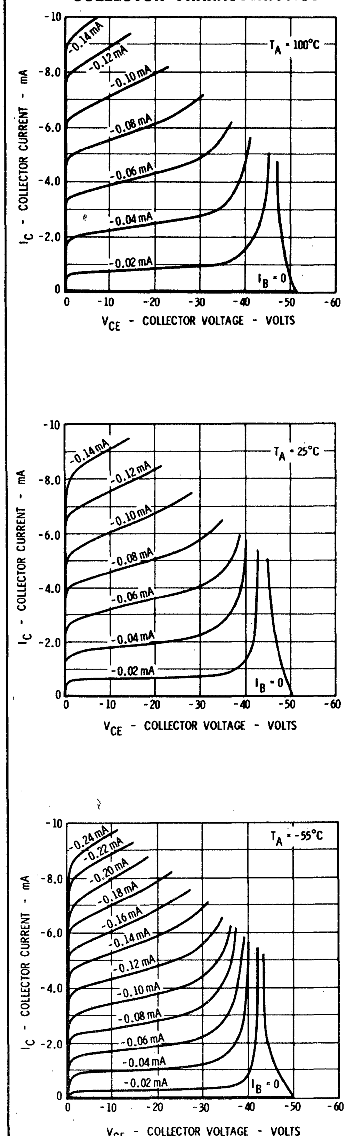


BASE CHARACTERISTICS*

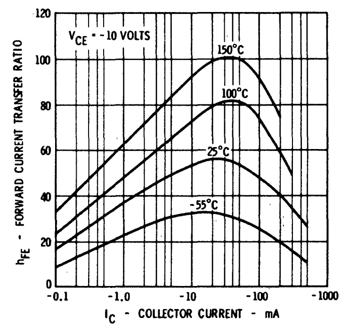


HIGH VOLTAGE

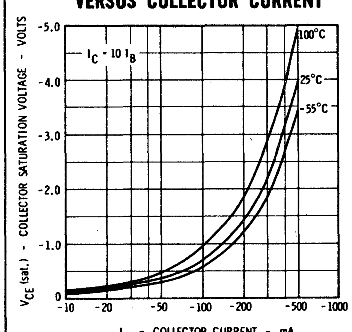
COLLECTOR CHARACTERISTICS*



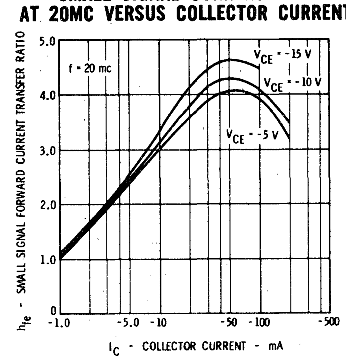
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

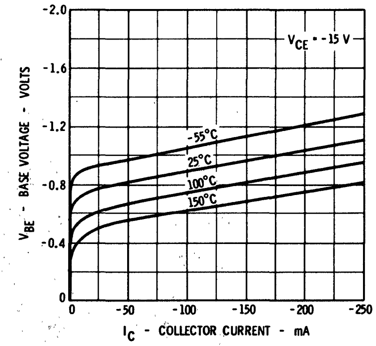


SMALL SIGNAL CURRENT GAIN AT 20MC VERSUS COLLECTOR CURRENT

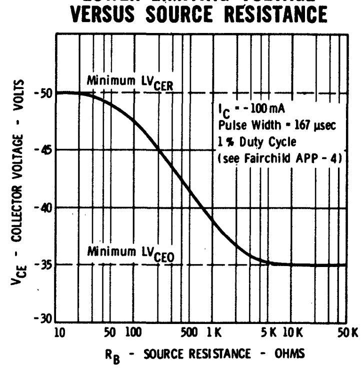


TYPICAL ELECTRICAL CHARACTERISTICS

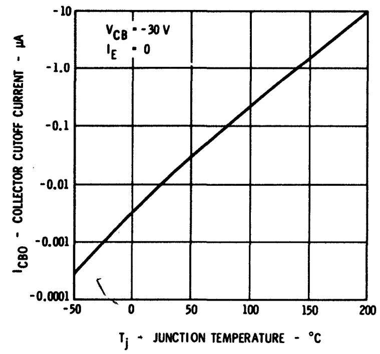
BASE VOLTAGE VERSUS COLLECTOR CURRENT (NON-SATURATED — HIGH SPEED PULSE)



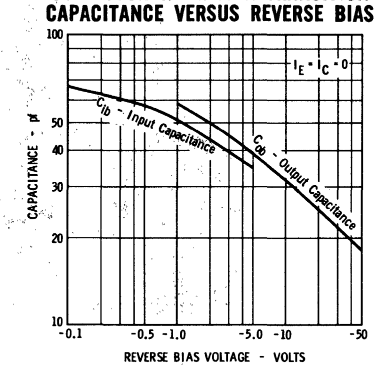
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



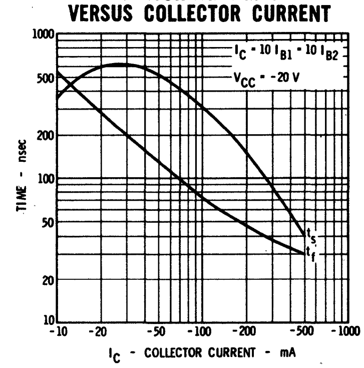
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



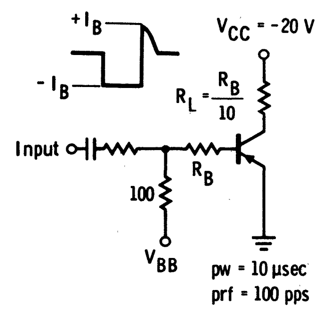
COLLECTOR & EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS



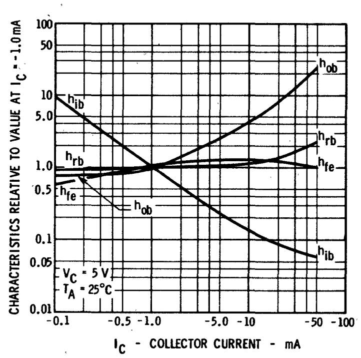
SWITCHING TIMES VERSUS COLLECTOR CURRENT

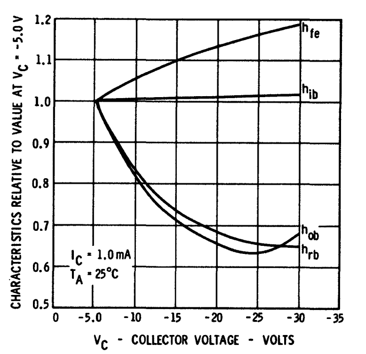


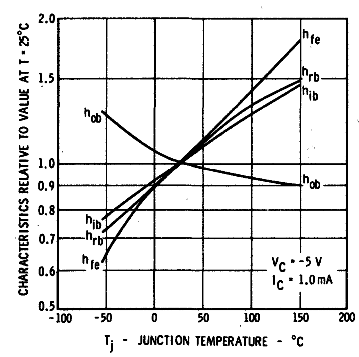
SATURATED SWITCHING CIRCUIT



TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1 kc)







TEST CONDITIONS
$V_C = -5$ V; $I_C = 1.0$ mA; f = 1.0 kc

Sym.	† FACT Subgroup	Character.	2N721 • 2N1131 Min.	Typ.	Max.	2N722 • 2N1132 Min.	Typ.	Max.
h_{fe}	4	Current Transfer Ratio	15	34	50	25	57	100
h_{ib}	4	Input Resistance	25Ω	27	35Ω	25Ω	27	35Ω
h_{rb}	4	Voltage Feedback Ratio		1.3	8.0×10^{-4}		2.0	8.0×10^{-4}
h_{ob}	4	Output Conductance		0.3	1.0μmho		0.3	1.0μmho

TEST CONDITIONS
$V_C = -10$ V; $I_C = 5.0$ mA; f = 1.0 kc

Sym.	† FACT Subgroup	Character.	2N721 • 2N1131 Min.	Typ.	Max.	2N722 • 2N1132 Min.	Typ.	Max.
h_{fe}	4	Current Transfer Ratio	20	38		30	60	
h_{ib}	4	Input Resistance		6.2	10Ω		6.2	10Ω
h_{rb}	4	Voltage Feedback Ratio		1.3	8.0×10^{-4}		2.0	8.0×10^{-4}
h_{ob}	4	Output Conductance		0.5	5.0μmho		0.6	5.0μmho

† NOTE: These Numerals Apply to the Fairchild FACT Program.

FAIRCHILD SEMICONDUCTOR
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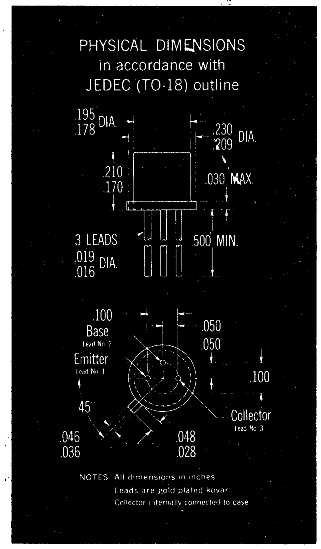
2N743 • 2N744

NPN HIGH-SPEED SATURATED SWITCHES

SILICON PLANAR* EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2369A

GENERAL DESCRIPTION - The Fairchild 2N743 and 2N744 are NPN silicon PLANAR epitaxial transistors designed for use in high-speed saturated switching applications. They are suitable for most satellite and conventional, small-signal, RF, and digital type circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures			
Storage Temperature			-65°C to +300°C
Operating Junction Temperature			175°C Maximum
Lead Temperature (Soldering, 10 sec time limit)			230°C Maximum
Maximum Power Dissipation			
Total Dissipation at 25°C Case Temperature		[Notes 2 and 3]	1.0 Watt
at 25°C Ambient Temperature		[Notes 2 and 3]	0.3 Watt
Maximum Voltages and Current			
V_{CBO}	Collector to Base Voltage		20 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]		12 Volts
V_{EBO}	Emitter to Base Voltage		5.0 Volts
I_C	Collector Current		200 mA

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	2N743 Min.	2N743 Max.	2N744 Min.	2N744 Max.	Units	Test Conditions
h_{FE}	DC Current Gain	20	60	40	120		I_C = 10 mA V_{CE} = 0.35 V
h_{FE}(-55°C)	DC Current Gain	10		20			I_C = 10 mA V_{CE} = 0.35 V
h_{FE}	DC Pulse Current Gain [Note 5]	10		20			I_C = 100 mA V_{CE} = 1.0 V
h_{FE}	DC Current Gain	10		20			I_C = 1.0 mA V_{CE} = 0.25 V
V_{CE}(sat)	Collector Saturation Voltage (T_A = 170°C)		0.35		0.35	Volt	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage (T_A = 170°C)		1.0		1.0	Volt	I_C = 100 mA I_B = 10 mA
V_{BE}(sat)	Base Saturation Voltage	0.65	0.85	0.65	0.85	Volt	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage (T_A = -55°C)		1.1		1.1	Volts	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage (pulsed) [Note 5]		1.5		1.5	Volts	I_C = 100 mA I_B = 10 mA
V_{BE}(sat)	Base Saturation Voltage (pulsed) [Note 5] T_A = -55°C		1.6		1.6	Volts	I_C = 100 mA I_B = 10 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	9.0		9.0		dB	I_C = 10 mA V_{CE} = 10 V
C_{ob}	Output Capacitance		5.0		5.0	pF	I_E = 0 V_{CB} = 5.0 V
I_{CBO}	Collector Cutoff Current		1.0		1.0	μA	I_E = 0 V_{CB} = 20 V
I_{CES}	Collector Cutoff Current		1.0		1.0	μA	V_{CE} = 20 V V_{BE} = 0
I_{CE} (100°C)	Collector Cutoff Current		30		30	μA	V_{CE} = 10 V V_{BE} = 0.35 V
I_{CES}(170°C)	Collector Cutoff Current		100		100	μA	V_{CE} = 20 V V_{BE} = 0
I_{EBO}	Emitter Cutoff Current		10		10	μA	I_C = 0 V_{EB} = 5.0 V
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	12		12		Volts	I_C = 10 mA (pulsed) I_B = 0
τ_s	Charge Storage Time Constant (see Fig. 1) [Note 6]		14		18	nsec	$I_C = I_{B_1} = I_{B_2}$ = 10 mA
T_{on}	Turn On Time (see Figure 2) (Circuit Condition 2)		12		12	nsec	I_C = 100 mA, I_{B_1} = 40 mA, I_{B_2} = 20 mA
T_{on}	Turn On Time (see Figure 2) (Circuit Condition 1)		16		16	nsec	I_C = 10 mA, I_{B_1} = 3.0 mA, I_{B_2} = 1.5 mA
T_{off}	Turn Off Time (see Figure 2) (Circuit Condition 1)		24		24	nsec	I_C = 10 mA, I_{B_1} = 3.0 mA, I_{B_2} = 1.5 mA
T_{off}	Turn Off Time (see Figure 2) (Circuit Condition 2)		40		45	nsec	I_C = 100 mA, I_{B_1} = 40 mA, I_{B_2} = 20 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 175°C and junction-to-case thermal resistance of 150°C/watt (derating factor of 6.7 mW/°C); junction-to-ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.
(6) Measured on Sampling Scope. PW ≥ 200 nsec.

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

FIGURE 1

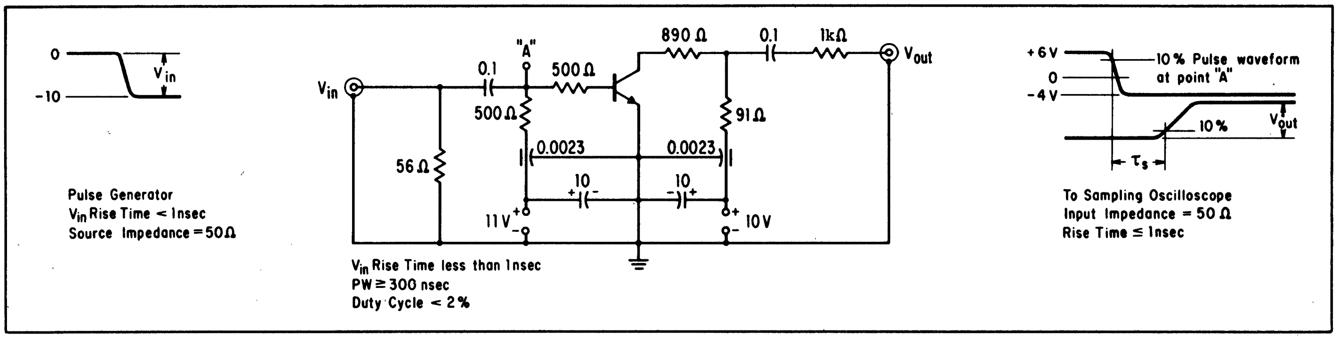
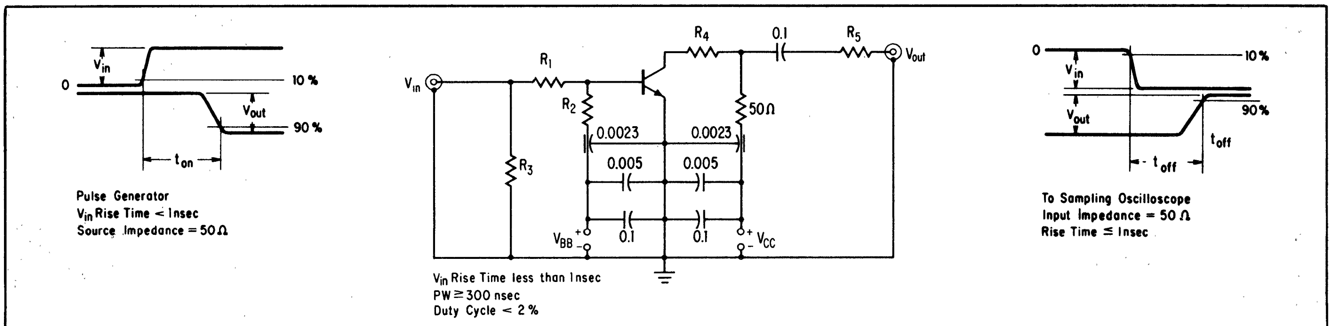
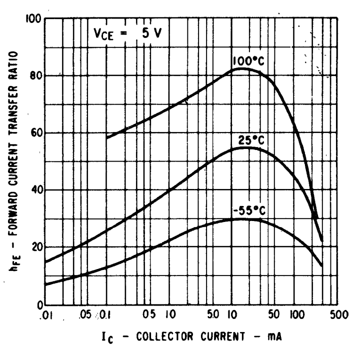


FIGURE 2

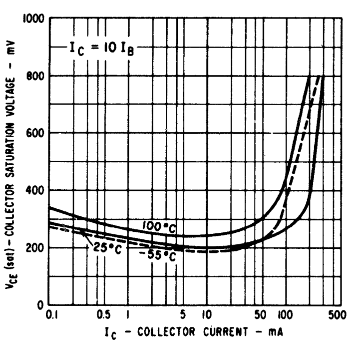


	I_C ma	$I_{B(1)}$ ma	$I_{B(2)}$ ma	$V_{BE(O)}$ V	V_{CC} V	$R_1 = R_2$ Ω	R_3 Ω	R_4 Ω	R_5 Ω	t_{on} V_{BB}, V	t_{on} V_{in}, V	t_{off} V_{BB}, V	t_{off} V_{in}, V
1	10	3	-1.5	-1.5	3.0	3.3k	50	220	0	-3.0	15.0	12.0	-15.0
2	100	40	-20.0	-2.4	6.0	330	56	0	1k	-4.5	20.0	15.3	-20.0

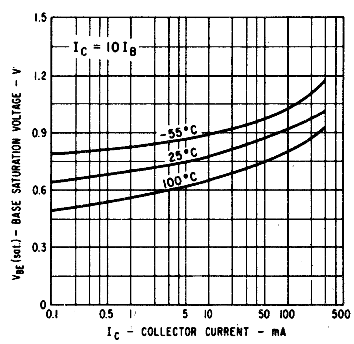
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



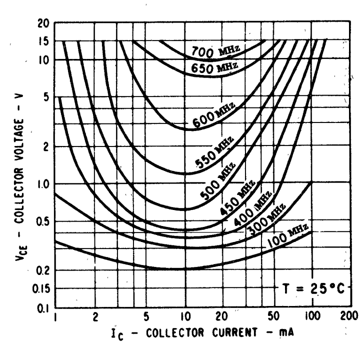
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



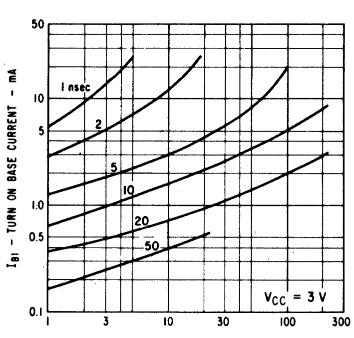
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



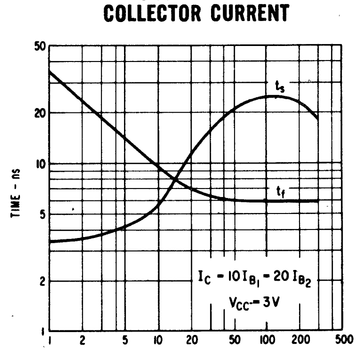
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



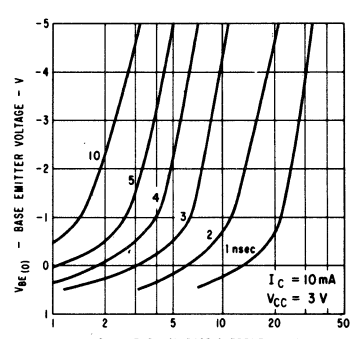
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



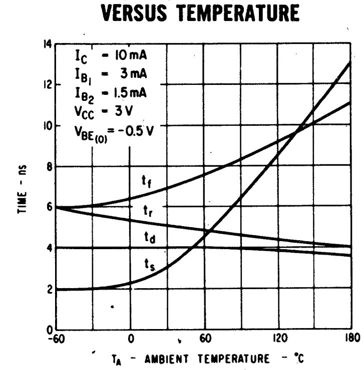
STORAGE AND FALL TIME VERSUS COLLECTOR CURRENT



DELAY TIME VERSUS $V_{BE(o)}$ AND TURN ON BASE CURRENT



SWITCHING TIMES VERSUS TEMPERATURE

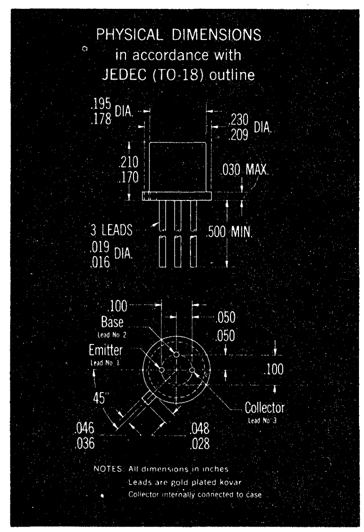


2N753

NPN MEDIUM SPEED SWITCH

SILICON PLANAR* EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2369 A



GENERAL DESCRIPTION - The Fairchild 2N753 is an NPN silicon PLANAR epitaxial transistor designed specifically for high-speed, low-power saturated switching applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		-65°C to + 175°C
Operating Junction Temperature		175°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)		1.0 Watt
at 25°C Ambient Temperature (Notes 2 and 3)		0.3 Watt
Maximum Voltages and Current		
V_{CBO}	Collector to Base Voltage	25 Volts
V_{CER}	Collector to Emitter Voltage (R_{BE} = 10 Ω) (Note 4)	20 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	15 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	50 mA

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	40	120		I_C = 10 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.6	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage	0.7	0.9	Volts	I_C = 10 mA	I_B = 1.0 mA
I_{CBO}	Collector Cutoff Current		0.5	μA	I_E = 0	V_{CB} = 15 V
I_{CBO}	Collector Cutoff Current		10	μA	I_E = 0	V_{CB} = 25 V
I_{CBO}(150°C)	Collector Cutoff Current		30	μA	I_E = 0	V_{CB} = 15 V
I_{CER}	Collector-Emitter Cutoff Current Resistance Return		10	μA	V_{CE} = 20 V	R_{BE} = 100 KΩ
I_{EBO}	Emitter Cutoff Current		10	μA	I_C = 0	V_{EB} = 5.0 V
C_{obo}	Output Capacitance (f = 1.0 MHz)		5.0	pF	I_E = 0	V_{CB} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.0			I_E = -10 mA	V_{CE} = 10 V
BV_{CER}	Collector-Emitter Breakdown Voltage, Resistance Return (Note 4)	20		Volts	I_C = 10 mA (pulsed)	R_{BE} = 10 Ω
BV_{CEO}	Collector-Emitter Breakdown Voltage, Open Circuit (Note 4)	15		Volts	I_C = 10 mA (pulsed)	I_B = 0
τ_s	Charge Storage Time Constant (Note 5)		35	nsec	I_C = 10 mA	V_{CC} = 10 V
t_{on}	Turn On Time (Note 6)		40	nsec	V_{CC} = 3.0 V	R_L = 270 Ω
t_{off}	Turn Off Time (Note 6)		75	nsec	V_{CC} = 3.0 V	R_L = 270 Ω

NOTES:

* Planar is a patented Fairchild process.

(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 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.67 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) R_L = 1 kΩ, I_{B1} = I_{B2} = 10 mA (see Figure 2)

(6) I_{B1} = 3.0 mA, I_{B2} = 1.0 mA, t_w ≥400 nsec, duty cycle <2%, (see Figure 1).

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FIGURE 1

Turn-On and Turn-Off Circuit

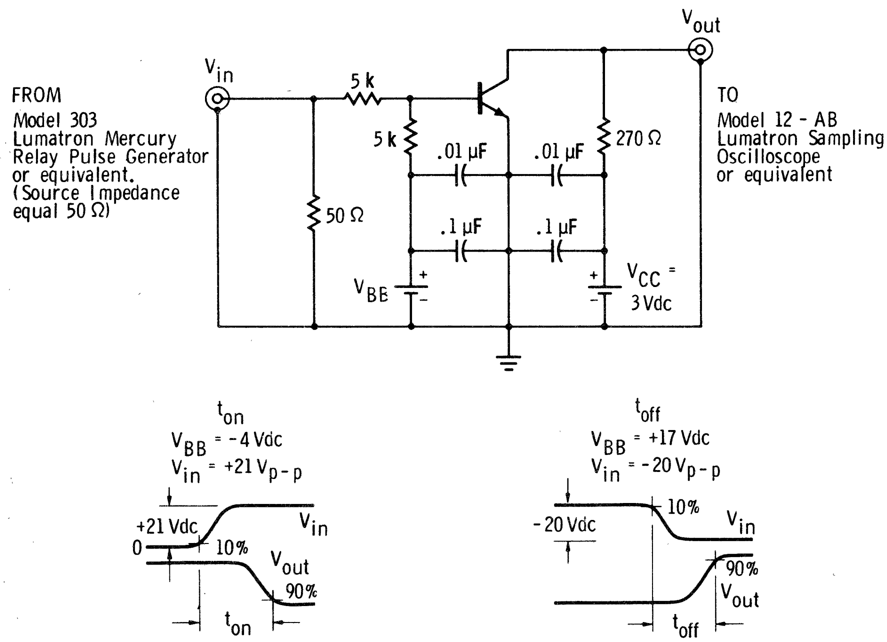
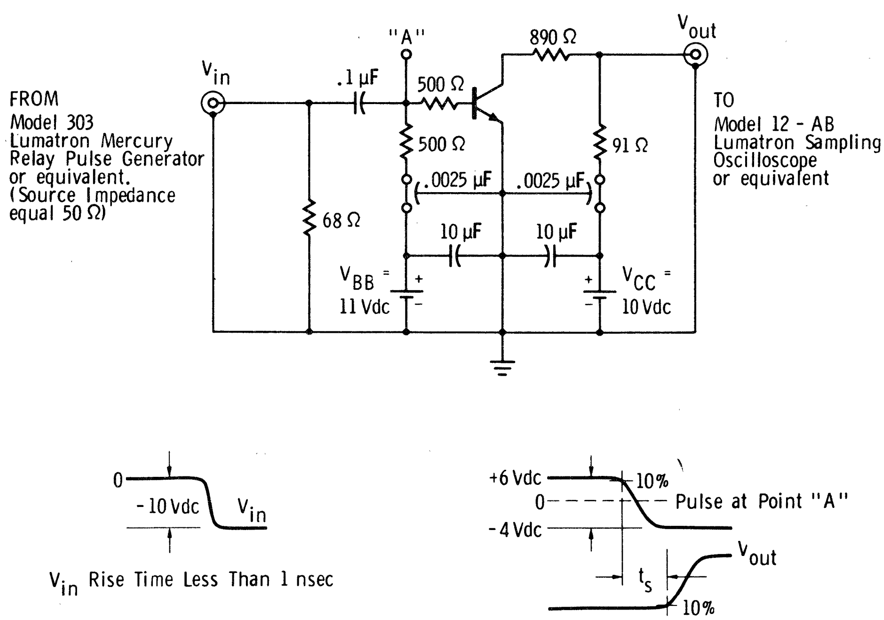


FIGURE 2

Storage Time Circuit



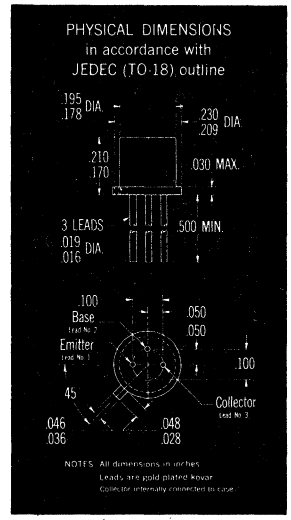
2N783

NPN HIGH-SPEED SWITCH

SILICON PLANAR* EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE
SEE FAIRCHILD 2N2369A

GENERAL DESCRIPTION - The Fairchild 2N783 is an NPN silicon PLANAR epitaxial transistor designed specifically for high-speed, low-power saturated switching applications.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		-65°C to +300°C
Operating Junction Temperature		175°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	1.0 Watt
at 25°C Ambient Temperature	(Notes 2 and 3)	0.3 Watt
Maximum Voltages and Current		
V_{CBO} Collector to Base Voltage		40 Volts
V_{CER} Collector to Emitter Voltage (R_{BE} = 10Ω)		20 Volts
V_{EBO} Emitter to Base Voltage		5.0 Volts
I_C Collector Current		200 mA

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	20	60		I_C = 10 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage	0.7	0.9	Volts	I_C = 10 mA	I_B = 1.0 mA
I_{CBO}	Collector Cutoff Current		250	nA	I_E = 0	V_{CB} = 25 V
I_{CBO}(150°C)	Collector Cutoff Current		30	μA	I_E = 0	V_{CB} = 25 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.0			I_C = 10 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance (f = 1.0 MHz)		3.5	pF	I_E = 0	V_{CB} = 10 V
t_s	Storage Time (Note 4)		10	nsec	I_C = 10 mA	V_{CC} = 10 V
t_{on}	Turn On Time (Note 5)		16	nsec	I_{B1} = 3.0 mA	I_{B2} = 1.0 mA
t_{off}	Turn Off Time (Note 5)		30	nsec	I_{B1} = 3.0 mA	I_{B2} = 1.0 mA
BV_{CBO}	Collector to Base Breakdown Voltage	40		Volts	I_E = 0	I_C = 100 μA
BV_{CER}	Collector to Emitter Breakdown Voltage (R_{BE} = 10Ω)	20		Volts	I_C = 1.0 mA	V_{BE} = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	I_C = 0	I_E = 100 μA

* 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 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.67 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) I_{B1} = 10 mA, I_{B2} = 10 mA, R_L = 1 kΩ, (see Figure 2).

(5) V_{CC} = 3.0 V, R_L = 270Ω, (see Figure 1).

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FIGURE 1

TURN-ON AND TURN-OFF CIRCUIT

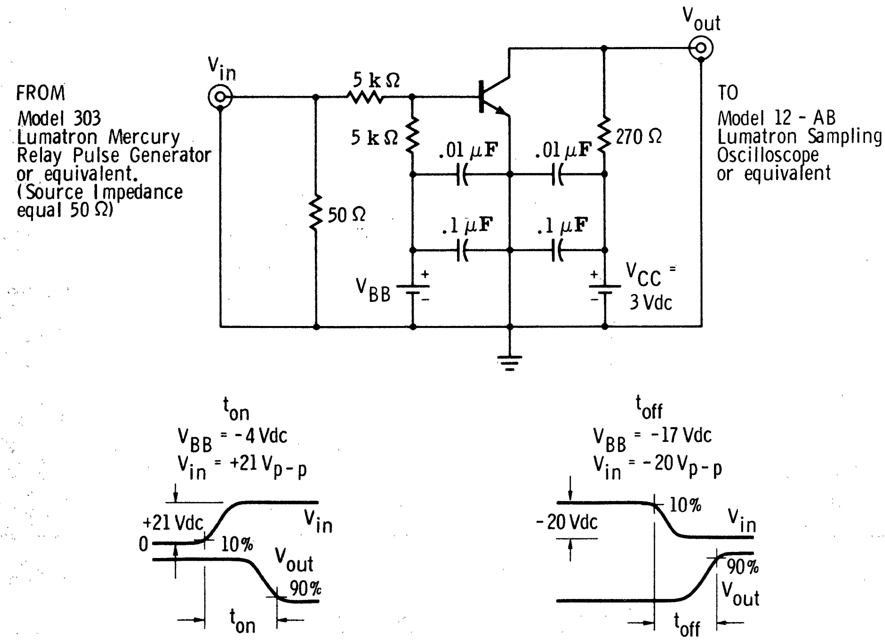
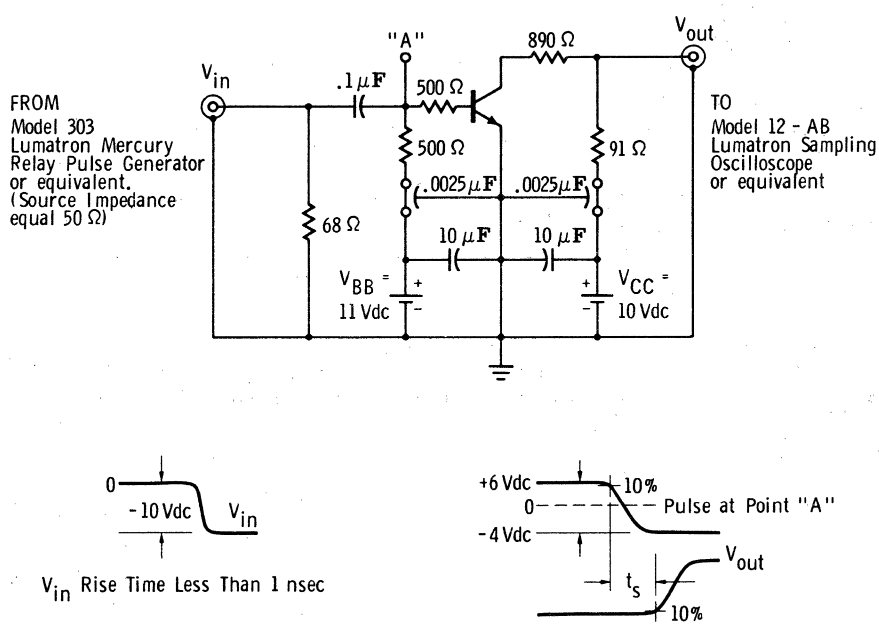


FIGURE 2

STORAGE TIME CIRCUIT



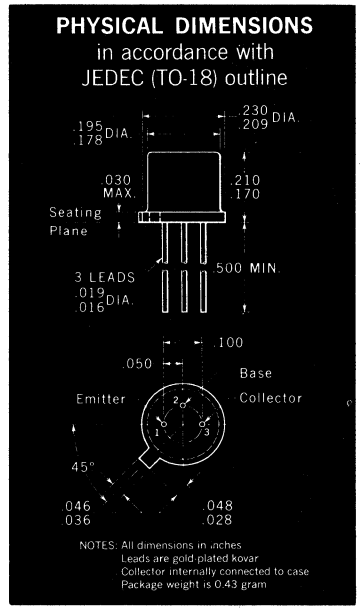
2N834

NPN HIGH-SPEED SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2369

GENERAL DESCRIPTION – The Fairchild 2N834 is an NPN silicon PLANAR epitaxial transistor designed for high-speed saturated switching applications. It is suitable for most satellite and conventional, small signal, RF, and digital type circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +175°C
Operating Junction Temperature	175°C Maximum
Lead Temperature (Soldering, 10 sec time limit)	240°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	[Notes 2 and 3]	1.0 Watt
at 25°C Ambient Temperature	[Notes 2 and 3]	0.3 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	40 Volts
V_{CES}	Collector to Emitter Voltage	30 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	200 mA

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

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 4]	25			I_C = 10 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.25	Volt	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.4	Volt	I_C = 50 mA	I_B = 5.0 V
V_{BE}(sat)	Base Saturation Voltage		0.9	Volt	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	3.5			I_C = 10 mA	V_{CE} = 15 V
f_T	Gain-Bandwidth Product (f = 100 mc)	350		mc	I_C = 10 mA	V_{CE} = 15 V
I_{CBO}	Collector Cutoff Current		0.5	μA	I_E = 0	V_{CB} = 20 V
I_{CBO} (150°C)	Collector Cutoff Current		30	μA	I_E = 0	V_{CB} = 20 V
I_{CES}	Collector Cutoff Current		10	μA	V_{CE} = 30 V	V_{BE} = 0
C_{ob}	Output Capacitance		4.0	pf	I_E = 0	V_{CB} = 10 V
τ_s	Charge Storage Time Constant		25	nsec	See Figure 1	
T_{on}	Turn On Time		35	nsec	See Figure 2	
T_{off}	Turn Off Time		75	nsec	See Figure 2	
BV_{CBO}	Collector to Base Breakdown Voltage	40		Volts	I_C = 100 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	I_E = 100 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 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.67 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) Pulse Conditions: length $\leq$ 300 μsec; duty cycle $\leq$ 2%.

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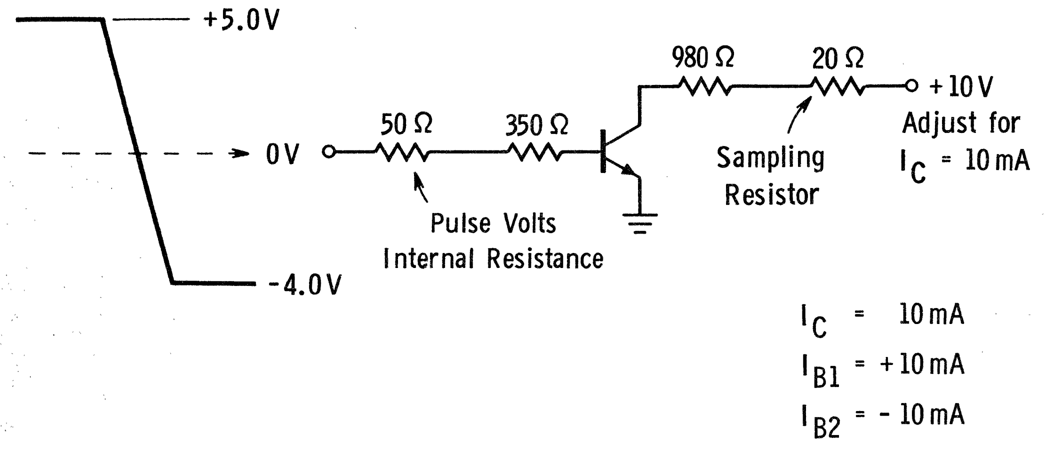


Figure 1

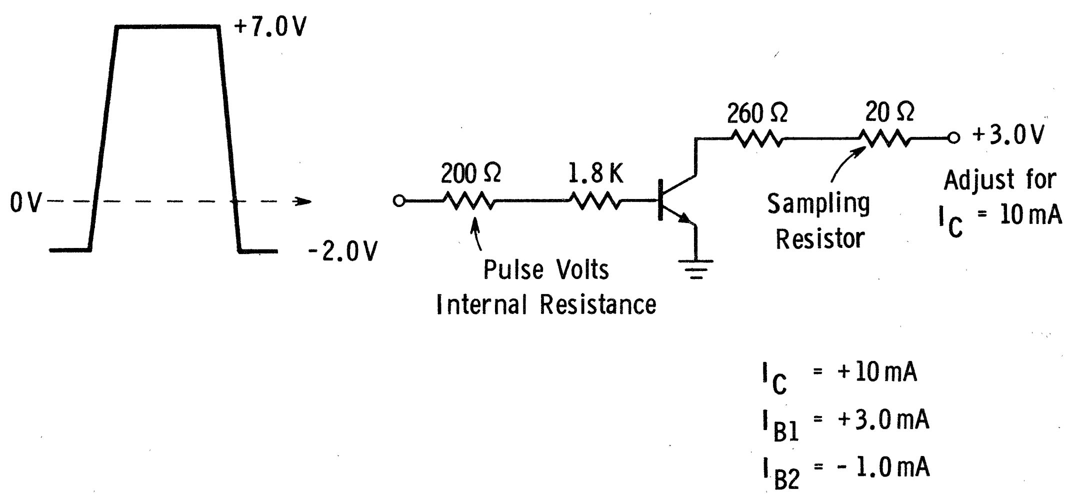


Figure 2

2N835

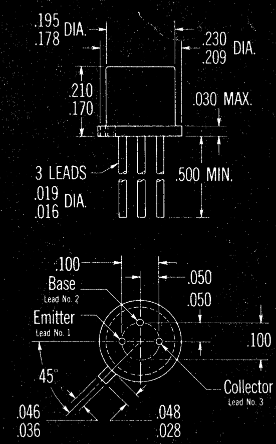
NPN HIGH-SPEED SWITCH

DIFFUSED SILICON PLANAR*EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2369A

GENERAL DESCRIPTION - The Fairchild 2N835 is an NPN silicon PLANAR epitaxial transistor designed specifically for high-speed, low-power saturated switching applications.

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures	
Storage Temperature	-65°C to +175°C
Operating Junction Temperature	175°C Maximum
Lead Temperature (1/16" ± 1/32" from case for 10 sec)	240°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	1.0 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.3 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	25 Volts
V_{CES} Collector to Emitter Voltage	20 Volts
V_{CEO} Collector to Emitter Voltage	20 Volts
V_{EBO} Emitter to Base Voltage	3.0 Volts
I_C Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	20			I_C = 10 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.3	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage		0.9	Volts	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0			I_C = 10 mA	V_{CE} = 15 V
f_T	Gain-Bandwidth Product	300		MHz	I_C = 10 mA	V_{CE} = 15 V
I_{CBO}	Collector Cutoff Current		0.5	μA	I_E = 0	V_{CB} = 20 V
I_{CBO}(150°C)	Collector Cutoff Current		30	μA	I_E = 0	V_{CB} = 20 V
I_{CES}	Collector Cutoff Current		10	μA	V_{CE} = 20 V	V_{BE} = 0
I_{EBO}	Emitter Cutoff Current		10	μA	I_C = 0	V_{EB} = 3.0 V
C_{ob}	Output Capacitance		4.0	pf	I_E = 0	V_{CB} = 10 V
T_{on}	Turn On Time		20	nsec	See Figure 2	
T_{off}	Turn Off Time		35	nsec	See Figure 2	
τ_s	Charge Storage Time Constant		35	nsec	See Figure 1	
BV_{CBO}	Collector to Base Breakdown Voltage	25		Volts	I_C = 10 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0		Volts	I_E = 10 μA	I_C = 0

* 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 175°C and junction-to-case thermal resistance of 150°C/watt (derating factor of 6.67 mW/°C); junction-to-ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).

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FIGURE 1—Charge storage time constant measurement circuit

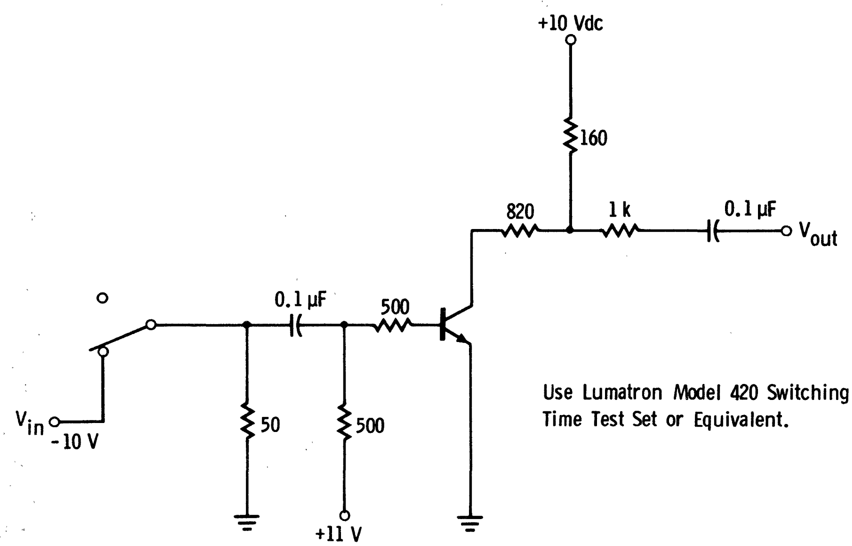
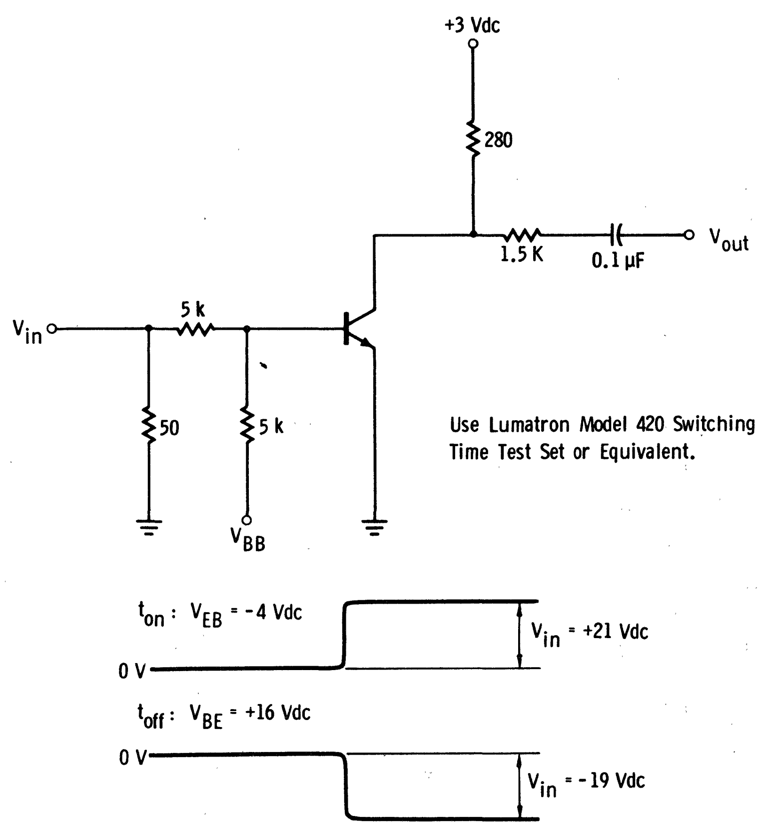


FIGURE 2—Turn-on and turn-off time measurement circuit

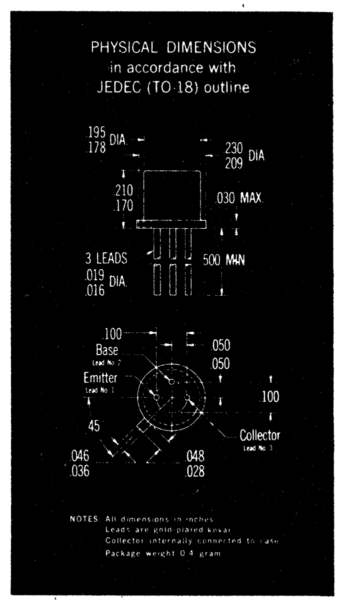


2N869

PNP NON-SATURATING SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR TRANSISTOR

GENERAL DESCRIPTION - The 2N869 is a double diffused silicon PNP planar transistor packaged in the JEDEC TO-18 outline. It is designed as a high-frequency general-purpose transistor and is used to advantage in complementary type circuits with the 2N916. Typical f_T is 150 mc.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	[Note 2 & 3]	1.2 Watts
at 100°C Case Temperature	[Note 2 & 3]	.68 Watt
at 25°C Ambient Temperature		.36 Watt

Maximum Voltages

V_{CBO} – Collector to Base Voltage		-25 Volts
V_{CER} – Collector to Emitter Voltage	($R_{BE} \leq 10\ \Omega$) [Note 4]	-25 Volts
V_{CEO} – Collector to Emitter Voltage	[Note 4]	-18 Volts
V_{EBO} – Emitter to Base Voltage		-5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain [Note 5]	20			I_C = 10 mA	V_{CE} = -5.0 V
V_{BE}(sat)	Base Saturation Voltage		-1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		-1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	High Frequency Current Gain f = 100 mc	1.0			I_C = 10 mA	V_{CE} = -15 V
C_{ob}	Output Capacitance		9.0	pf	I_E = 0	V_{CB} = -10 V
C_{TE}	Emitter Transition Capacitance		11	pf	I_C = 0	V_{EB} = -0.5 V
I_{CBO}	Collector Cutoff Current		10	mμA	I_E = 0	V_{CB} = -15 V
I_{CBO}(150°C)	Collector Cutoff Current		25	μA	I_E = 0	V_{CB} = -15 V
BV_{CBO}	Collector to Base Breakdown Voltage [Note 4]	-25		Volts	I_C = 10 μA	I_E = 0
V_{CER}(sust)	Collector to Emitter Sustaining Voltage [Note 4]	-25		Volts	I_C = 30 mA (pulsed)	$R_{BE} \leq$ 10 Ω
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		Volts	I_C = 0	I_E = 10 μA

(See notes on back page)

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NOTES:

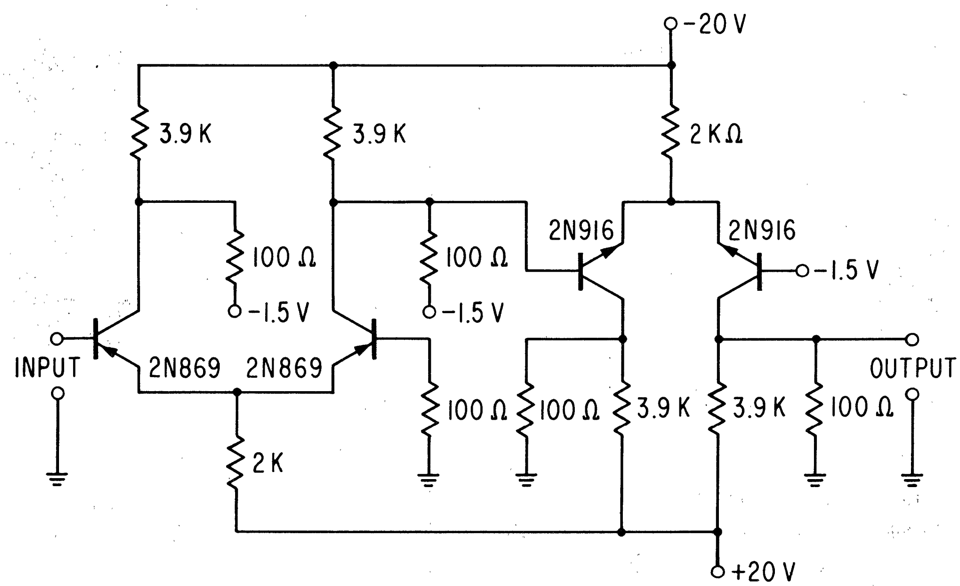
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.

(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).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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



COMPLEMENTARY HIGH SPEED NON-SATURATED
STEERING LOGIC CURRENT
t_{pd} < 5 nsec/stage

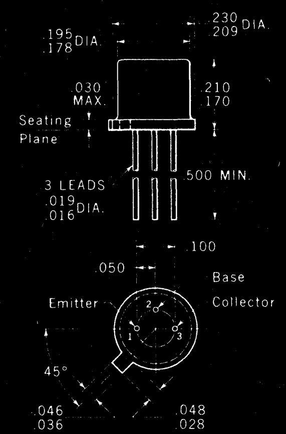
2N869A

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

The **2N869A** is a 550 mc PNP diffused silicon PLANAR epitaxial transistor designed for saturated and non-saturated switching circuits requiring up to 200 milliamperes of collector current. It is also suitable for most small-signal RF amplifier applications. This transistor is designed to meet the environmental requirements of MIL-S-19500.

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 RATING [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+200°C**
Operating Junction 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 Current

V_{CBO}	Collector to Base Voltage	**−25** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**−18** Volts
V_{EBO}	Emitter to Base Voltage	**−5.0** Volts
I_C	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**	**75**	**120**		$I_C = 30$ mA	$V_{CE} = -0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**30**	**67**			$I_C = 10$ mA	$V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**25**	**30**			$I_C = 100$ mA	$V_{CE} = -1.0$ V
V_{CE} (sat)	Collector Saturation Voltage		**−0.07**	**−0.15**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		**−0.1**	**−0.2**	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		**−0.28**	**−0.5**	Volts	$I_C = 100$ mA	$I_B = 10$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	**4.0**	**5.5**			$I_C = 10$ mA	$V_{CE} = -15$ V
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**−18**			Volts	$I_C = 10$ mA (pulsed	$I_B = 0$
t_{on}	Turn On Time [Note 6]		**23**	**50**	nsec	$I_C \approx 30$ mA	$I_{B1} \approx 1.5$ mA
t_{off}	Turn Off Time [Note 6]		**34**	**80**	nsec	$I_C \approx 30$ mA	$I_{B1} \approx 1.5$ mA, $I_{B2} \approx -1.5$ mA

Additional Electrical Characteristics on page 2.

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. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1} and I_{B2}.

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FAIRCHILD TRANSISTOR 2N869A

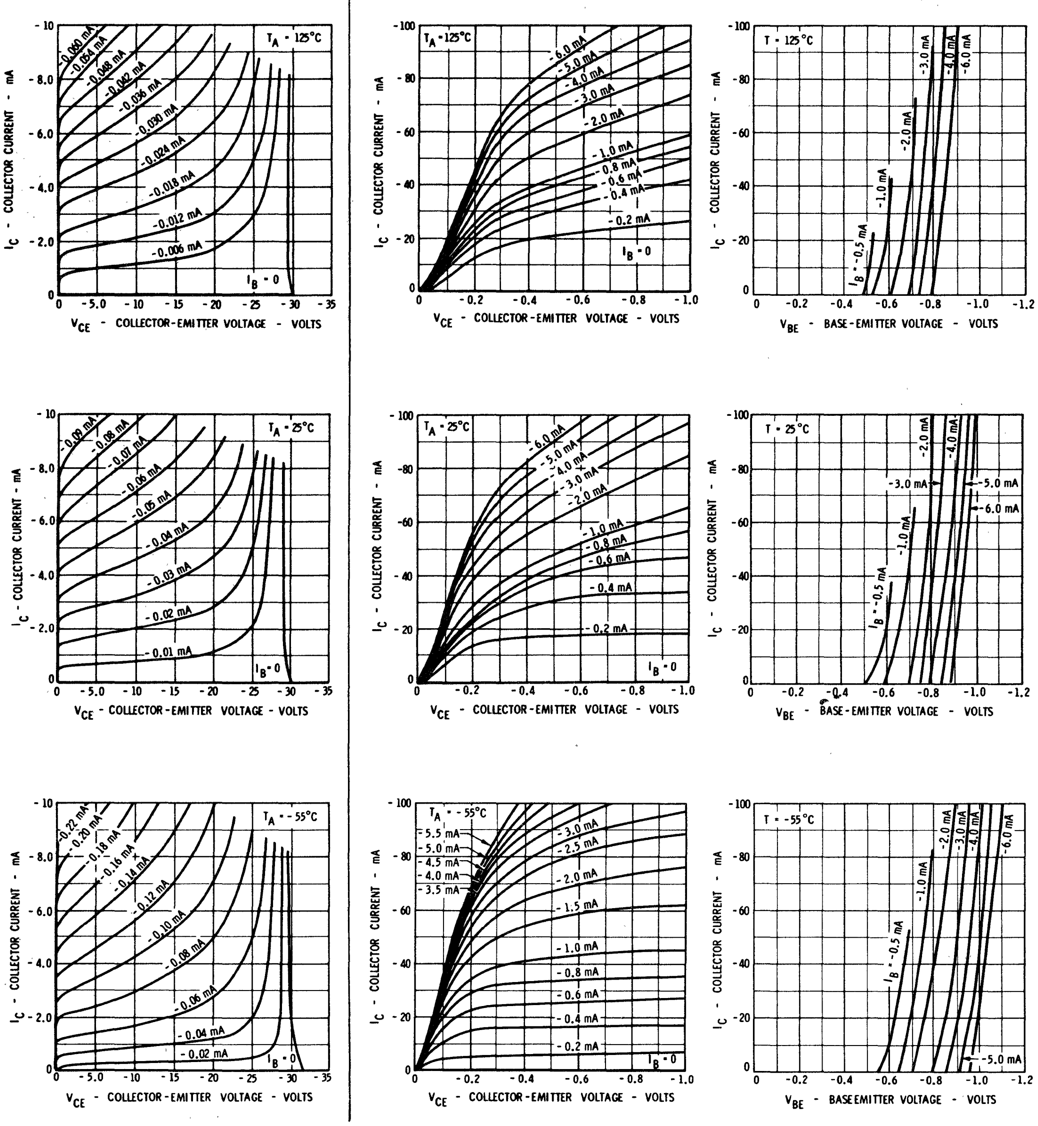
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	40	95	120		$I_C = 10$ mA	$V_{CE} = -5.0$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	17	43			$I_C = 30$ mA	$V_{CE} = -0.5$ V
V_{BE} (sat)	Base Saturation Voltage	−0.78	−0.92	−0.98	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE} (sat)	Base Saturation Voltage	−0.85	−1.1	−1.2	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{BE} (sat)	Base Saturation Voltage		−1.4	−1.7	Volts	$I_C = 100$ mA	$I_B = 10$ mA
I_{CES}	Collector Reverse Current		0.05	10	nA	$V_{CE} = -15$ V	$V_{BE} = 0$
I_{CBO} (150°C)	Collector Cutoff Current		0.1	25	μA	$V_{CB} = -15$ V	$I_E = 0$
C_{ob}	Output Capacitance		3.0	6.0	pf	$V_{CB} = -5.0$ V	$I_E = 0$
C_{TE}	Emitter Transition Capacitance		3.8	6.0	pf	$V_{EB} = -0.5$ V	$I_C = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−25			Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−25			Volts	$I_C = 10$ μA	$V_{EB} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0			Volts	$I_E = 10$ μA	$I_C = 0$

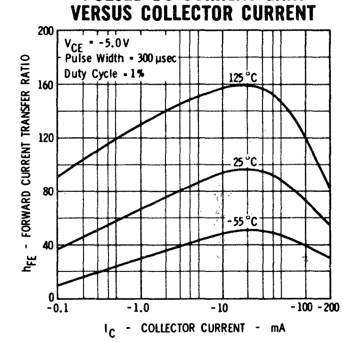
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

ACTIVE REGION

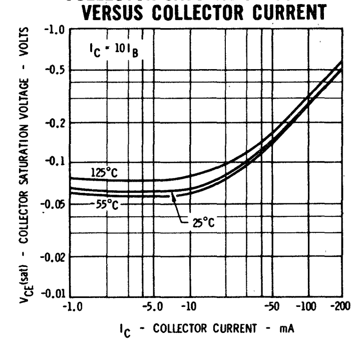
SATURATION REGION



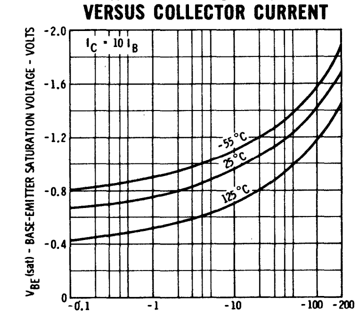
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



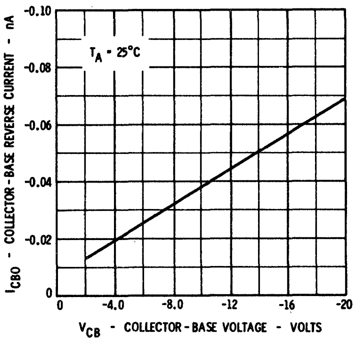
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



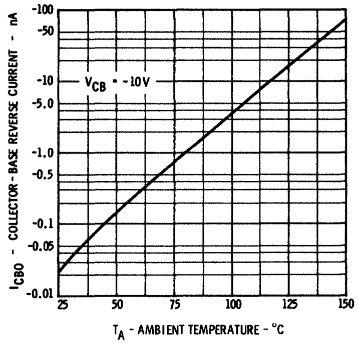
* Single family characteristics on Transistor Curve Tracer

TYPICAL ELECTRICAL CHARACTERISTICS

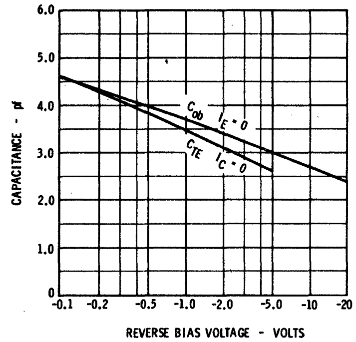
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



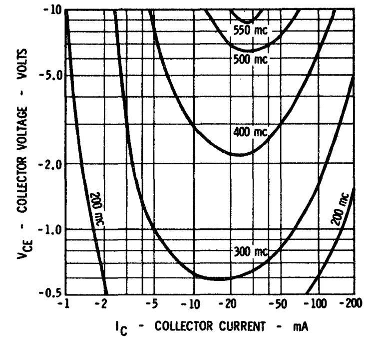
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



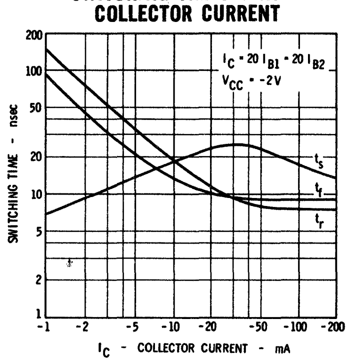
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



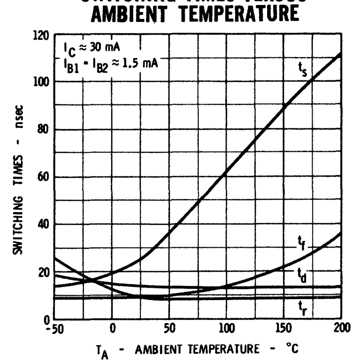
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



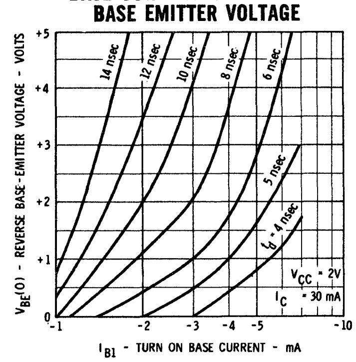
SWITCHING TIMES VERSUS COLLECTOR CURRENT



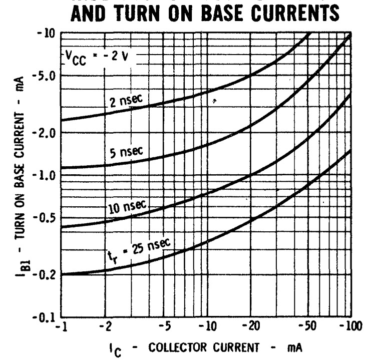
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



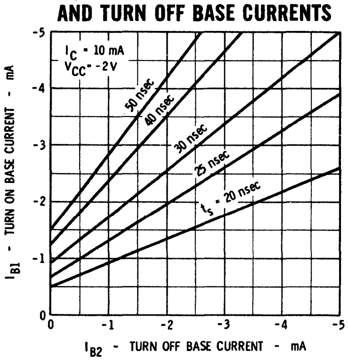
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



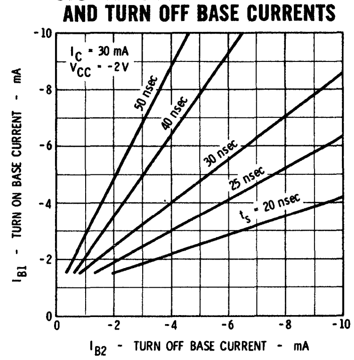
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



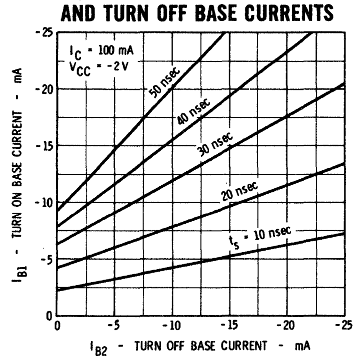
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



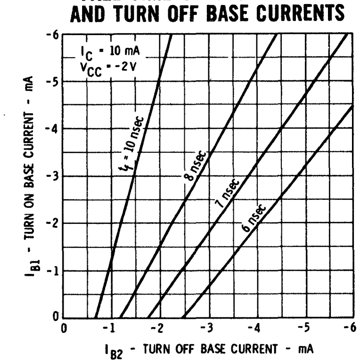
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



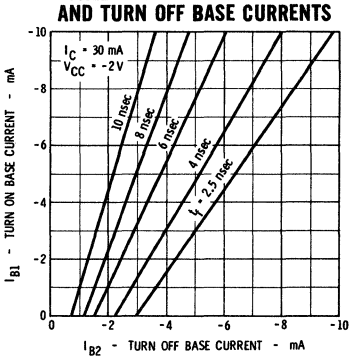
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



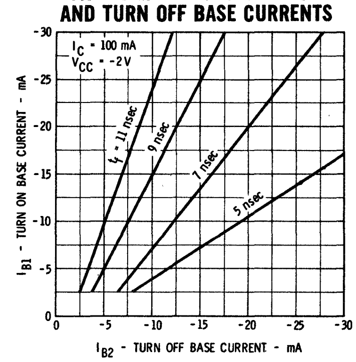
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



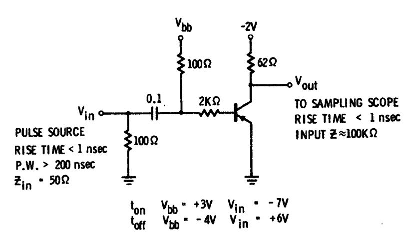
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

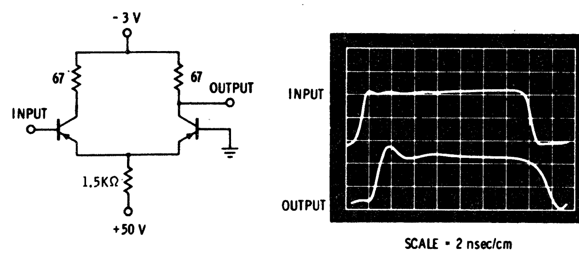


SWITCHING TIME TEST CIRCUIT



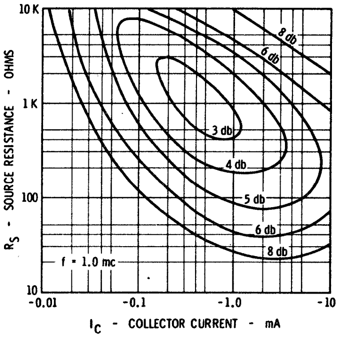
TYPICAL ELECTRICAL CHARACTERISTICS

NON SATURATED SWITCHING PERFORMANCE

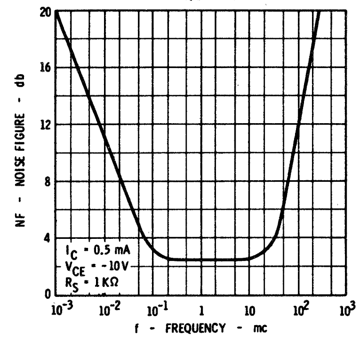


SCALE = 2 nsec/cm

NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT

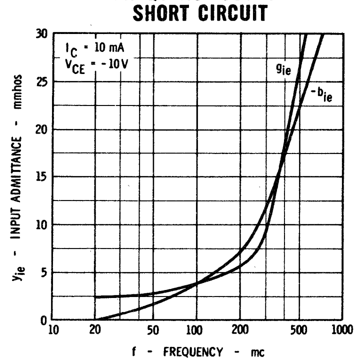


NOISE FIGURE VERSUS FREQUENCY

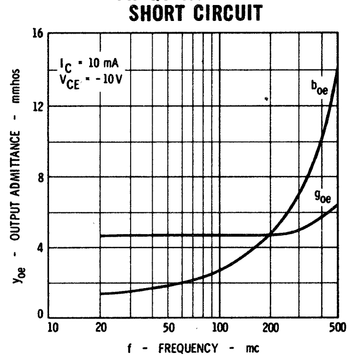


TYPICAL COMMON EMITTER "Y" PARAMETERS

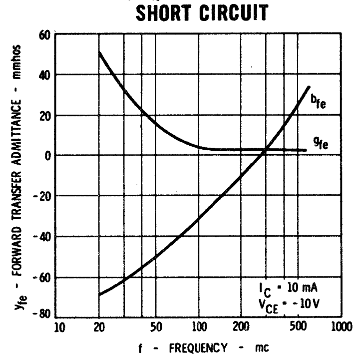
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



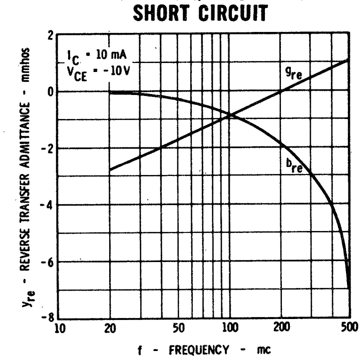
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



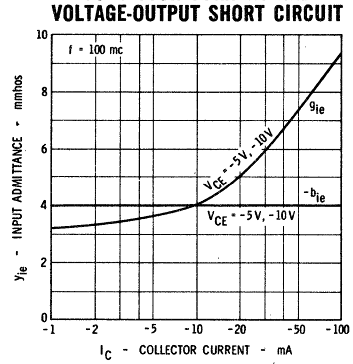
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



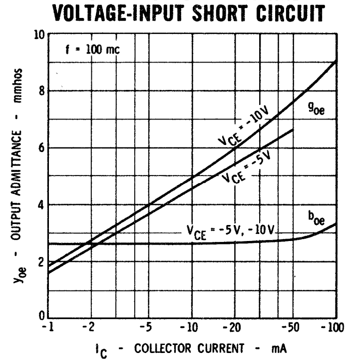
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



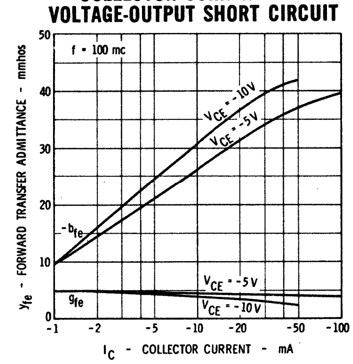
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



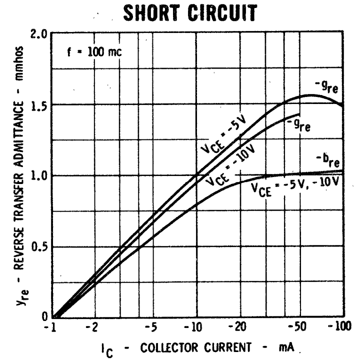
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



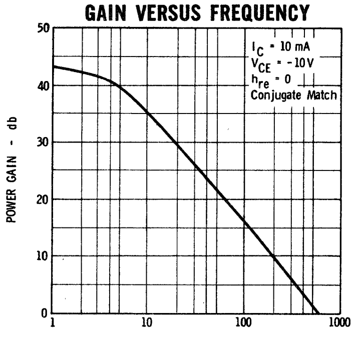
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



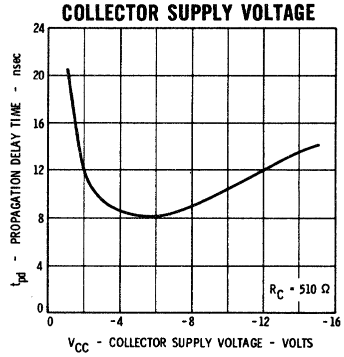
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



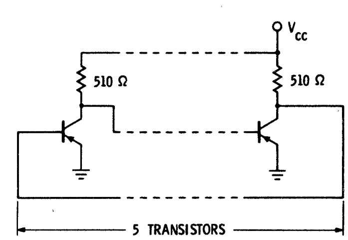
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



$$t_{pd} = \frac{1}{10 f_{osc}}$$

FM870 • 2N1889 • 2N870
FM871 • 2N1890 • 2N871

NPN HIGH VOLTAGE AMPLIFIER AND OSCILATOR TYPE

DIFFUSED SILICON PLANAR * TRANSISTORS

GENERAL DESCRIPTION — These transistors are designed for high voltage large signal amplifier and oscillator applications where PLANAR* reliability and performance are desired.

Low leakage (typically 50 nanoamperes at 100°C and 75 volts) together with nearly constant current gain over more than four decades substantially improves linearity in large signal high voltage applications such as servo motor drivers and some operational amplifiers. A typical gain bandwidth of 90 megahertz and low capacitance permit improved performance in high frequency circuits such as electrostatic deflection amplifiers for CRT's and high level video amplifiers.

These transistors are designed to meet the environmental requirements of MIL-S-19500.

ABSOLUTE MAXIMUM RATINGS [Note 1]

		FM870 FM871	2N1889 2N1890	2N870 2N871
Maximum Temperatures				
Storage Temperature		−65°C to +300°C All Units		
Operating Junction Temperature		200°C Maximum All Units		
Maximum Power Dissipation				
Total Dissipation at 25°C Case Temperature [Note 2 and 3]		4.0 Watts	3.0 Watts	1.8 Watts
at 100°C Case Temperature [Note 2 and 3]		2.3 Watts	1.7 Watts	1.0 Watt
at 25°C Ambient Temperature		0.375 Watt	0.8 Watt	0.5 Watt
Maximum Voltages				
V_{CBO}	Collector to Base Voltage	100 Volts	100 Volts	100 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\Omega$)[Note 4]	80 Volts	80 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	60 Volts	60 Volts	60 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts	7.0 Volts

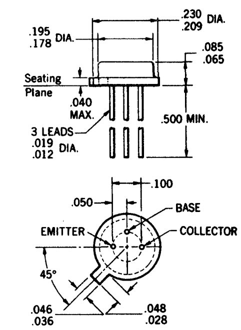
ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

		2N870•FM870 2N1889			2N871•FM871 2N1890					
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	40	75	120	100	130	300		$I_C = 150$ mA	$V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain [Note 5]	35	80			135			$I_C = 10$ mA	$V_{CE} = 10$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	20	40			65			$I_C = 10$ mA	$V_{CE} = 10$ V
h_{FE}	DC Current Gain	20	50			95			$I_C = 0.1$ mA	$V_{CE} = 10$ V
V_{BE} (sat)	Base Saturation Voltage		0.8	0.9		0.8	0.9	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.6	1.2		0.35	1.2	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{BE} (sat)	Base Saturation Voltage		0.9	1.3		0.9	1.3	Volts	$I_C = 150$ mA	$I_B = 15$ mA
V_{CE} (sat)	Collector Saturation Voltage		2.5	5.0		1.3	5.0	Volts	$I_C = 150$ mA	$I_B = 15$ mA
h_{fe}	High Frequency Current Gain f = 20 MHz	2.5	4.0		3.0	5.0			$I_C = 50$ mA	$V_{CE} = 10$ V
C_{obc}	Output Capacitance		13	15		13	15	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{TE}	Emitter Transition Capacitance		60	85		60	85	pF	$I_C = 0$	$V_{EB} = 0.5$ V
I_{CBO}	Collector Cutoff Current		0.4	10		0.4	10	nA	$I_E = 0$	$V_{CB} = 75$ V
I_{CBO} (150°C)	Collector Cutoff Current		1.0	15		1.0	15	μA	$I_E = 0$	$V_{CB} = 75$ V
BV_{CBO}	Collector to Base Breakdown Voltage	100			100			Volts	$I_C = 0$	$I_E = 0.1$ mA
V_{CER} (sust)	Collector to Emitter Sustaining Voltage [Note 4]	80			80			Volts	$I_C = 100$ mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 4]	60			60			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			7.0			Volts	$I_C = 0$	$I_E = 0.1$ mA
I_{EBO}	Emitter Cutoff Current		0.1	10		0.1	10	nA	$I_C = 0$	$V_{EB} = 5.0$ V

* Planar is a patented Fairchild process.

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-46) outline

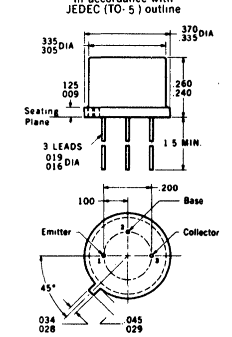


NOTES: All dimensions in inches
Leads are gold-plated Kovar
Lead No. 3 internally connected to case
Package weight is 0.34 gram

FM870 • FM871

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-5) outline

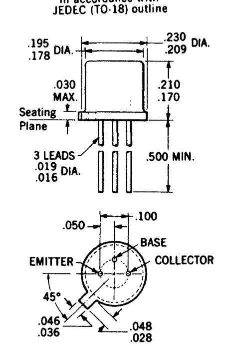


NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

2N1889 • 2N1890

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated Kovar*
Lead No. 3 internally connected to case
Package weight is 0.44 gram

2N870 • 2N871

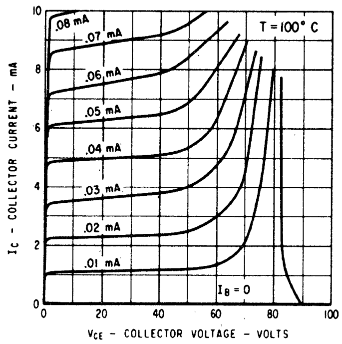
NOTES:

(1) These ratings are limiting values above which the serviceability of any 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. See thermal network on page 4 for typical pulse ratings.
(3) These ratings give a maximum junction temperature of 200°C and thermal resistance (junction-to-case) for the FM870 and FM871 of 43.7°C/watt (derating factor of 22.9 mW/°C); for the 2N1889 and 2N1890 58.3°C/watt (derating factor of 17.2 mW/°C) and for the 2N870 and 2N871 97.1°C/watt (derating factor of 10.3 mW/°C).
(4) These ratings refer to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

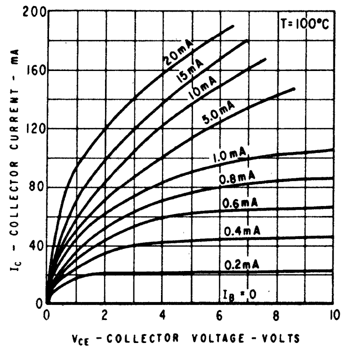
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL ELECTRICAL CHARACTERISTICS

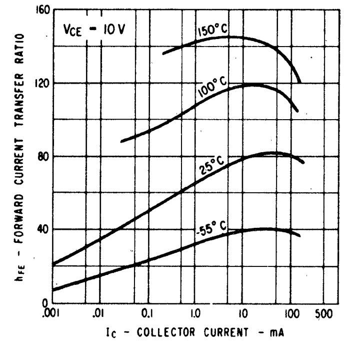
HIGH VOLTAGE COLLECTOR CHARACTERISTICS*



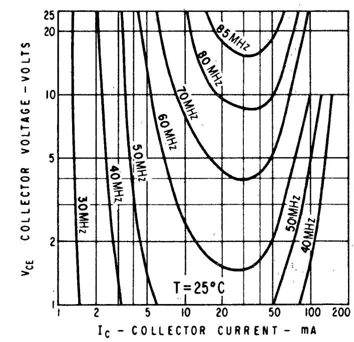
SATURATION REGION COLLECTOR CHARACTERISTICS*

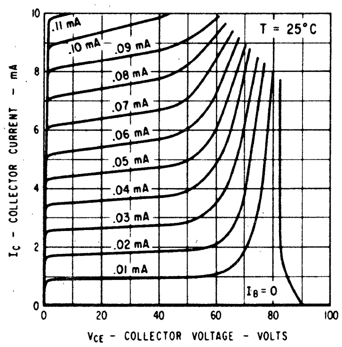


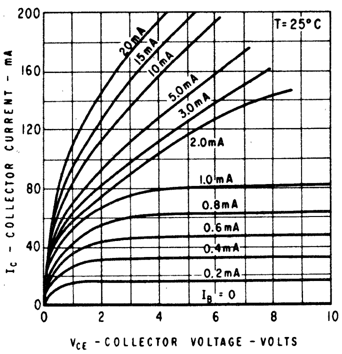
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



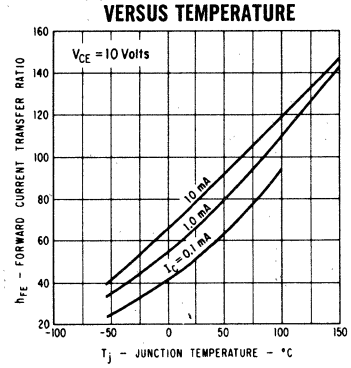
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



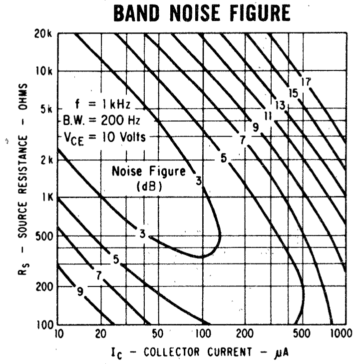


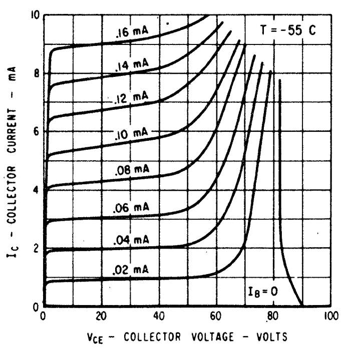


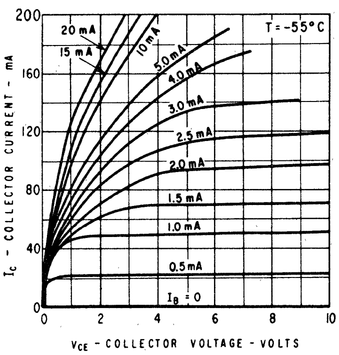
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



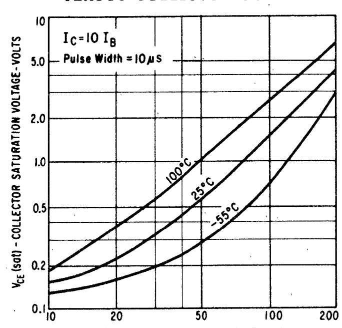
CONTOURS OF NARROW BAND NOISE FIGURE



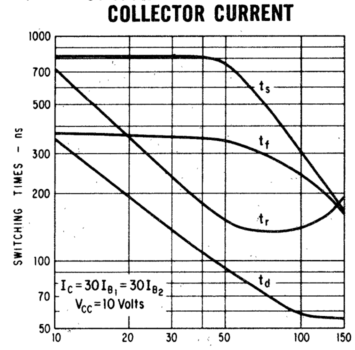




COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

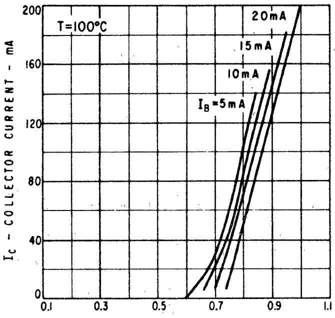


SWITCHING TIMES VERSUS COLLECTOR CURRENT

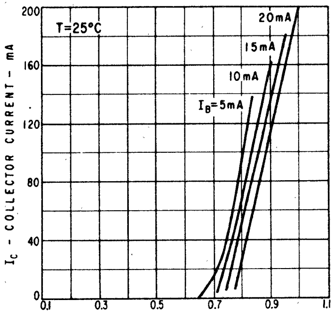


GRAPHS IN THIS SECTION APPLY TO ALL TRANSISTORS

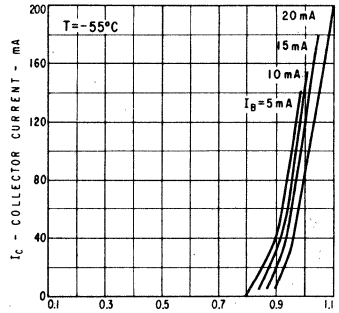
BASE CHARACTERISTICS*



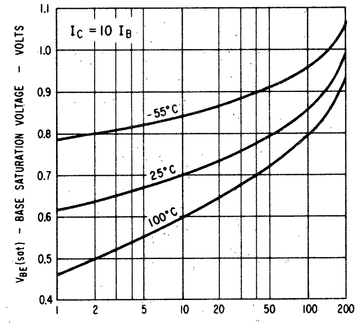
BASE CHARACTERISTICS*



BASE CHARACTERISTICS*



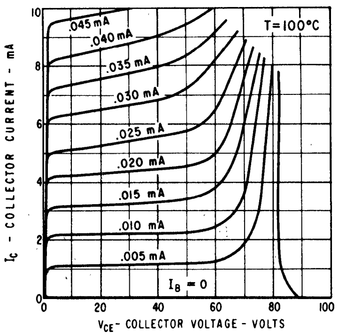
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

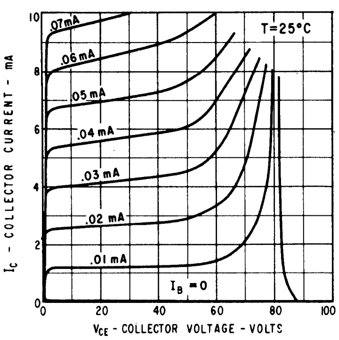


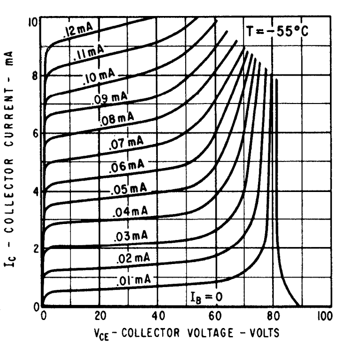
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

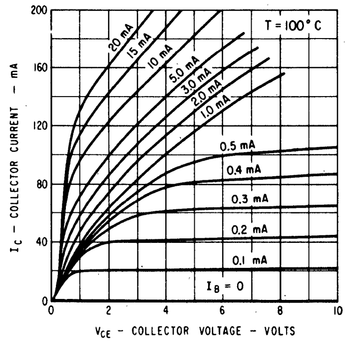
HIGH VOLTAGE COLLECTOR CHARACTERISTICS*

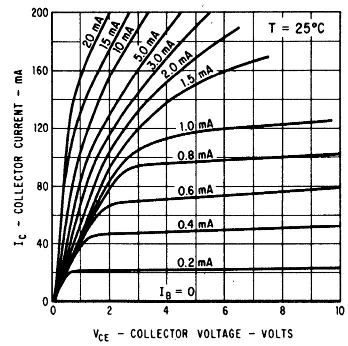


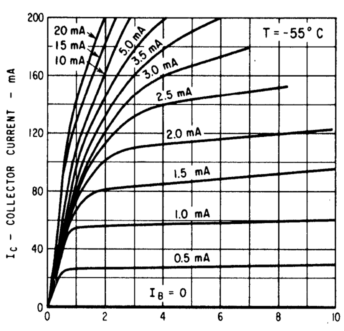




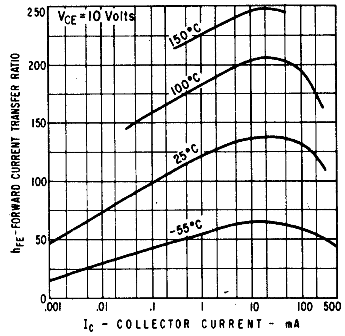
SATURATION REGION COLLECTOR CHARACTERISTICS*



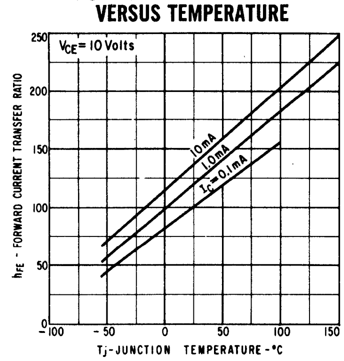




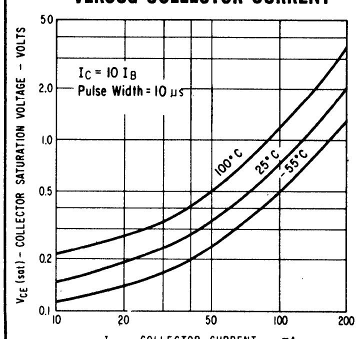
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



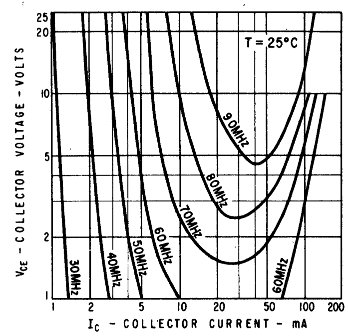
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



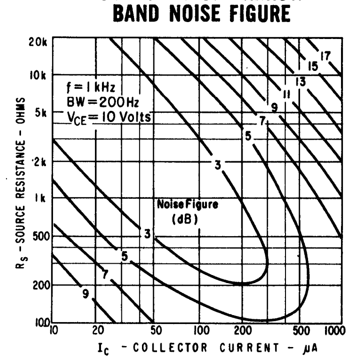
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



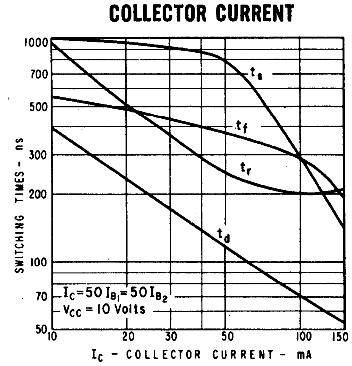
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



CONTOURS OF NARROW BAND NOISE FIGURE

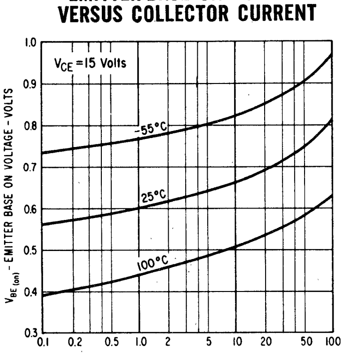


SWITCHING TIMES VERSUS COLLECTOR CURRENT

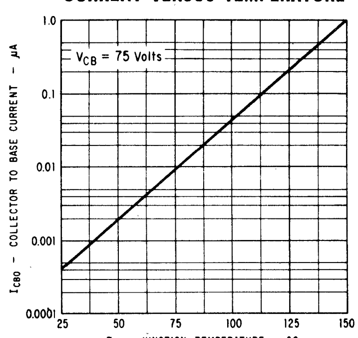


GRAPHS IN THIS SECTION APPLY TO ALL TRANSISTORS

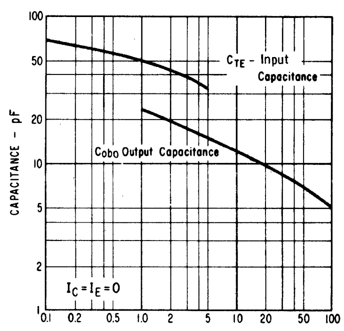
EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT



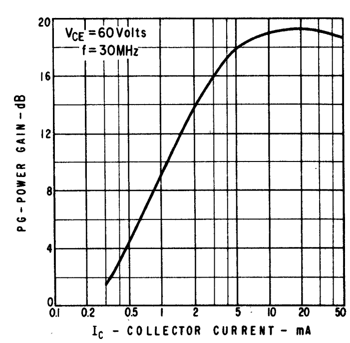
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



POWER GAIN VERSUS COLLECTOR CURRENT

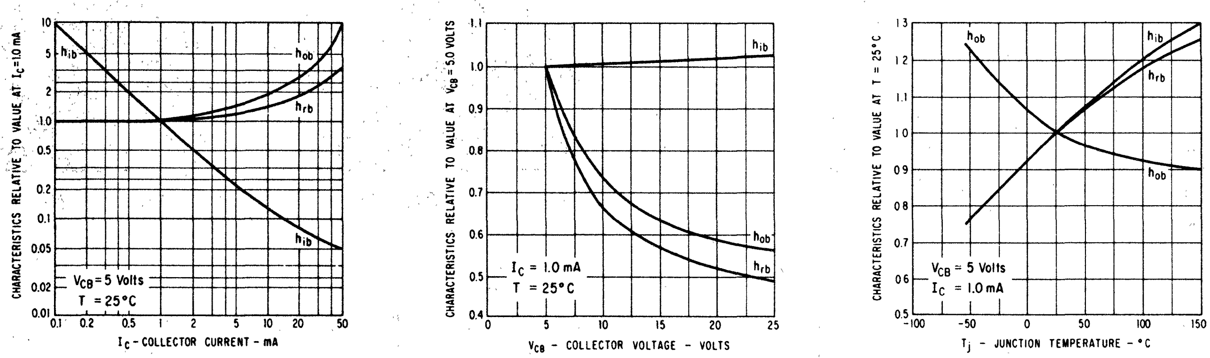


* Single family characteristic on Transistor Curve Tracer.

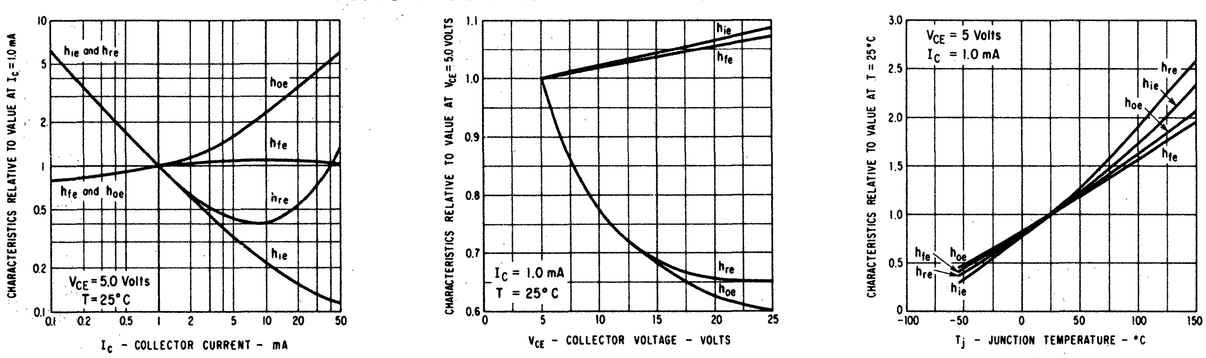
SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

SYMBOL	CHARACTERISTIC	FM870·2N1889 2N870 MIN.	TYP.	MAX.	FM871·2N1890 2N871 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{ib}	Input Resistance	20	26.9	30	20	27.5	30	ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ib}	Input Resistance	4.0	6.1	8.0	4.0	6.4	8.0	ohms	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{ob}	Output Conductance		0.12	0.5		0.15	0.3	μmho	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance		0.14	0.5		0.16	0.3	μmho	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{rb}	Voltage Feedback Ratio		0.52	1.25		0.92	1.50	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{rb}	Voltage Feedback Ratio		0.59	1.50		0.84	1.50	$x10^{-4}$	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{fe}	Small Signal Current Gain	30	72	100	50	125	200		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{fe}	Small Signal Current Gain	45	80	150	70	149	300		$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{ie}	Input Resistance		2.3			3.5		kohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance		9.0			16.5		μmho	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio		3.0			4.6		$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

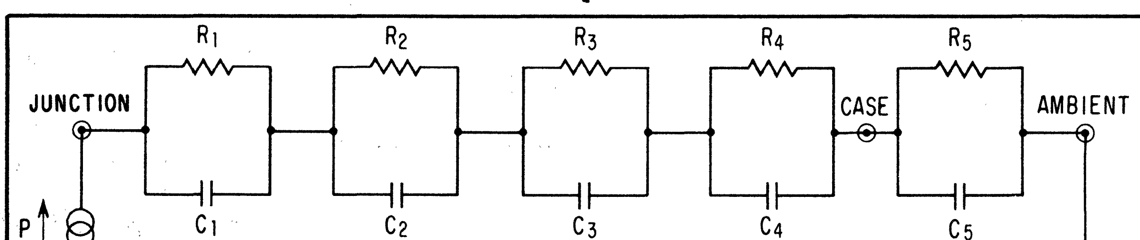
TYPICAL COMMON BASE CHARACTERISTICS



TYPICAL COMMON EMITTER CHARACTERISTICS



TYPICAL THERMAL EQUIVALENT CIRCUITS



	FM870 FM871	2N1889 2N1890	2N870 2N871	UNITS
R_1 =	5	5	5	°C/W
R_2 =	7	7	10	°C/W
R_3 =	7	15	20	°C/W
R_4 =	7	18	30	°C/W
R_5 =	360	125	240	°C/W

	FM870 FM871	2N1889 2N1890	2N870 2N871	UNITS
C_1 =	$50x10^{-6}$	$50x10^{-6}$	$50x10^{-6}$	joules/°C
C_2 =	$400x10^{-6}$	$570x10^{-6}$	$400x10^{-6}$	joules/°C
C_3 =	$3x10^{-3}$	$5x10^{-3}$	$3x10^{-3}$	joules/°C
C_4 =	$29 x 10^{-3}$	$55x10^{-3}$	$20x10^{-3}$	joules/°C
C_5 =	$83 x 10^{-3}$	$560x10^{-3}$	$188x10^{-3}$	joules/°C

	FM870 FM871	2N1889 2N1890	2N870 2N871	UNITS
τ_1 =	$250x10^{-6}$	$250x10^{-6}$	$250x10^{-6}$	sec
τ_2 =	$2.8x10^{-3}$	$4x10^{-3}$	$4x10^{-3}$	sec
τ_3 =	$20x10^{-3}$	$75x10^{-3}$	$60x10^{-3}$	sec
τ_4 =	$200x10^{-3}$	1	$600x10^{-3}$	sec
τ_5 =	30	70	45	sec

R = Thermal resistance in degrees Centigrade per watt.
C = Thermal capacitance in joules per degree Centigrade.
τ = Thermal time constant in seconds.
P = Power in watts.

2N910 • 2N911 • 2N912 • 2N1973 • 2N1974 • 2N1975

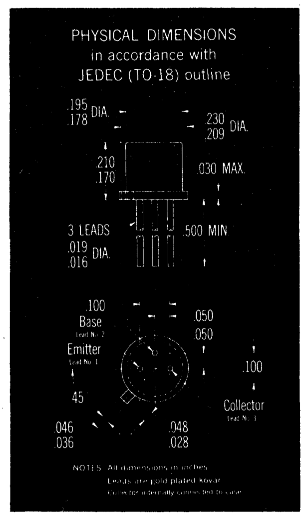
NPN SMALL SIGNAL

DIFFUSED SILICON PLANAR* TRANSISTORS

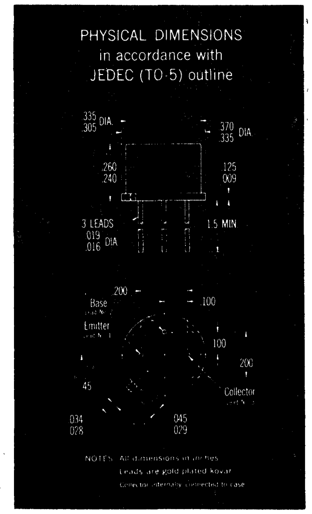
GENERAL DESCRIPTION - These NPN Double-Diffused Silicon Planar Transistors are designed for small-signal type applications. They replace grown junction and mesa types such as the 2N333 through 2N336 and 2N1564 through 2N1566. Their improved performance is reflected in lower noise... tighter parameter limits... lower leakage... and improved characteristic stability with age. The "h" parameters are specified at two operating levels. The three small-signal beta ranges, 76 to 200, 36 to 90 and 18 to 50; cover most small-signal applications. BV_{CBO} of 100 volts and f_T of 80 MHz offer a wide range of applications in Class-A amplifiers.

ABSOLUTE MAXIMUM RATINGS (25°C) (Note 1)

		2N910 2N911 2N912	2N1973 2N1974 2N1975
Maximum Temperatures			
Storage Temperature		-65°C to +300°C	-65°C to +300°C
Operating Junction Temperature		+200°C Maximum	+200°C Maximum
Maximum Power Dissipation (Notes 2 & 3)			
Total Dissipation at 25°C Case Temperature		1.8 Watts	3.0 Watts
at 100°C Case Temperature		1.0 Watt	1.7 Watts
at 25°C Ambient Temperature		0.5 Watt	0.8 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	100 Volts	100 Volts
V_{CER}	Collector to Emitter Sustaining Voltage	80 Volts	80 Volts
V_{CEO}	Collector to Emitter Sustaining Voltage	60 Volts	60 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts



2N910 2N911 2N912



2N1973 2N1974 2N1975

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

Symbol	Characteristics	2N910 2N1973 Min.	Typ.	Max.	2N911 2N1974 Min.	Typ.	Max.	2N912 2N1975 Min.	Typ.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	75	135		35	70		15	42			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	35	100		20	45		10	33			I_C = 0.1 mA V_{CE} = 10 V
h_{FE}(150°C)	DC Pulse Current Gain (Note 5)	30	50		15	30		10	15			I_C = 10 mA V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage	0.6	0.65	0.8	0.6	0.65	0.8	0.6	0.65	0.8	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.13	0.4		0.13	0.4		0.16	0.4	Volts	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage		0.72	0.9		0.73	0.9		0.7	0.9	Volts	I_C = 50 mA I_B = 5.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.22	1.2		0.22	1.2		0.24	1.2	Volts	I_C = 50 mA I_B = 5.0 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	4.0		2.5	3.5		2.0	3.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Output Capacitance			15			15			15	pF	I_E = 0 V_{CB} = 10 V
C_{ibo}	Input Capacitance			85			85			85	pF	I_C = 0 V_{EB} = 0.5 V
NF	Noise Figure (Note 6)			12			15			18	dB	I_C = 0.3 mA V_{CE} = 10 V
I_{CBO}	Collector Cutoff Current			25			25			25	mμA	I_E = 0 V_{CB} = 75 V
I_{CBO}(150°C)	Collector Cutoff Current			15			15			15	μA	I_E = 0 V_{CB} = 75 V
BV_{CBO}	Collector to Base Breakdown Voltage	100			100			100			Volts	I_C = 100 μA I_E = 0
V_{CER}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	80			80			80			Volts	I_C = 100 mA (pulsed) $R_{BE} \leq$ 10 Ω
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	60			60			60			Volts	I_C = 30 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			7.0			7.0			Volts	I_C = 0 I_E = 100 μA
I_{EBO}	Emitter Current			25			25			25	mμA	I_C = 0 V_{EB} = 5.0 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

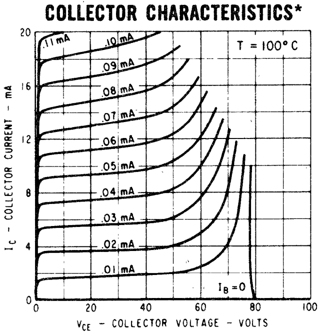
SMALL SIGNAL CHARACTERISTICS (f=1 kHZ)

Symbol	Characteristics	Min.	Typ.	Max.	Units	Test Conditions
h_{fe}	Small Signal Current Gain	76	125	200		I_C = 1.0 mA V_{CE} = 5.0 V
h_{fe}	Small Signal Current Gain	80	140	200		I_C = 5.0 mA V_{CE} = 5.0 V
h_{ib}	Input Resistance	20	26	30	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ib}	Input Resistance	4.0	6.0	8.0	Ohms	I_C = 5.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.75	3.0	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.95	4.0	$x10^{-4}$	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.13	0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.2	1.0	μmho	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ie}	Input Resistance		1000	1800	Ohms	I_C = 5.0 mA V_{CE} = 5.0 V
h_{oe}	Output Conductance		20	100	μmho	I_C = 5.0 mA V_{CE} = 5.0 V

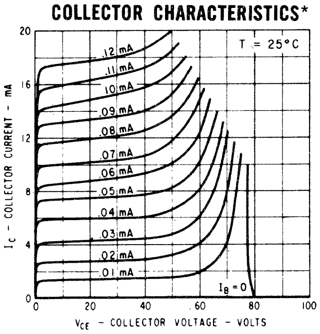
TYPICAL ELECTRICAL CHARACTERISTICS

HIGH VOLTAGE

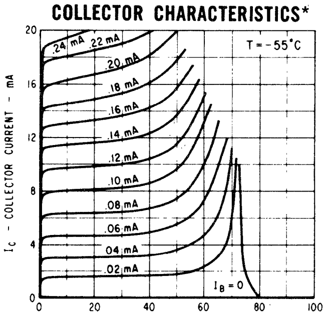
COLLECTOR CHARACTERISTICS*



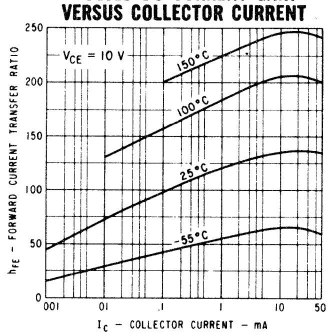
COLLECTOR CHARACTERISTICS*



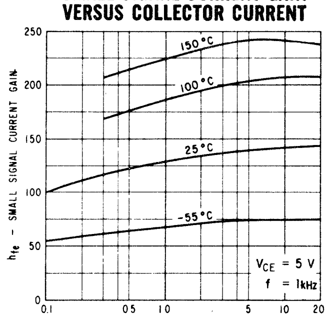
COLLECTOR CHARACTERISTICS*



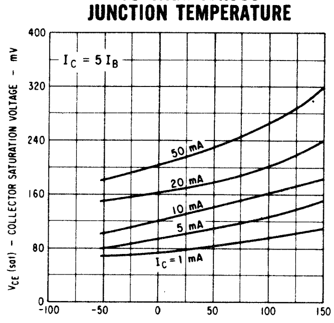
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



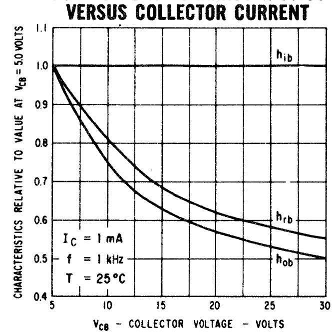
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



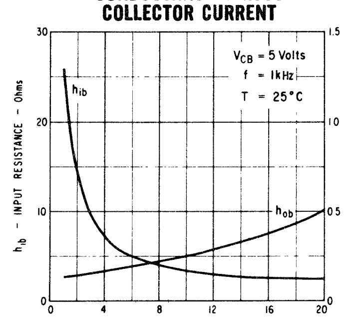
COLLECTOR SATURATION VOLTAGE VERSUS JUNCTION TEMPERATURE



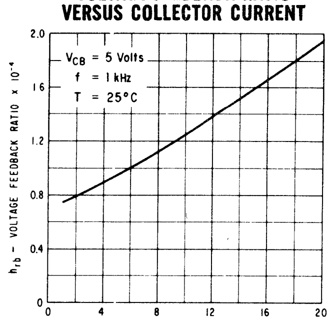
COMMON BASE CHARACTERISTICS VERSUS COLLECTOR CURRENT



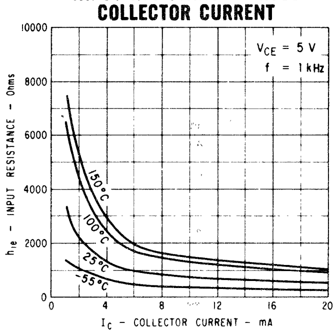
INPUT RESISTANCE AND OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



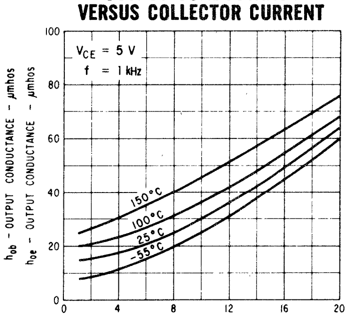
VOLTAGE FEEDBACK RATIO VERSUS COLLECTOR CURRENT



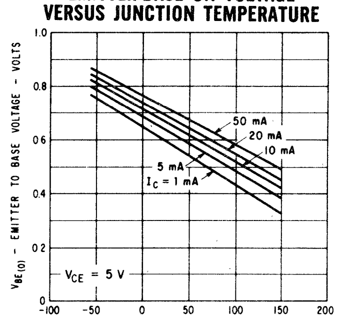
INPUT RESISTANCE VERSUS COLLECTOR CURRENT



OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



EMITTER-BASE ON VOLTAGE VERSUS JUNCTION TEMPERATURE



* Single family characteristics on Transistor Curve Tracer.

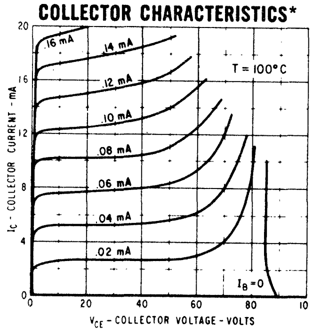
SMALL SIGNAL CHARACTERISTICS (f=1 kHZ)

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{fe}	Small Signal Current Gain	36	65	90		I_C = 1.0 mA V_{CE} = 5.0 V
h_{fe}	Small Signal Current Gain	40	70	100		I_C = 5.0 mA V_{CE} = 5.0 V
h_{ib}	Input Resistance	20	25	30	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ib}	Input Resistance	4.0	6.0	8.0	Ohms	I_C = 5.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.45	1.25	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.7	1.75	$x10^{-4}$	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.13	0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.15	1.0	μmho	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ie}	Input Resistance		600	1000	Ohms	I_C = 5.0 mA V_{CE} = 5.0 V
h_{oe}	Output Conductance		10	50	μmho	I_C = 5.0 mA V_{CE} = 5.0 V

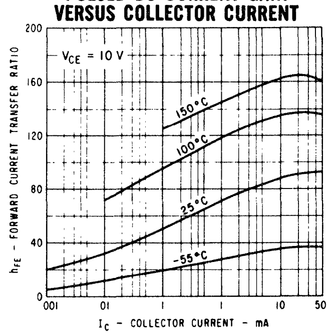
TYPICAL ELECTRICAL CHARACTERISTICS

HIGH VOLTAGE

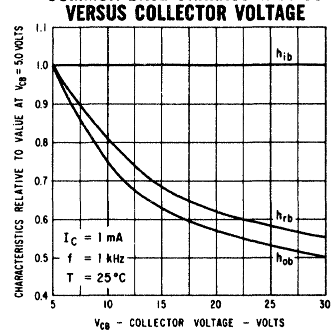
COLLECTOR CHARACTERISTICS*



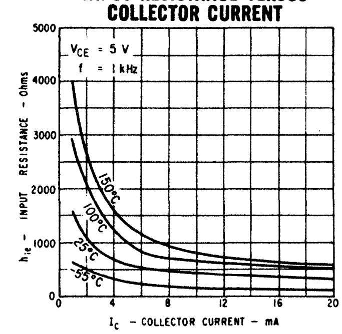
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



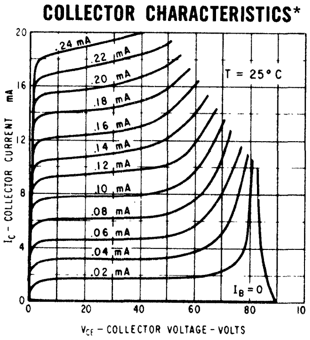
COMMON BASE CHARACTERISTICS VERSUS COLLECTOR VOLTAGE



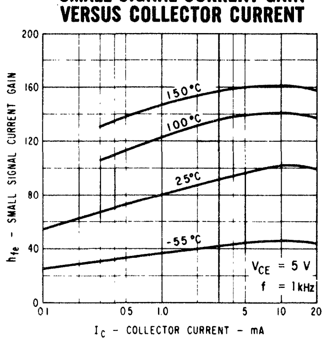
INPUT RESISTANCE VERSUS COLLECTOR CURRENT



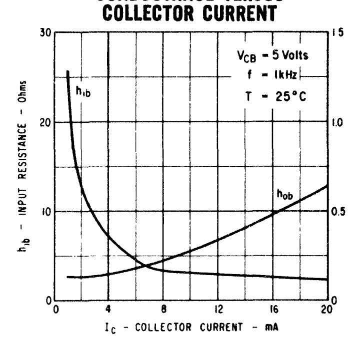
COLLECTOR CHARACTERISTICS*



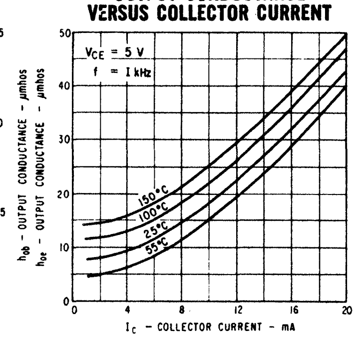
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



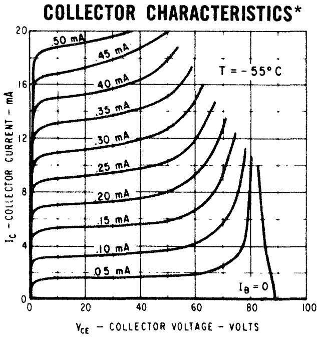
INPUT RESISTANCE AND OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



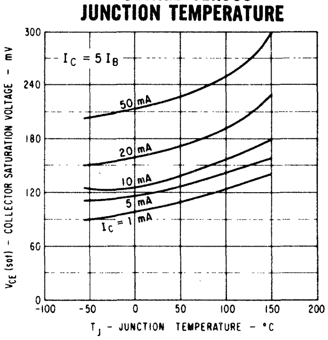
OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



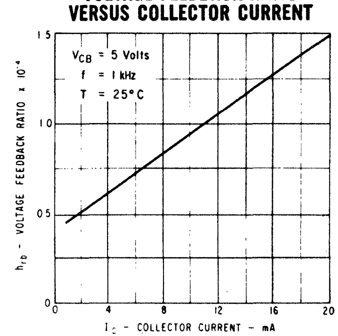
COLLECTOR CHARACTERISTICS*



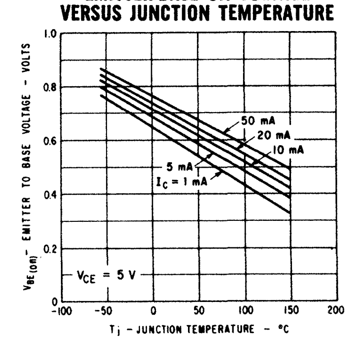
COLLECTOR SATURATION VOLTAGE VERSUS JUNCTION TEMPERATURE



VOLTAGE FEEDBACK RATIO VERSUS COLLECTOR CURRENT



EMITTER-BASE ON VOLTAGE VERSUS JUNCTION TEMPERATURE



* Single family characteristics on Transistor Curve Tracer.

SMALL SIGNAL CHARACTERISTICS (f=1 kHZ)

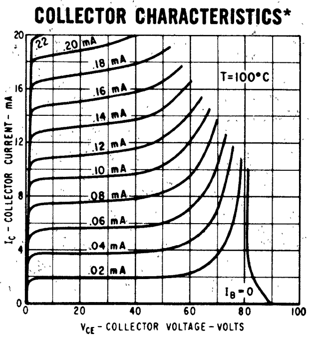
Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{fe}	Small Signal Current Gain	18	38	50		I_C = 1.0 mA V_{CE} = 5.0 V
h_{fe}	Small Signal Current Gain	20	45	50		I_C = 5.0 mA V_{CE} = 5.0 V
h_{ib}	Input Resistance	20	26	30	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ib}	Input Resistance	4.0	6.0	8.0	Ohms	I_C = 5.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.3	1.25	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		0.5	1.75	$x10^{-4}$	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.13	0.5	µmho	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance		0.2	1.0	µmho	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ie}	Input Resistance		350	600	Ohms	I_C = 5.0 mA V_{CE} = 5.0 V
h_{oe}	Output Conductance		8.0	25	µmho	I_C = 5.0 mA V_{CE} = 5.0 V

NOTES:
(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operation.
(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N1973, 2N1974, and 2N1975; for the 2N910, 2N911, and 2N912 97.3°C/Watt (derating factor of 10.3 mW/°C). Junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the 2N1973, 2N1974, and 2N1975; for the 2N910, 2N911, and 2N912 350°C/Watt (derating factor of 2.86 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 µsec; duty cycle ≤ 2%.
(6) Frequency = 1000 Hz, 200 Hz bandwidth, R_g = 510 Ω.

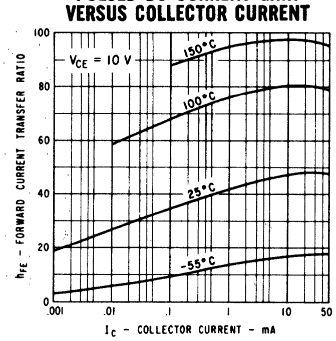
HIGH VOLTAGE

TYPICAL ELECTRICAL CHARACTERISTICS

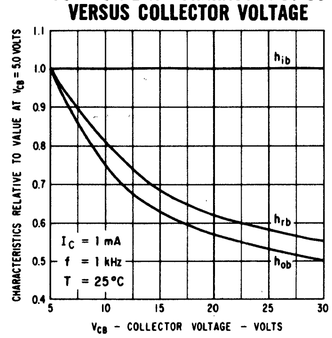
COLLECTOR CHARACTERISTICS*



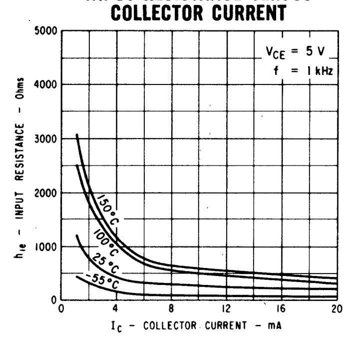
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



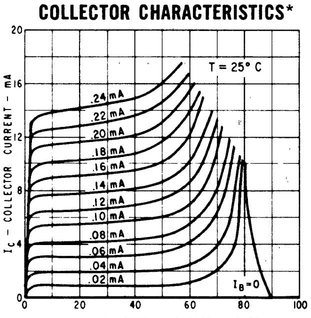
COMMON BASE CHARACTERISTICS VERSUS COLLECTOR VOLTAGE



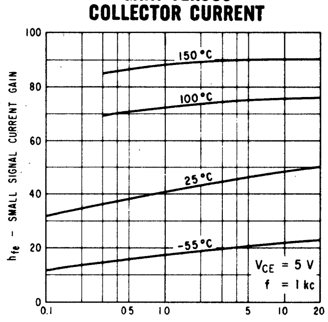
INPUT RESISTANCE VERSUS COLLECTOR CURRENT



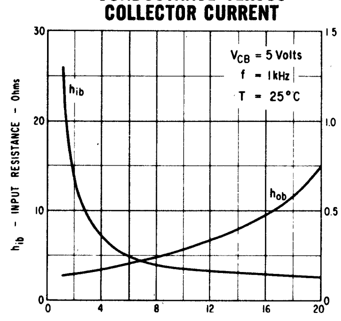
COLLECTOR CHARACTERISTICS*



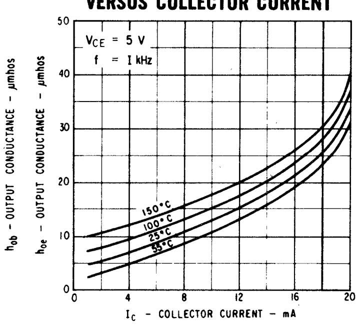
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



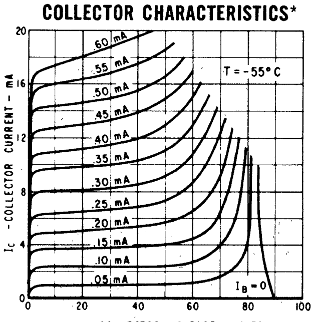
INPUT RESISTANCE AND OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



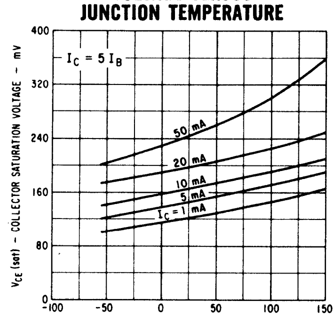
OUTPUT CONDUCTANCE VERSUS COLLECTOR CURRENT



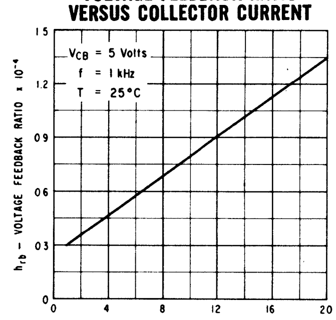
COLLECTOR CHARACTERISTICS*



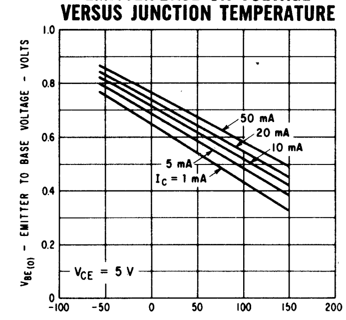
COLLECTOR SATURATION VOLTAGE VERSUS JUNCTION TEMPERATURE



VOLTAGE FEEDBACK RATIO VERSUS COLLECTOR CURRENT



EMITTER-BASE ON VOLTAGE VERSUS JUNCTION TEMPERATURE



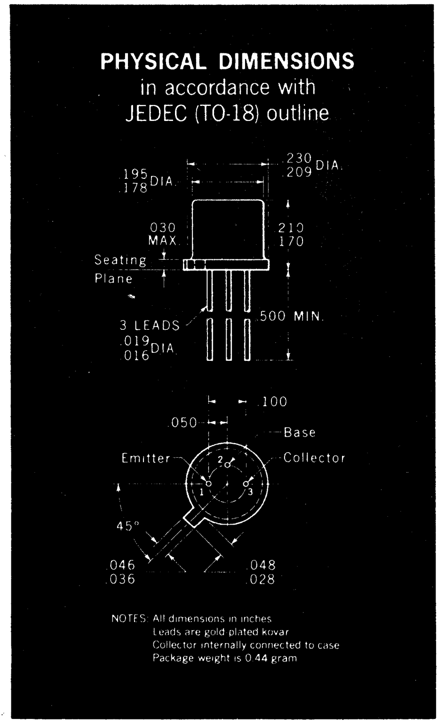
* Single family characteristics on Transistor Curve Tracer

2N914

NPN SATURATED LOGIC SWITCH AND VHF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The 2N914 is an NPN Double-Diffused Silicon Planar Epitaxial Transistor encased in the JEDEC TO-18 package. It provides improved operation over the popular 2N706 and 2N708, and also gives greater latitude in circuit design. The Planar structure provides low leakage currents, wide beta range, and superior reliability. The epitaxial feature gives an extremely low V_{CE}(sat) that is relatively temperature insensitive. The 2N914 is primarily a universal switch but it is also an excellent high-speed high-gain logic and memory driver at collector currents up to 500 milliamperes.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Solder, No 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

V_{CBO}	Collector to Base Voltage	40 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\,\Omega$) (Note 4)	20 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	15 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts

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

Symbol	†FACT Subgroup	Characteristics		Min.	Typ.	Max.	Units	Test Conditions
*h_{FE}	1a	DC Pulse Current Gain	(Note 5)	30	55	120		I_C = 10 mA V_{CE} = 1.0 V
h_{FE}(-55°C)	4	DC Pulse Current Gain	(Note 5)	12	28			I_C = 10 mA V_{CE} = 1.0 V
h_{FE}	4	DC Pulse Current Gain	(Note 5)	10	17			I_C = 500 mA V_{CE} = 5.0 V
*V_{BE}(sat)	1a	Base Saturation Voltage		0.70	0.74	0.80	Volts	I_C = 10 mA I_B = 1.0 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage			0.40	0.70	Volts	I_C = 200 mA I_B = 20 mA
V_{CE}(sat)	4	Collector Saturation Voltage (-55°C to +125°C)	(Note 6)		0.20	0.25	Volts	I_C = 10 I_B
h_{fe}	4	High Frequency Current Gain (f = 100 Mc)		3.0	3.7			I_C = 20 mA V_{CE} = 10 V
C_{obo}	4	Output Capacitance			4.5	6.0	pf	I_E = 0 V_{CB} = 10 V
C_{ibo}	4	Input Capacitance				9.0	pf	I_C = 0 V_{EB} = 0.5 V

†NOTE: These numerals apply to the Fairchild FACT Program.

*NOTE: FACT Program End-Point Measurement Parameter.

Additional Electrical Characteristics on page 4

FAIRCHILD SEMICONDUCTOR

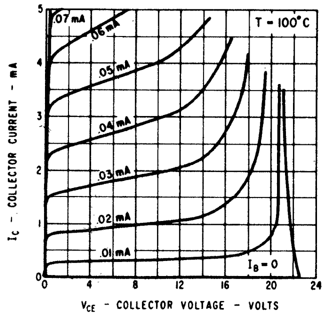
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

TYPICAL COLLECTOR AND BASE CHARACTERISTICS *

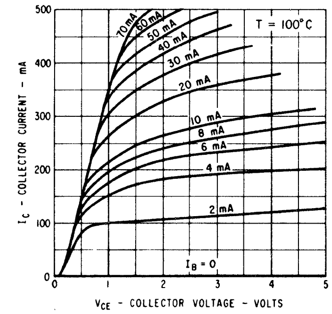
ACTIVE REGION

COLLECTOR CHARACTERISTIC

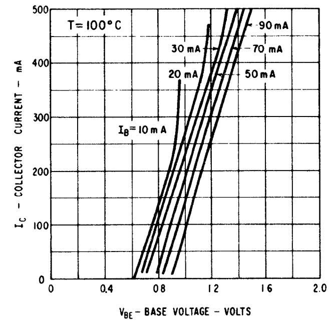


SATURATION REGION

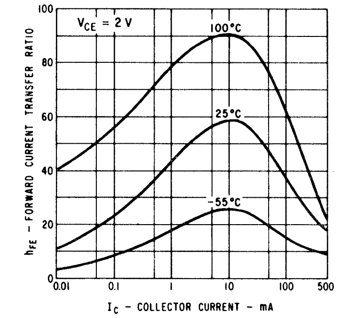
COLLECTOR CHARACTERISTICS



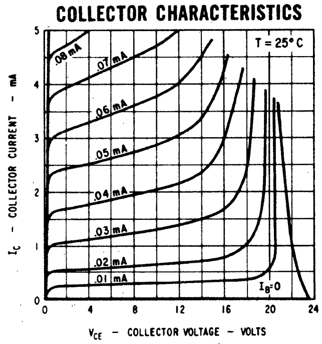
BASE CHARACTERISTICS



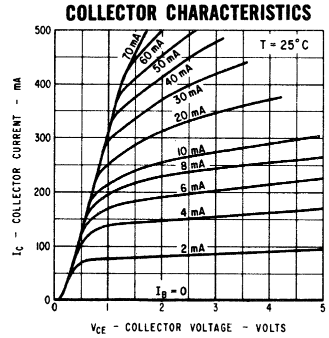
PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT



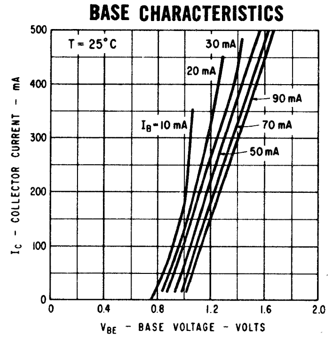
COLLECTOR CHARACTERISTICS



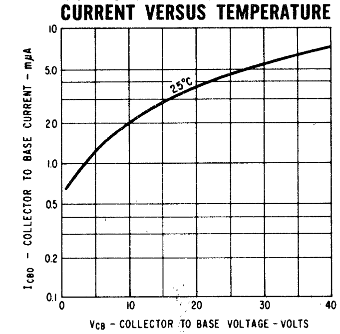
COLLECTOR CHARACTERISTICS



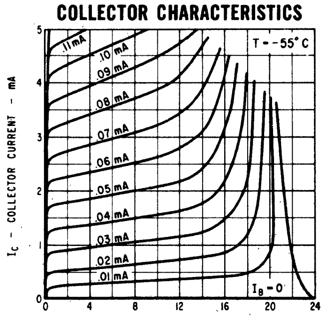
BASE CHARACTERISTICS



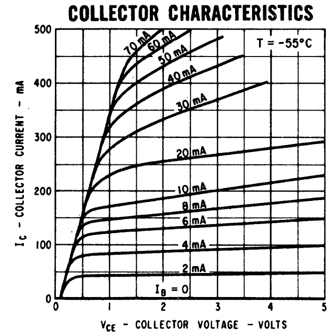
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



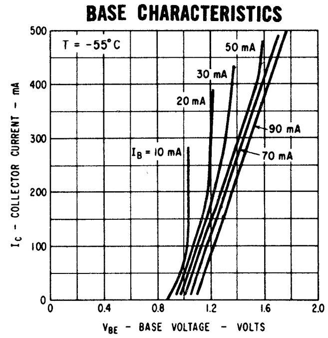
COLLECTOR CHARACTERISTICS



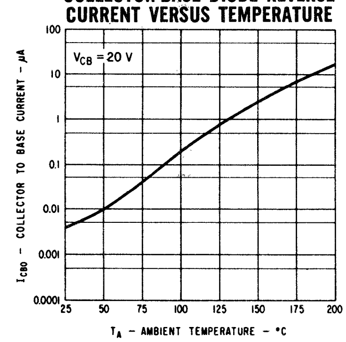
COLLECTOR CHARACTERISTICS



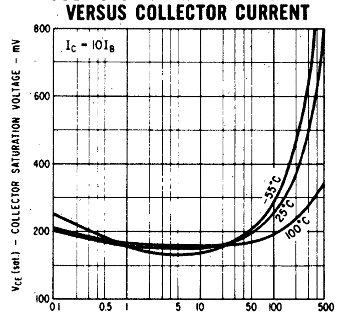
BASE CHARACTERISTICS



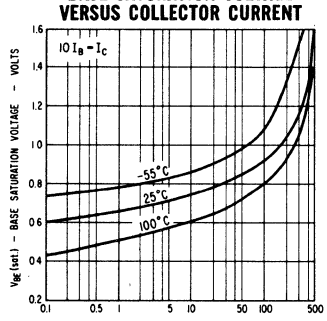
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



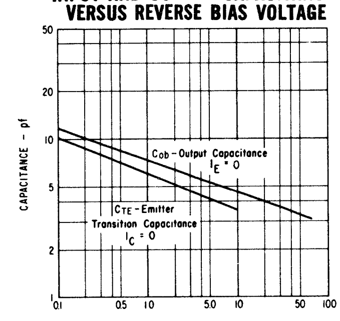
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



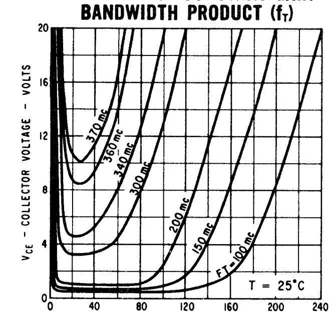
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



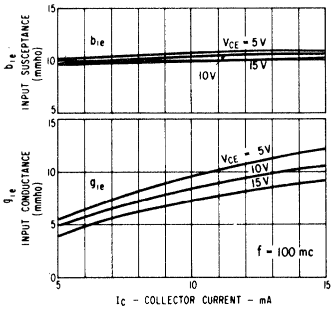
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



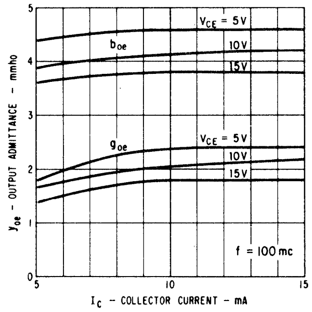
* Single family characteristics on Transistor Curve Tracer

TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

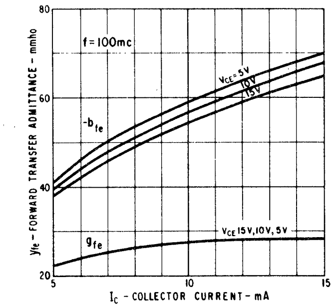
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



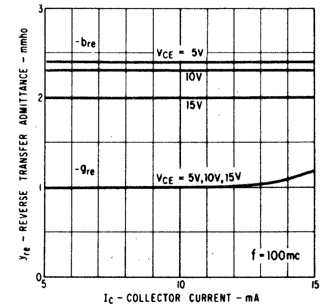
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



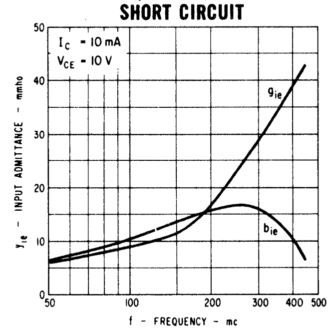
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



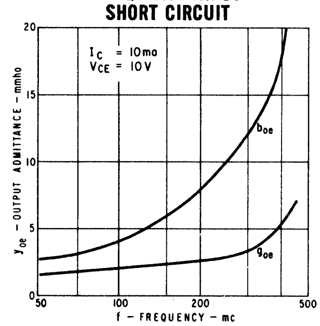
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



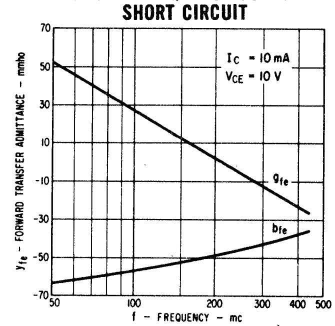
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



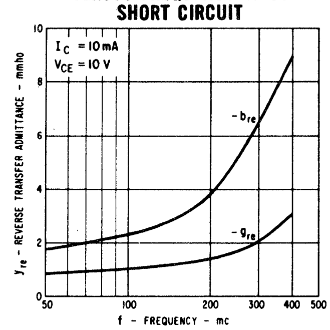
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT

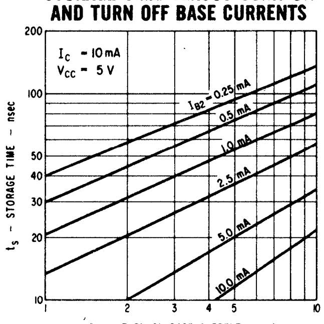


REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT

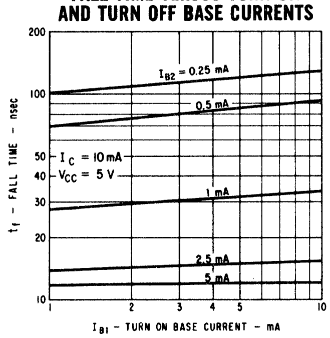


TYPICAL SWITCHING CHARACTERISTICS

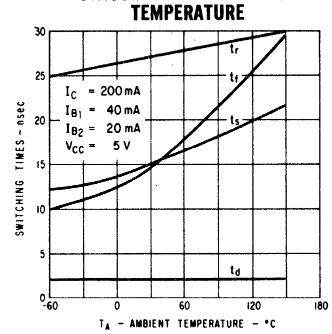
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



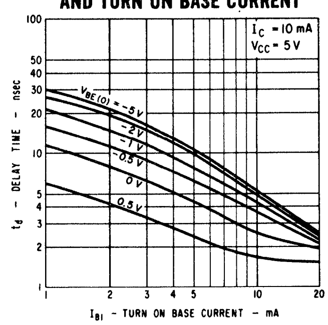
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



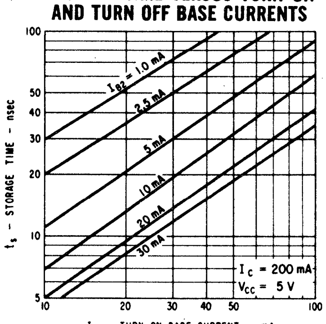
SWITCHING TIMES VERSUS TEMPERATURE



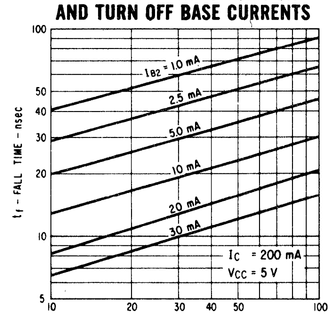
DELAY TIME VERSUS $V_{BE(o)}$ AND TURN ON BASE CURRENT



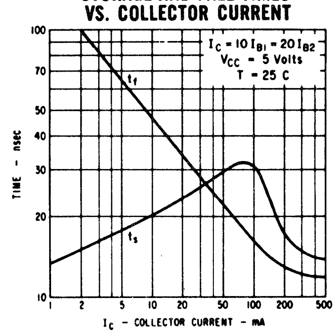
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



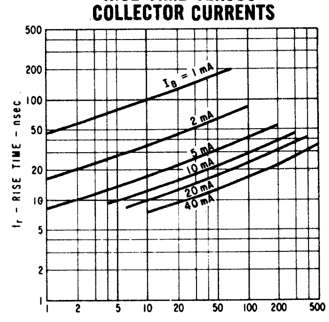
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



STORAGE AND FALL TIMES VS. COLLECTOR CURRENT



RISE TIME VERSUS COLLECTOR CURRENTS



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

Symbol	†FACT Subgroup	Characteristics	Min.	Typ.	Max.	Units	Test Conditions
$^{*}I_{CBO}$	1b	Collector Cutoff Current		4.0	25	mμA	$I_E = 0$ $V_{CB} = 20$ V
$I_{CBO}(150°C)$	4	Collector Cutoff Current		3.0	15	μA	$I_E = 0$ $V_{CB} = 20$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	40			Volts	$I_C = 1.0$ μA $I_E = 0$
$V_{CER}(sust)$	4	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	20			Volts	$I_C = 30$ mA (pulsed) $R_{BE} \leq 10$ Ω
$V_{CEO}(sust)$	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	15			Volts	$I_C = 30$ mA (pulsed) $I_B = 0$
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	5.0			Volts	$I_C = 0$ $I_E = 10$ μA
$^{*}I_{EBO}$	1b	Emitter Current		0.007	0.1	μA	$I_C = 0$ $V_{EB} = 4.0$ V
$I_{CEX}(125°C)$	4	Collector Current		3.0	10	μA	$V_{CE} = 20$ V $V_{BE} = +0.25$ V
τ_s	4	Charge Storage Time Constant (Notes 7 and 8)		13	20	nsec	$I_C = I_{B1} \approx 20$ mA, $I_{B2} \approx -20$ mA
t_{d+r}	4	Turn On Time (Note 8)		25	40	nsec	$I_C \approx 200$ mA, $I_{B1} \approx 40$ mA
t_{s+f}	4	Turn Off Time (Note 8)		25	40	nsec	$I_C \approx 200$ mA, $I_{B1} \approx 40$ mA, $I_{B2} \approx -20$ mA

†NOTE: These numerals apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

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 145°C/Watt (derating factor of 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/Watt (derating factor of 2.1 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse conditions: Length = 300 μsec; duty cycle = 1%.
(6) I_C = 1.0 mA through 20 mA.
(7) Measured on Sampling Scope. PW ≥ 200 nsec.
(8) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

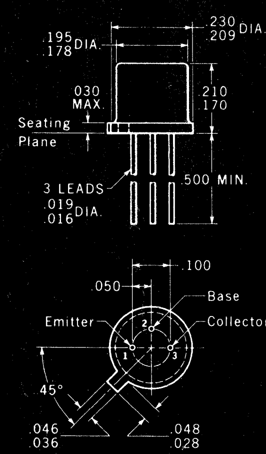
2N915 • 2N916

NPN HIGH FREQUENCY AMPLIFIER AND OSCILLATOR TYPE

DIFFUSED SILICON PLANAR TRANSISTORS

The **2N915** and **2N916** are NPN double-diffused silicon PLANAR transistors. These units are designed for low-power non-saturating switching circuits and low-noise VHF amplifier and oscillator applications.

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 0.44 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+300°C**
Operating Junction Temperature	**200°C** Maximum
Lead Temperature (Soldering, No 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		**2N915**	**2N916**
V_{CBO}	Collector to Base Voltage	**70** Volts	**45** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**50** Volts	**25** Volts
V_{EBO}	Emitter to Base Voltage	**5.0** Volts	**5.0** Volts

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

SYMBOL	† FACT Subgroup	CHARACTERISTIC	2N915 Min.	2N915 Typ.	2N915 Max.	2N916 Min.	2N916 Typ.	2N916 Max.	UNITS	TEST CONDITIONS	
*h_{FE}	1a	DC Pulse Current Gain [Note 5]	**50**	**110**	**200**					$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{FE}	4	DC Pulse Current Gain [Note 5]				**50**	**100**	**200**		$I_C = 10$ mA	$V_{CE} = 1.0$ V
*V_{BE} (sat)	1a	Base Saturation Voltage		**0.77**	**0.9**		**0.78**	**0.9**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
*V_{CE} (sat)	1a	Collector Saturation Voltage		**0.45**	**1.0**		**0.25**	**0.5**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
h_{fe}	4	High Frequency Current Gain (f = 100 mc)	**2.5**	**3.6**		**3.0**	**4.0**			$I_C = 10$ mA	$V_{CE} = 15$ V
C_{ob}	4	Output Capacitance		**3.0**	**3.5**				pf	$I_E = 0$	$V_{CB} = 10$
C_{ob}	4	Output Capacitance					**4.2**	**6.0**	pf	$I_E = 0$	$V_{CB} = 5.0$ V
C_{TE}	4	Emitter Transition Capacitance		**6.5**	**10**		**6.5**	**10**	pf	$I_C = 0$	$V_{EB} = 0.5$ V

† NOTE: These Numerals Apply to the Fairchild Fact Program
* NOTE: FACT Program End-Point Measurement Parameter

Additional Electrical Characteristics on pages 2 and 5. Small Signal Characteristics on page 4.

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 operation.
(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 145°C/Watt (derating factor of 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/Watt (derating factor of 2.06 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse conditions: length = 300 μsec; duty cycle = 1%.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

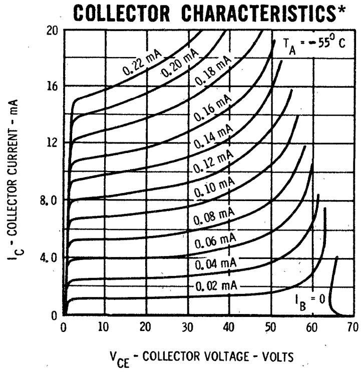
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	† FACT Subgroup	CHARACTERISTIC	Min.	Typ.	Max.	UNITS	TEST CONDITIONS	
*I_{CBO}	1b	Collector Cutoff Current		0.8	10	nA	$I_E = 0$	$V_{CB} = 60$ V
I_{CBO} (150°C)	4	Collector Cutoff Current		0.5	30	μA	$I_E = 0$	$V_{CB} = 60$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	70			Volts	$I_E = 0$	$I_C = 100$ μA
V_{CEO} (sust)	1a	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	50			Volts	$I_C = 10$ mA (pulsed)	$I_B = 0$
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	5.0			Volts	$I_E = 10$ μA	$I_C = 0$
$r_b'C_c$	4	Collector Base Time Constant (f = 40 mc)		170	300	psec	$I_C = 10$ mA	$V_{CB} = 10$ V

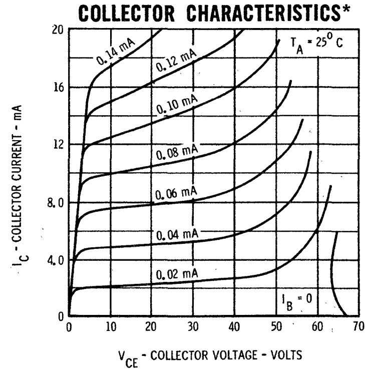
† NOTE: These Numerals Apply to the Fairchild Fact Program
* NOTE: FACT Program End-Point Measurement Parameter

TYPICAL ELECTRICAL CHARACTERISTICS

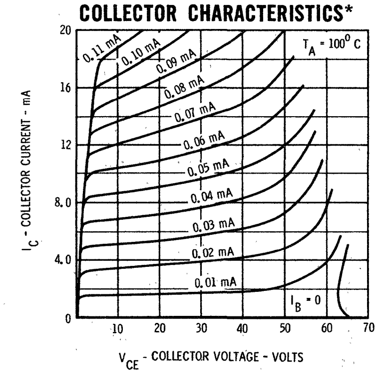
COLLECTOR CHARACTERISTICS*



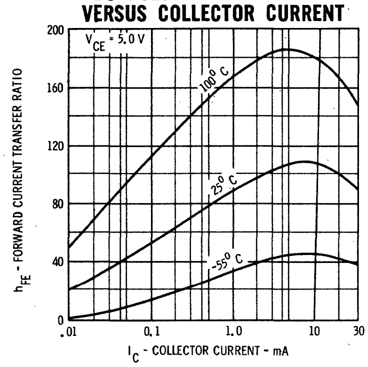
COLLECTOR CHARACTERISTICS*



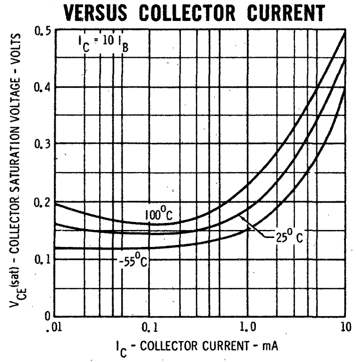
COLLECTOR CHARACTERISTICS*



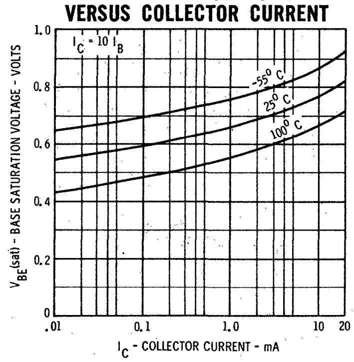
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



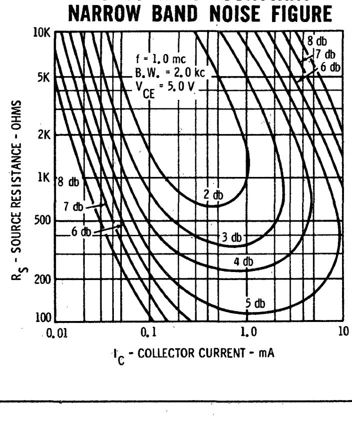
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



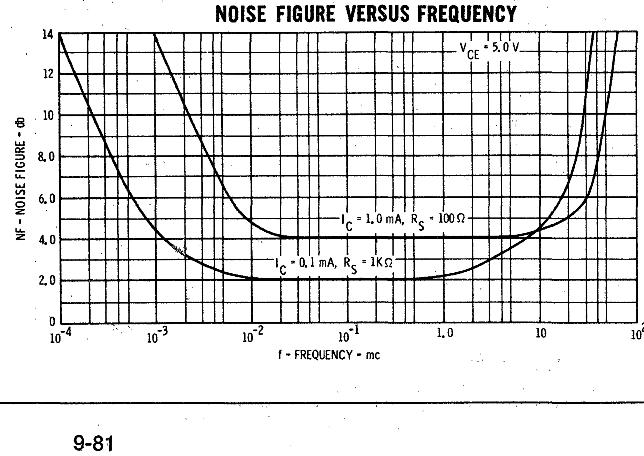
* Single family characteristics on Transfer Curve Tracer

TYPICAL NOISE FIGURE CHARACTERISTICS

CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE

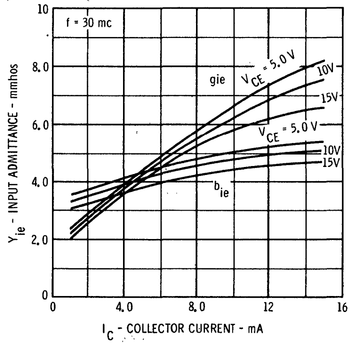


NOISE FIGURE VERSUS FREQUENCY

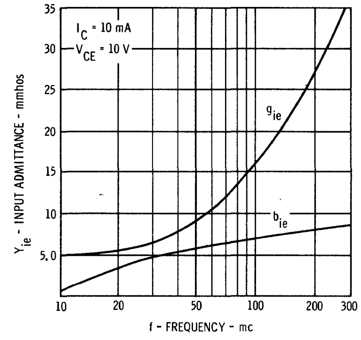


TYPICAL ELECTRICAL CHARACTERISTICS

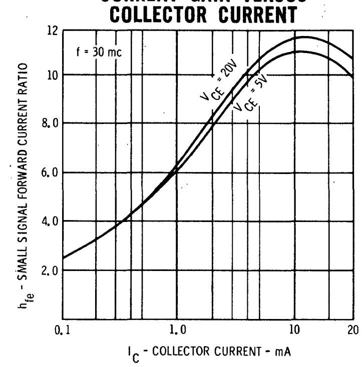
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



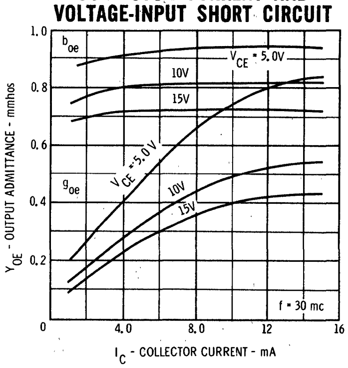
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



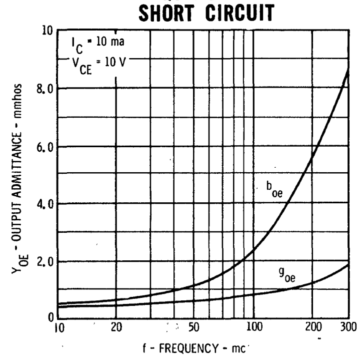
HIGH FREQUENCY CURRENT GAIN VERSUS COLLECTOR CURRENT



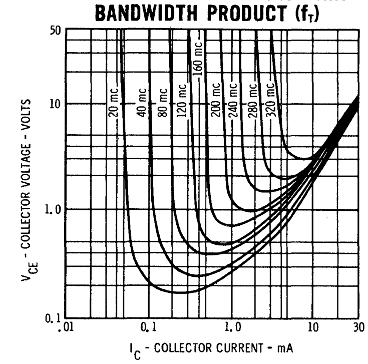
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



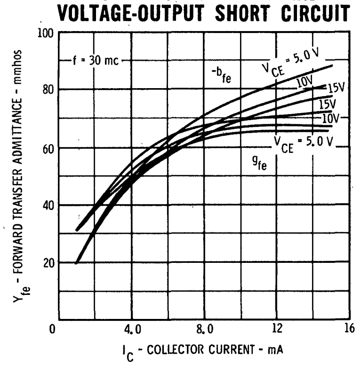
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



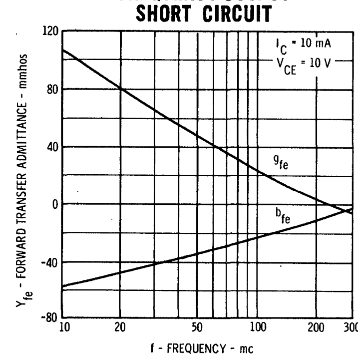
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



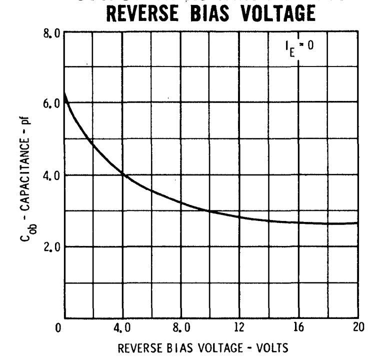
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



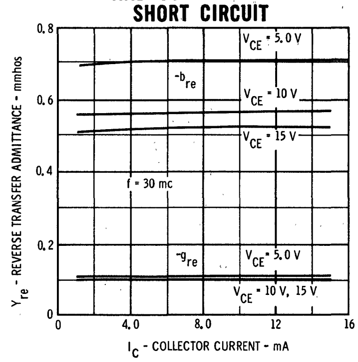
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



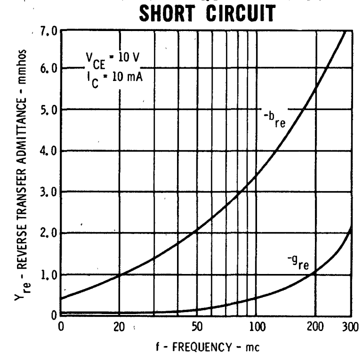
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



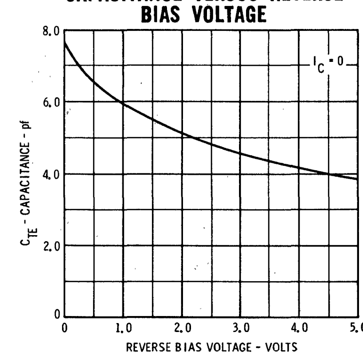
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



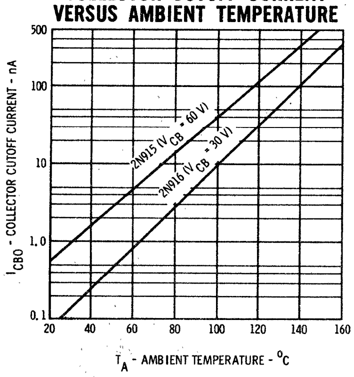
EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



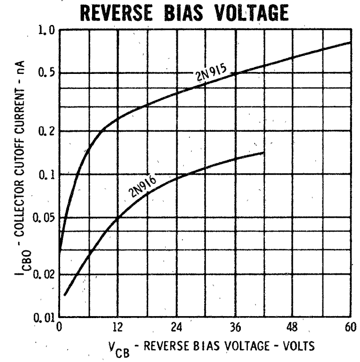
TYPICAL ELECTRICAL CHARACTERISTICS

2N915 • 2N916

COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE

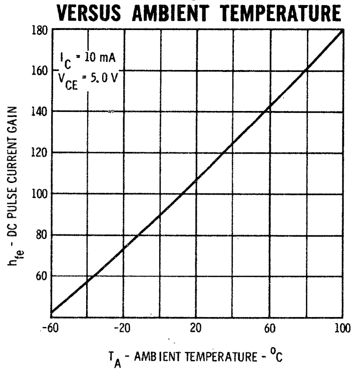


COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE

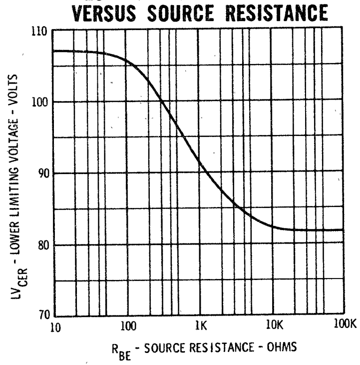


2N915

DC PULSED CURRENT GAIN VERSUS AMBIENT TEMPERATURE

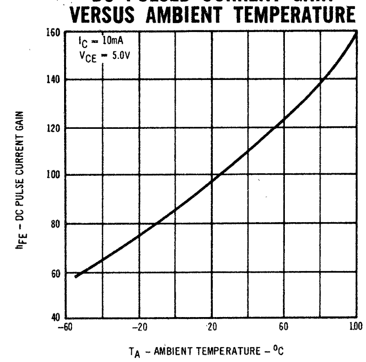


LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE

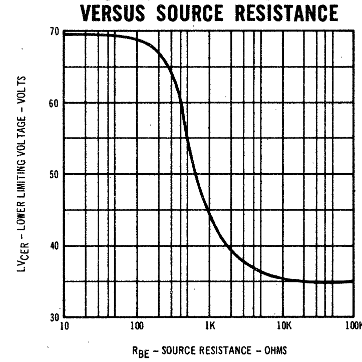


2N916

DC PULSED CURRENT GAIN VERSUS AMBIENT TEMPERATURE



LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE

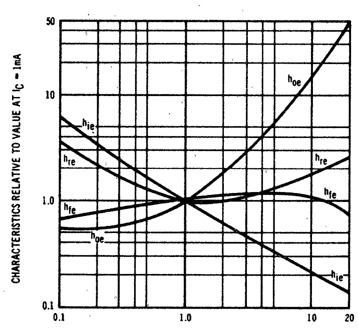


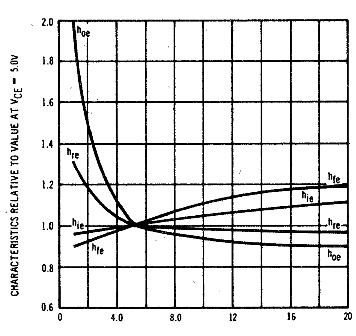
SMALL SIGNAL CHARACTERISTICS (f = 1 kc)

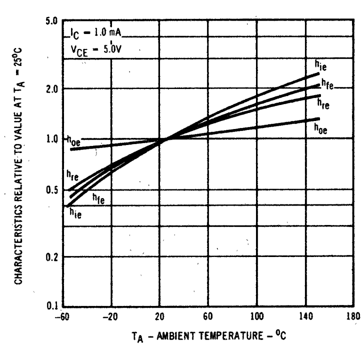
SYMBOL	† FACT Subgroup	CHARACTERISTIC	2N915 Min.	2N915 Typ.	2N915 Max.	2N916 Min.	2N916 Typ.	2N916 Max.	UNITS	TEST CONDITIONS
h_{fe}	4	Small Signal Current Gain	40	115	200	40	100	200		$I_C = 1.0$ mA $V_{CE} = 5.0$ V
			50	140	250	50	120	250		$I_C = 5.0$ mA $V_{CE} = 5.0$ V
h_{ie}	4	Input Resistance		3.0	6.0		2.6	6.0	Kohms	$I_C = 1.0$ mA $V_{CE} = 5.0$ V
				0.7	2.0		0.6	2.0	Kohms	$I_C = 5.0$ mA $V_{CE} = 5.0$ V
h_{oe}	4	Output Conductance		12	75		6.0	75	μmho	$I_C = 1.0$ mA $V_{CE} = 5.0$ V
				45	125		35	125	μmho	$I_C = 5.0$ mA $V_{CE} = 5.0$ V

† NOTE: These Numerals Apply to the Fairchild Fact Program

TYPICAL COMMON EMITTER CHARACTERISTICS







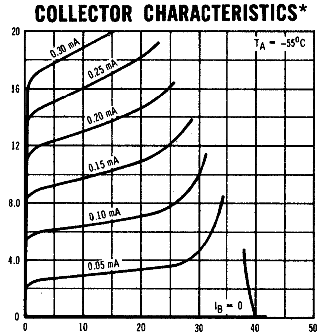
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	† FACT Subgroup	CHARACTERISTIC	Min.	Typ.	Max.	UNITS	TEST CONDITIONS	
$^{*}I_{CBO}$	1b	Collector Cutoff Current		0.1	10	nA	$I_E = 0$	$V_{CB} = 30$ V
I_{CBO} (150°C)	4	Collector Cutoff Current		0.2	10	μA	$I_E = 0$	$V_{CB} = 30$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	45			Volts	$I_C = 10\ \mu$A	$I_E = 0$
V_{CEO} (sust)	1a	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	25			Volts	$I_C = 10$ mA (pulsed)	$I_B = 0$
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	5.0			Volts	$I_E = 10\ \mu$A	$I_C = 0$
$r_b'C_c$	4	Collector-Base Time Constant (f = 40 mc)		200	300	psec	$I_C = 10$ mA	$V_{CB} = 10$ V

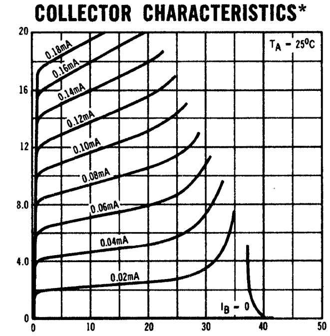
† NOTE: These Numerals Apply to the Fairchild Fact Program
* NOTE: FACT Program End-Point Measurement Parameter

TYPICAL ELECTRICAL CHARACTERISTICS

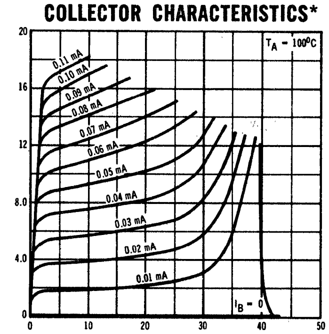
COLLECTOR CHARACTERISTICS*



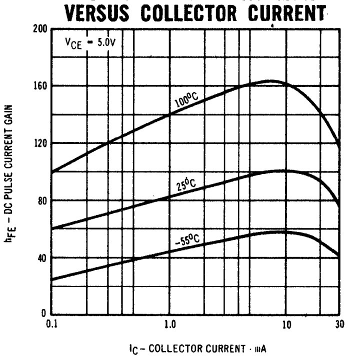
COLLECTOR CHARACTERISTICS*



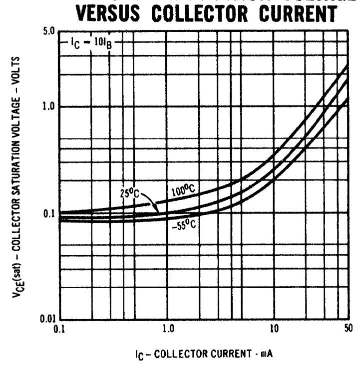
COLLECTOR CHARACTERISTICS*



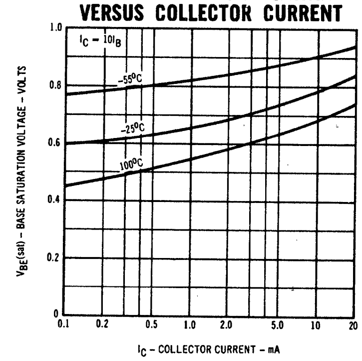
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



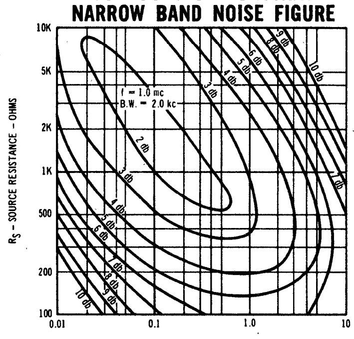
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



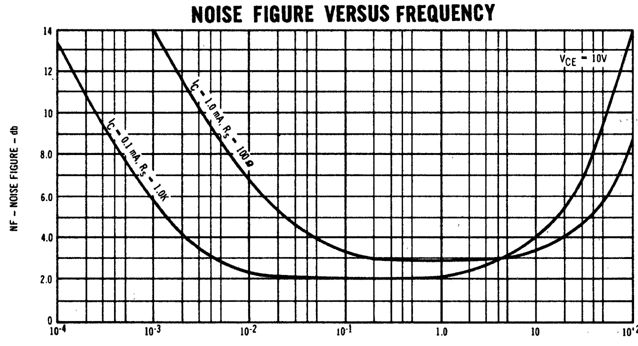
* Single family characteristics on Transistor Curve Tracer

TYPICAL NOISE FIGURE CHARACTERISTICS

CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE

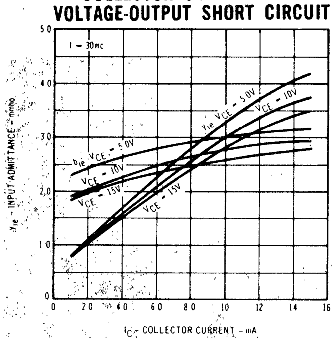


NOISE FIGURE VERSUS FREQUENCY

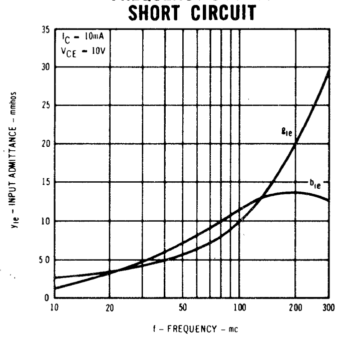


TYPICAL ELECTRICAL CHARACTERISTICS

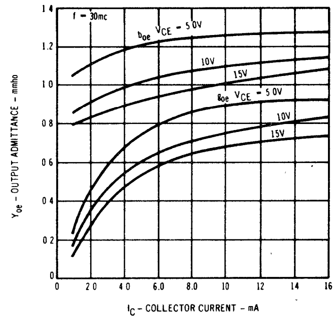
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



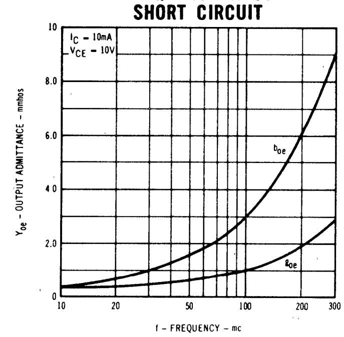
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



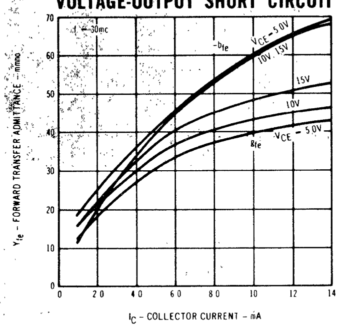
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



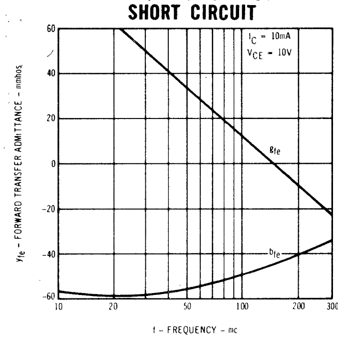
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



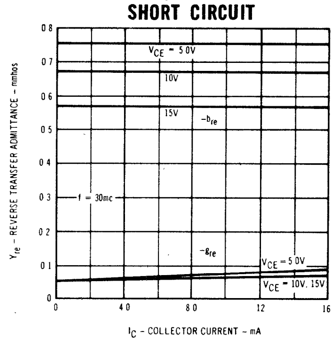
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



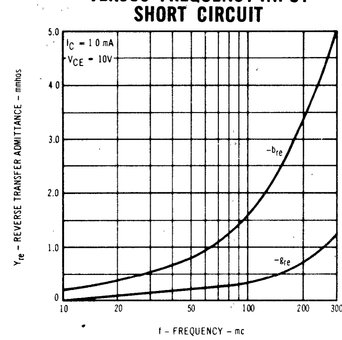
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



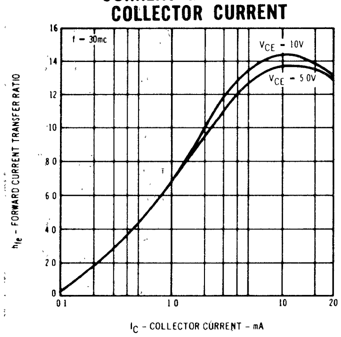
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



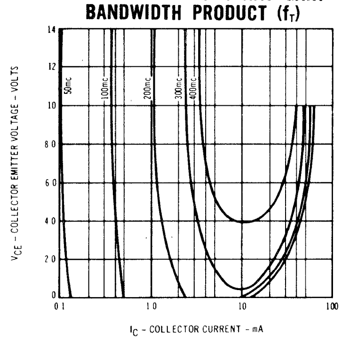
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



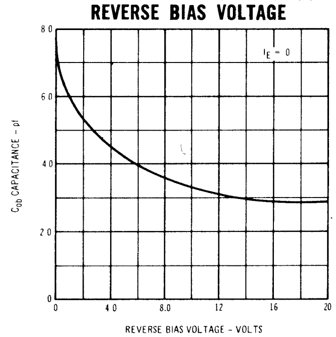
HIGH FREQUENCY CURRENT GAIN VERSUS COLLECTOR CURRENT



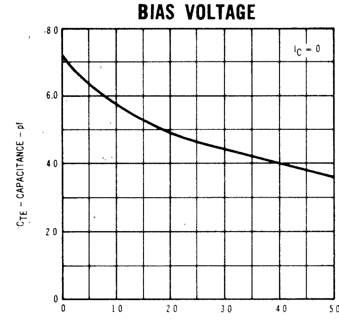
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

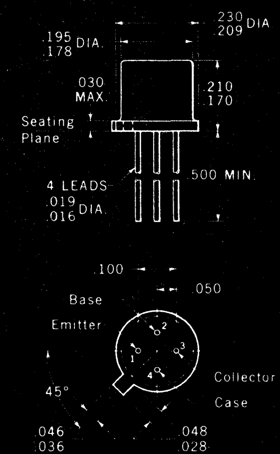
2N918

NPN ULTRA-HIGH FREQUENCY OSCILLATOR AND AMPLIFIER

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

The 2N918 is an NPN double-diffused silicon PLANAR Epitaxial Transistor. It is designed for low-noise high-frequency amplifiers; 1 GHz local oscillators; non-neutralized i-f amplifiers and non-saturating circuits with rise and fall times of less than 2.5 nanoseconds.

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold plated kovar
Package weight is 0.47 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, No Time Limit)	+300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	0.3 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.2 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	30 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	15 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts
I_C	Collector Current	50 mA

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

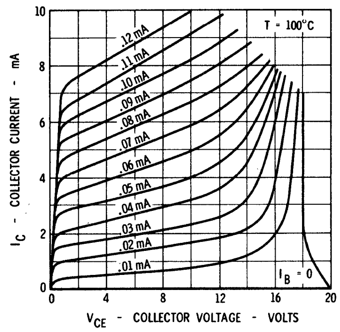
Symbol	Characteristics	Min.	Typ.	Max.	Units	Test Conditions
h_{FE}	DC Current Gain	20	50			I_C = 3.0 mA V_{CE} = 1.0 V
V_{BE}(sat)	Base Saturation Voltage			1.0	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage			0.4	Volts	I_C = 10 mA I_B = 1.0 mA
C_{obo}	Common-Base, Open-Circuit Output Capacitance		1.0	1.7	pF	I_E = 0 V_{CB} = 10 V
C_{obo}	Common-Base, Open-Circuit Output Capacitance		1.8	3.0	pF	I_E = 0 V_{CB} = 0
C_{ibo}	Input Capacitance			2.0	pF	I_C = 0 V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current			10	nA	I_E = 0 V_{CB} = 15 V
I_{CBO}(150°C)	Collector Cutoff Current			1.0	μA	I_E = 0 V_{CB} = 15 V
h_{fe}	High Frequency Current Gain (f = 100MHz)	6.0	9.0			I_C = 4.0 mA V_{CE} = 10 V
G_{pe}	Available Power Gain (nuetralized) (f = 200MHz)	15	18		dB	I_C = 6.0 mA V_{CB} = 12 V
P_o	Power Output (f = 500MHz)	30	40		mW	I_C = 8.0 mA V_{CB} = 15 V
η	Collector Efficiency (f = 500MHz)	25			%	I_C = 8.0 mA V_{CB} = 15 V
NF	Noise Figure (Note 5)		3.0	6.0	dB	I_C = 1.0 mA V_{CE} = 6.0 V; f = 60 MHz, Rg = 400 Ω
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	15			Volts	I_C = 3.0 mA I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	30			Volts	I_C = 1.0 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0			Volts	I_C = 0 I_E = 10 μA

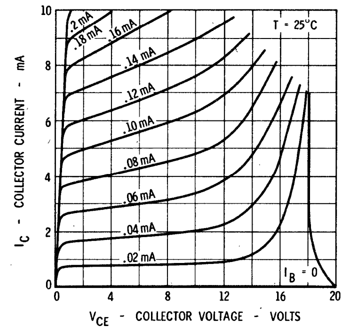
* Planar is a patented Fairchild process.

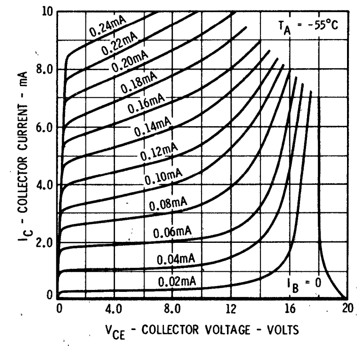
(See notes on back page)

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL COLLECTOR CHARACTERISTICS*

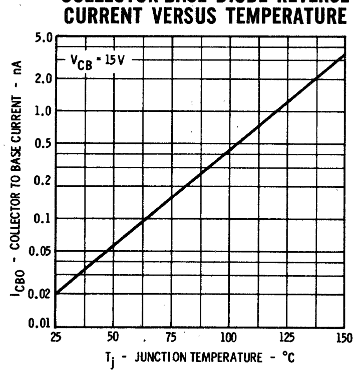




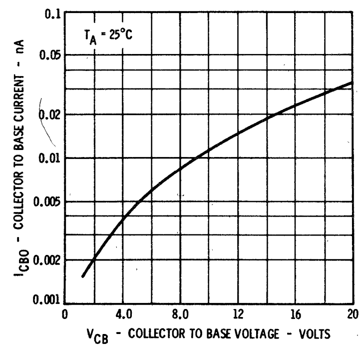


TYPICAL ELECTRICAL CHARACTERISTICS

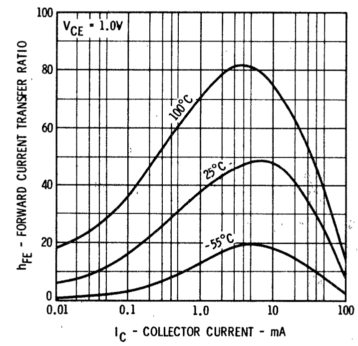
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



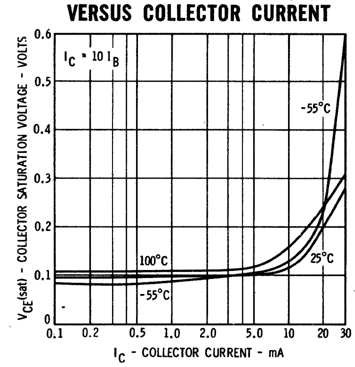
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



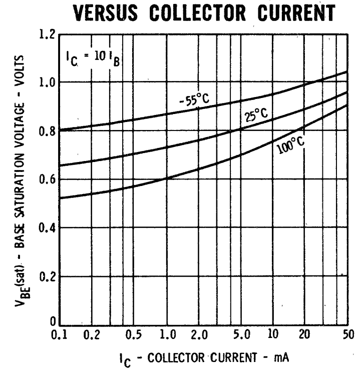
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



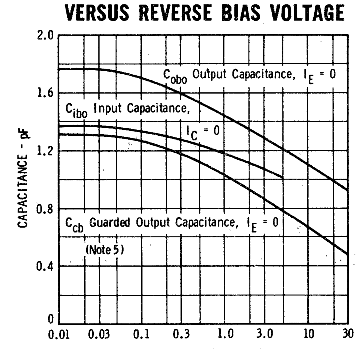
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



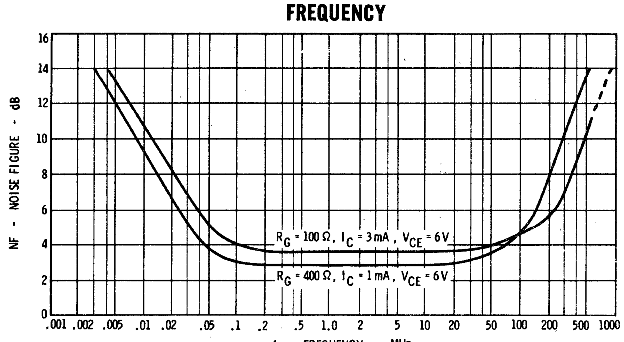
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



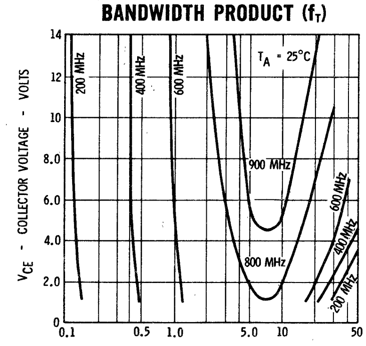
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



NOISE FIGURE VERSUS FREQUENCY



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

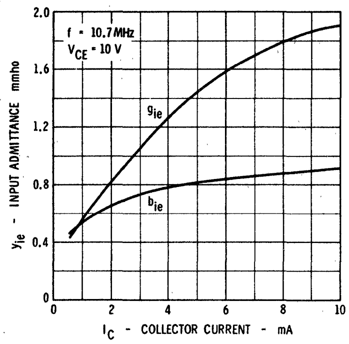


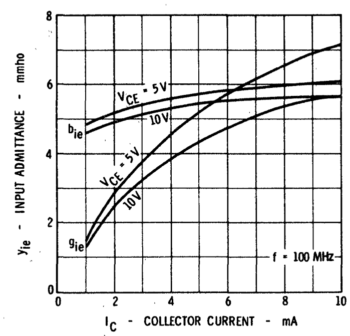
* Single family characteristics on Transistor Curve Tracer.

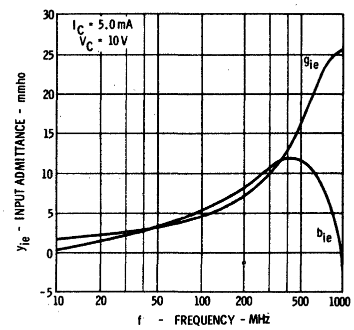
TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

10.7 MHz	100 MHz	vs. FREQUENCY
V_{CE} = 10V	vs. COLLECTOR CURRENT	V_{CE} = 10V I_C = 5 mA

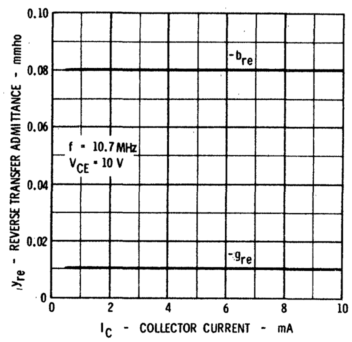
y_{ie}
Input Admittance (output short circuit)

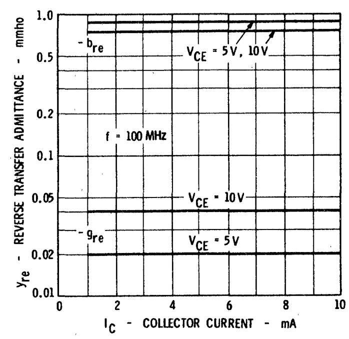


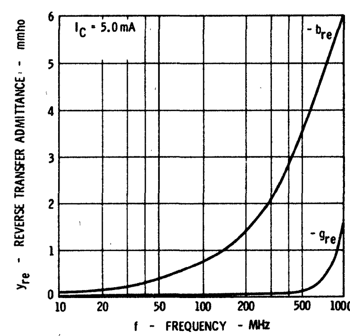




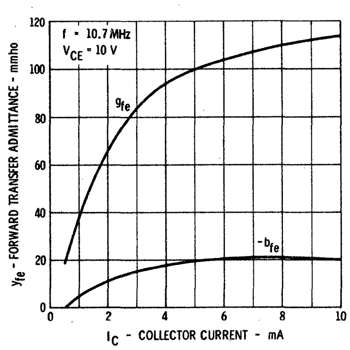
y_{re}
Reverse Transfer Admittance (input short circuit)

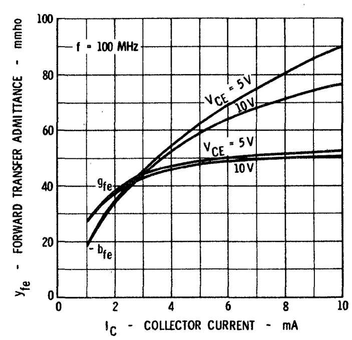


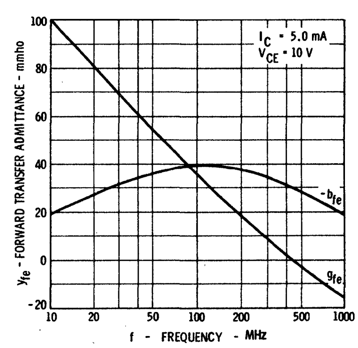




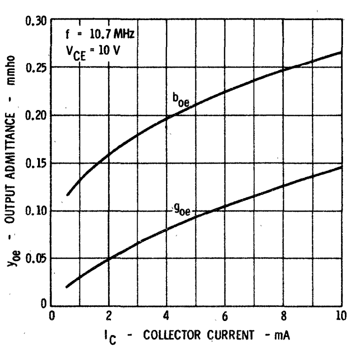
y_{fe}
Forward Transfer Admittance (output short circuit)

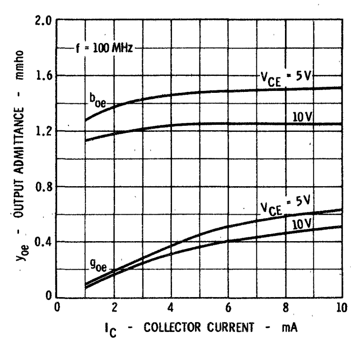


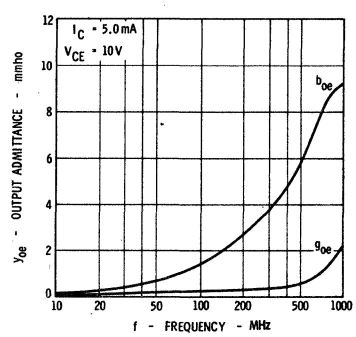




y_{oe}
Output Admittance (input short circuit)

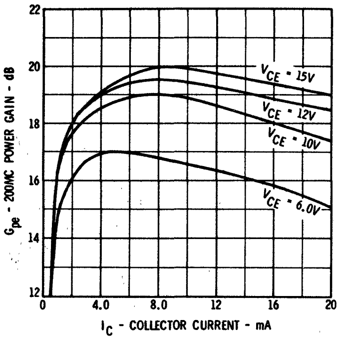


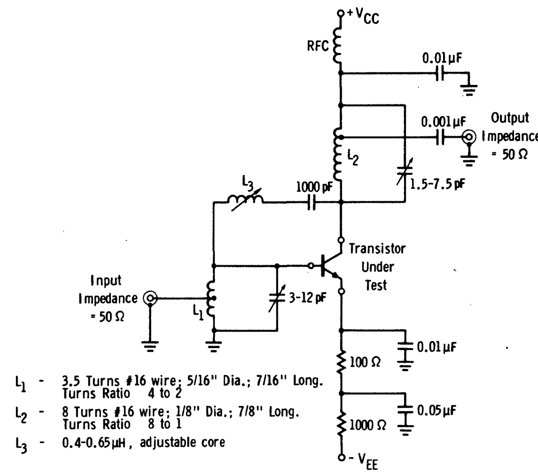




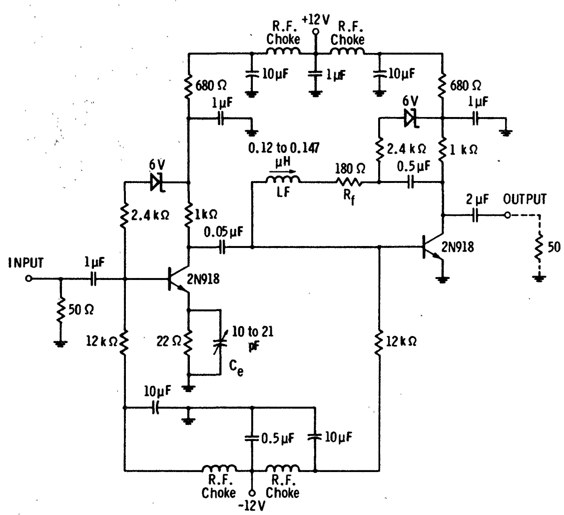
NEUTRALIZED 200 MHz POWER GAIN AMPLIFIER TEST CIRCUIT

TYPICAL PERFORMANCE

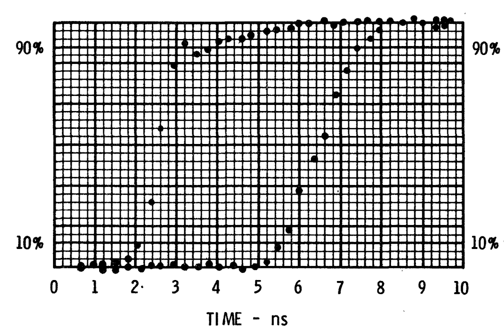




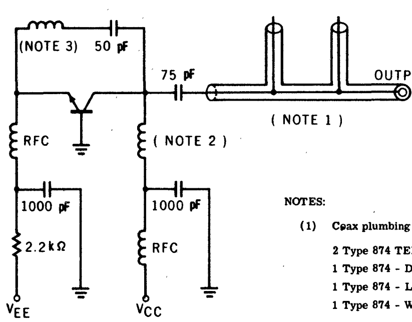
TWO STAGE VIDEO AMPLIFIER



INPUT TO OUTPUT DELAY—4ns



500 MHz OSCILLATOR TEST CIRCUIT



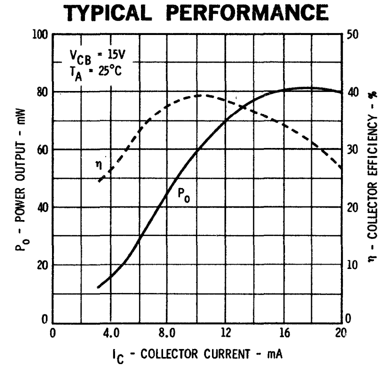
NOTES:

(1) Coax plumbing consists of the following GR air lines:
2 Type 874 TEE
1 Type 874 - D20 Adjustable Stub
1 Type 874 - LA Adjustable Line
1 Type 874 - WN3 Short-Circuit Termination

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

(3) 9 turns #22 AWG wire, 3/16 inch OD, 1/2 inch long

TYPICAL PERFORMANCE



NOTES:

(1) These ratings are limiting values above which the serviceability of any 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 584°C/Watt (derating factor of 1.71 mW/°C). Junction-to-ambient thermal resistance of 875°C/Watt (derating factor of 1.14 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) C_{cb} is measured using three terminal measurement technique with case and emitter guarded.

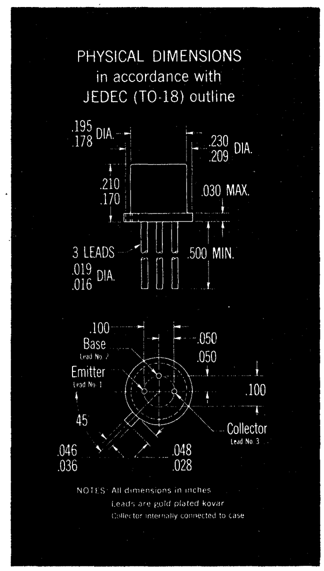
2N929 • 2N930

NPN LOW LEVEL, LOW LNOISE AMPLIFIER

SILICON PLANAR* TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2483 AND 2N2484

GENERAL DESCRIPTION - The Fairchild 2N929 and 2N930 are NPN silicon PLANAR transistors designed for use in high-performance, low-level, low-noise amplifier circuits from audio through high frequency ranges.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures		
Storage Temperature		-65°C to +300°C
Operating Junction Temperature		175°C Maximum
Lead Temperature (Soldering, 10 sec time limit)		230°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature	[Notes 2 and 3]	0.6 Watt
at 25°C Ambient Temperature	[Notes 2 and 3]	0.3 Watt
Maximum Voltages and Current		
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
I_C Collector Current		30 mA

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	2N929 Min.	2N929 Max.	2N930 Min.	2N930 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain [Note 5]		350		600		I_C = 10 mA V_{CE} = 5.0 V
h_{FE}	DC Current Gain	60		150			I_C = 500 μA V_{CE} = 5.0 V
h_{FE}	DC Current Gain	40	120	100	300		I_C = 10 μA V_{CE} = 5.0 V
h_{FE} (-55°C)	DC Current Gain	10		20			I_C = 10 μA V_{CE} = 5.0 V
V_{BE}	Base-Emitter Voltage [Note 5]	0.6	1.0	0.6	1.0	Volt	I_C = 10 mA I_B = 0.5 mA
V_{CE}(sat)	Collector Saturation Voltage [Note 5]		1.0		1.0	Volt	I_C = 10 mA I_B = 0.5 mA
h_{ib}	Input Resistance (f = 1 kHz)	25	32	25	32	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance (f = 1 kHz)		1.0		1.0	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio (f = 1 kHz)		600		600	$\times 10^{-6}$	I_C = 1.0 mA V_{CB} = 5.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	60	350	150	600		I_C = 1.0 mA V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 30 MHz)	1.0		1.0			I_C = 500 μA V_{CE} = 5.0 V
I_{CBO}	Collector-Base Cutoff Current		10		10	nA	I_E = 0 V_{CB} = 45 V
I_{CES}	Collector-Emitter Cutoff Current		10		10	nA	V_{CE} = 45 V V_{EB} = 0
I_{CES} (170°C)	Collector-Emitter Cutoff Current		10		10	μA	V_{CE} = 45 V V_{EB} = 0
I_{EBO}	Emitter-Base Cutoff Current		10		10	nA	I_C = 0 V_{EB} = 5.0 V
I_{CEO}	Collector-Emitter Cutoff Current		2.0		2.0	nA	I_B = 0 V_{CE} = 5.0 V
C_{obo}	Output Capacitance		8.0		8.0	pF	I_E = 0 V_{CB} = 5.0 V
NF	Noise Figure		4.0		3.0	dB	I_C = 10 μA V_{CE} = 5.0 V f = 1 kHz, Rs = 10 kΩ, BW = 200 Hz
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	45		45		Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		5.0		Volts	I_C = 0 I_E = 10 nA

* 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 175°C and junction-to-case thermal resistance of 250°C/watt (derating factor of 4.0 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. For more information send for Fairchild Publication APP-4.

(5) Pulse conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

FAIRCHILD SEMICONDUCTOR

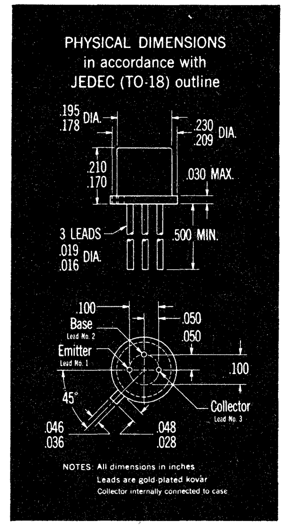
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N978 • 2N1991

PNP GENERAL-PURPOSE TYPE

DIFFUSED SILICON TRANSISTORS

GENERAL DESCRIPTION - The 2N978 and 2N1991 are double diffused silicon PNP transistors. They are designed for industrial high-speed switching and amplifier applications and can be used in complementary type circuitry with the Fairchild 2N1985 and 2N1987. Typical f_T is 50 mc.



2N978

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

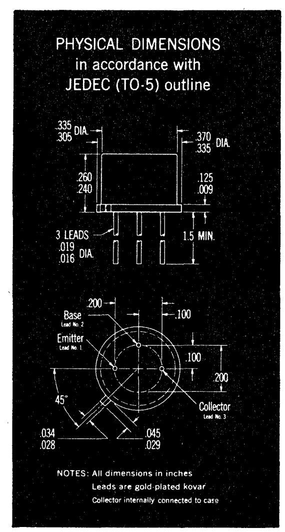
Storage Temperature		-65°C to +150°C
Operating Junction Temperature		+150°C Maximum
Maximum Power Dissipation	**2N978**	**2N1991**
Total Dissipation at 25°C Case Temperature [Note 2 & 3]	1.25	2.0 Watts
at 100°C Case Temperature [Note 2 & 3]	0.50	1.0 Watt
at 25°C Ambient Temperature	0.33	0.6 Watt

Maximum Voltages

V_{CBO} - Collector to Base Voltage	-30 Volts
V_{CEO} - Collector to Emitter Voltage	-20 Volts
V_{EBO} - Emitter to Base Voltage	-5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristics	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain [Note 5]	15	60		I_C = 150 mA	V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain [Note 5]	15			I_C = 30 mA	V_{CE} = -10 V
V_{BE}(sat)	Base Saturation Voltage		-1.5	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage		-1.5	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain f = 20 mc	2.0			I_C = 50 mA	V_{CE} = -10 V
C_{ob}	Output Capacitance		45	pf	I_E = 0	V_{CB} = -10 V
I_{CBO}	Collector Cutoff Current		5.0	μA	I_E = 0	V_{CB} = -10 V
I_{CBO}(+150°C)	Collector Cutoff Current		200	μA	I_E = 0	V_{CB} = -10 V
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Pulsed) [Note 4]	-20		Volts	I_C = 100 mA	I_B = 0
I_{EBO}	Emitter Current		200	μA	I_C = 0	V_{EB} = -1.0 V



2N1991

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 operation.

(3) These ratings give a maximum junction temperature of 150°C and junction-to-case thermal resistance of 62.5°C/watt (derating factor of 16 mW/°C) for the 2N1991; and for the 2N978, 100°C/watt (derating factor of 10 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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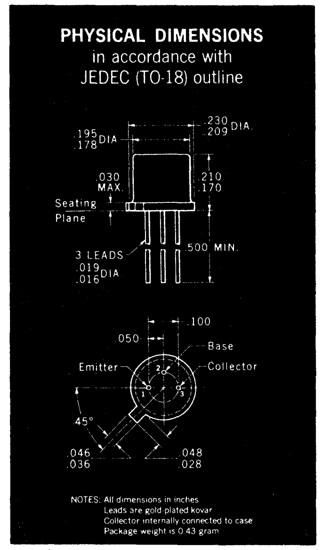
2N995

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR



GENERAL DESCRIPTION - The 2N995 is a double diffused silicon PNP planar epitaxial transistor packaged in the JEDEC TO-18 outline. It is designed as a high-frequency, low noise, general-purpose transistor which will replace germanium units in many applications. It may be used to advantage in complementary type circuits with the 2N914. Typical f_T is 150 Mc.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +200°C
Operating Junction Temperature		200°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 & 3)	1.2 Watts
at 100°C Case Temperature	(Notes 2 & 3)	0.68 Watt
at 25°C Ambient Temperature		0.36 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		-20 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-15 Volts
V_{EBO}	Emitter to Base Voltage		-4.0 Volts

ELECTRICAL CHARACTERISTICS (25°C Unless Otherwise Noted)

Symbol	† FACT Sungroup	Characteristic	Min.	Type.	Max.	Units	Test Conditions
*h_{FE}	1a	DC Current Gain (Note 5)	35		140		I_C = 20 mA V_{CE} = -1.0 V
*V_{BE}(sat)	1a	Base Saturation Voltage			-0.95	Volts	I_C = 20 mA I_B = 2.0 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage			-0.2	Volts	I_C = 20 mA I_B = 2.0 mA
f_T	4	Gain Bandwidth Product	100			Mc	I_C = 10 mA V_{CE} = -10 V
C_{obo}	4	Output Capacitance			10	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	4	Input Capacitance			11	pf	I_C = 0 V_{EB} = -0.5 V
*I_{CBO}	1b	Collector Cutoff Current			5.0	nA	I_E = 0 V_{CB} = -15 V
I_{CBO}	4	Collector Cutoff Current (150°C)			25	μA	I_E = 0 V_{CB} = -15 V
t_{on}	4	Turn On Time		65		nsec	I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA
t_{off}	4	Turn Off Time		125		nsec	I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA
NF	4	Noise Figure (Note 6)		6		db	I_C = 100 μA V_{CE} = 5.0 V
η	4	100 Mc Oscillator Efficiency		40		%	I_C = 10 mA V_{CB} = -10 V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-20			Volts	I_C = 10 μA I_E = 0
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-15			Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-4.0			Volts	I_E = 10 μA I_C = 0

† NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

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 operation.
3. These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 145°C/Watt (derating factor of 6.9 mW/°C).
4. Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
5. Pulse Conditions: length = 300 μsec; duty cycle ≤ 1%.
6. f = 1 Kc, Power Bandwidth of 200 cps, R_G = 2 K.

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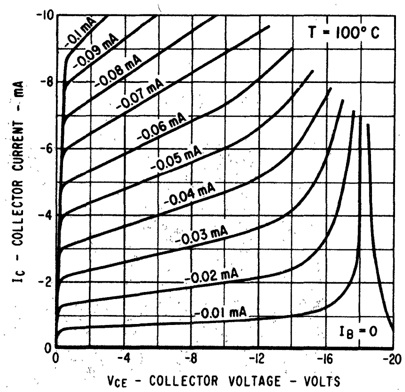
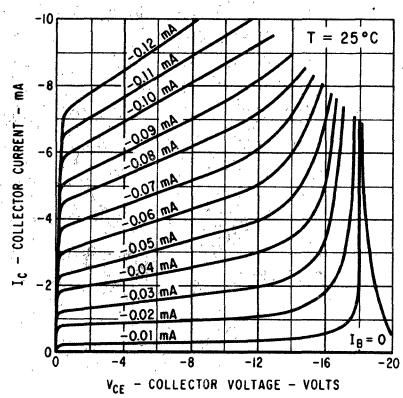
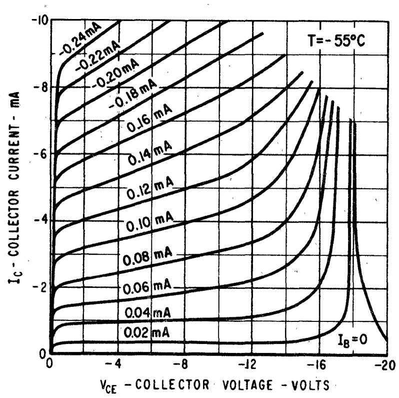
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

ACTIVE REGION

COLLECTOR CHARACTERISTICS

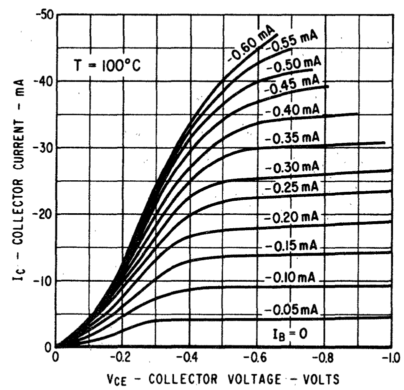


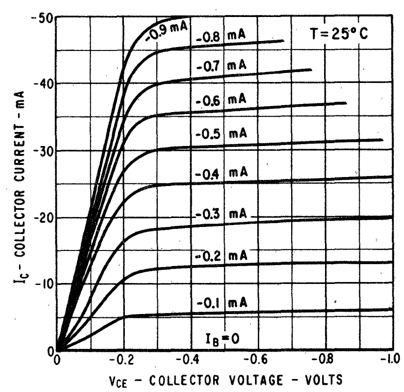


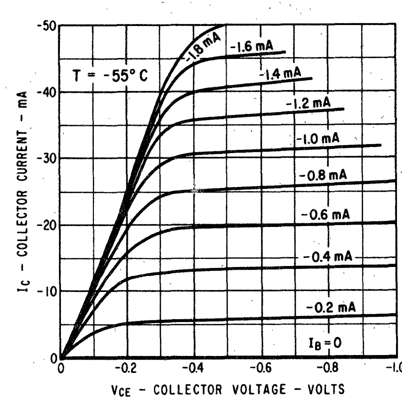


SATURATION REGION

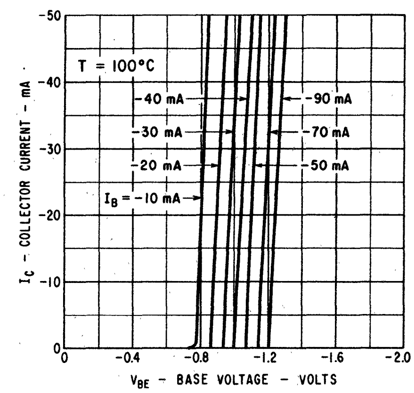
COLLECTOR CHARACTERISTICS

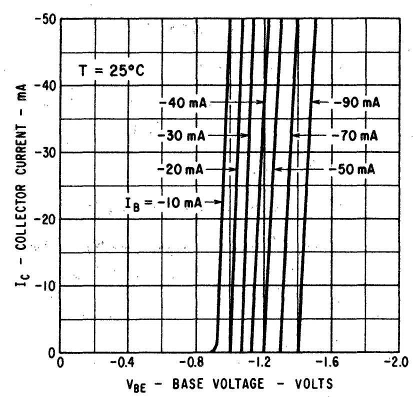


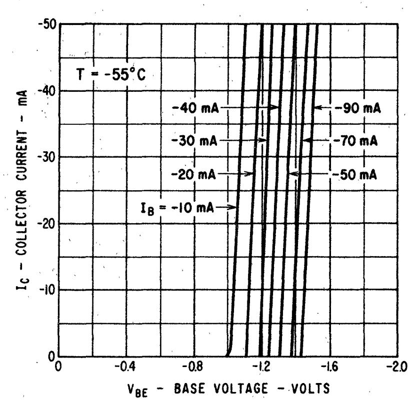




BASE CHARACTERISTICS

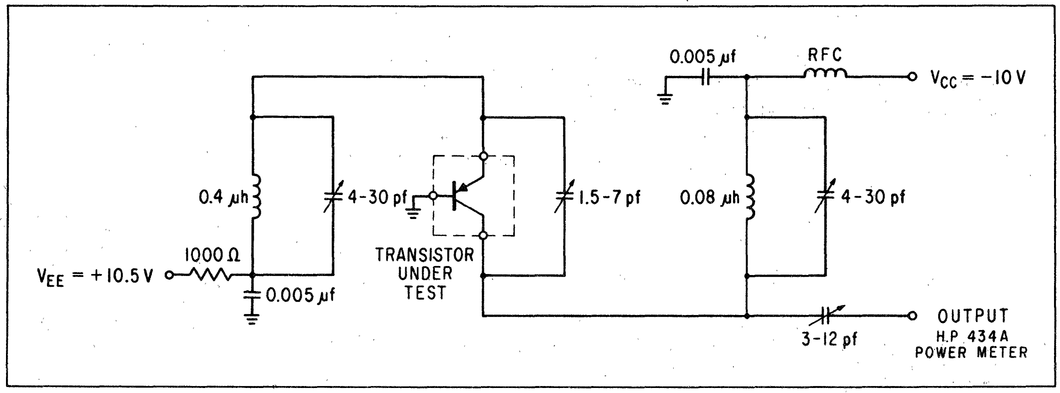






* Single family characteristic on Transistor Curve Tracer.

OSCILLATOR EFFICIENCY CIRCUIT ($I_C = 10\,mA$, $V_{CB} = -10V$)



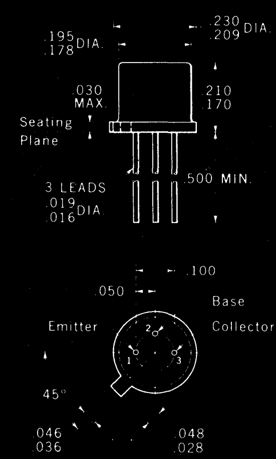
2N996

PNP HIGH SPEED SWITCH AND LOW NOISE AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The 2N996 is a PNP double-diffused silicon Planar Epitaxial Transistor. It is designed for use as a high-frequency ultra low noise, general purpose transistor which will replace germanium units in many applications. This transistor has the desirable attributes of low saturation resistance and fast switching capabilities at currents as high as 100 milliamperes.

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 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

V_{CBO}	Collector to Base Voltage		-15 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-12 Volts
V_{EBO}	Emitter to Base Voltage		-4.0 Volts

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

Symbol	† FACT Subgroup	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
* h_{FE}	1a	DC Pulse Current Gain (Note 5)	35	75			I_C = 20 mA	V_{CE} = -1.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	30	65			I_C = 60 mA	V_{CE} = -0.3 V
* V_{BE}(sat)	1a	Base Saturation Voltage		-0.8	-0.95	Volts	I_C = 20 mA	I_B = 2.0 mA
* V_{CE}(sat)	1a	Collector Saturation Voltage		-0.22	-0.3	Volts	I_C = 60 mA	I_B = 2.0 mA
C_{obo}	4	Open Circuit Output Capacitance		7.5	10	pf	I_E = 0	V_{CB} = -10 V
C_{ibo}	4	Open Circuit Input Capacitance		7.0	11	pf	I_C = 0	V_{EB} = -0.5 V
h_{fe}	4	High Frequency Current Gain (f = 100 Mc)	1.0	2.3			I_C = 10 mA	V_{CE} = -10 V
* I_{CBO}	1b	Collector Cutoff Current		0.2	5.0	mμA	I_E = 0	V_{CB} = -10 V
I_{CBO} (150°C)	4	Collector Cutoff Current		0.2	15	μA	I_E = 0	V_{CB} = -10 V
NF	4	Noise Figure (Note 6)		3.0		db	I_C = 50 μA	V_{CE} = -5.0 V
BV_{CBO}	1a	Collector Breakdown Voltage	-15			Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-12			Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-4.0			Volts	I_E = 10 μA	I_C = 0
I_{EBO}	4	Emitter Cutoff Current			10	μA	I_C = 0	V_{EB} = -4.0 V
η	4	Oscillator Efficiency (f = 100 Mc)		40		%	I_C = 10 mA	V_{CB} = -7.0 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

(See notes on back page)

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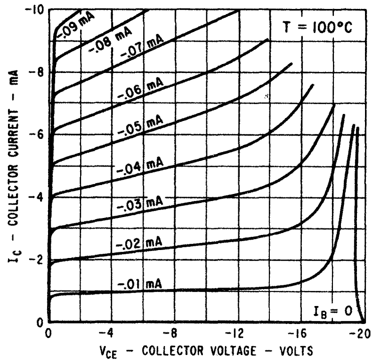
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

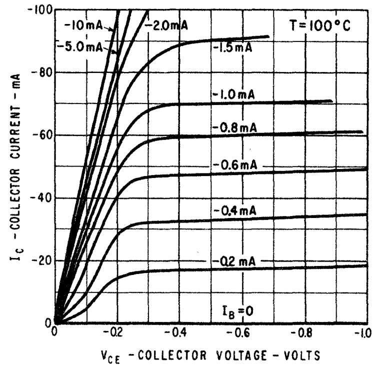
HIGH VOLTAGE

SATURATION REGION

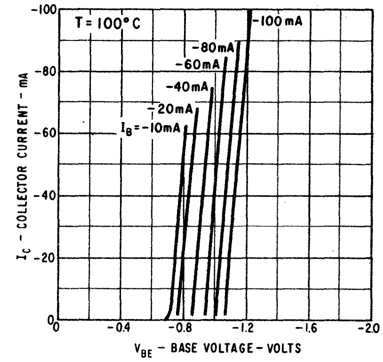
COLLECTOR CHARACTERISTICS

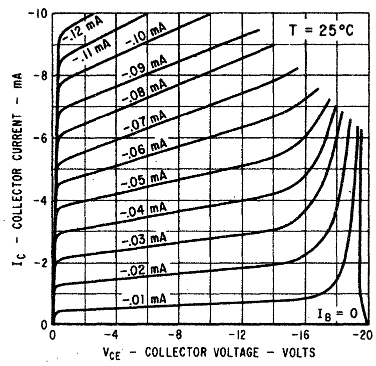


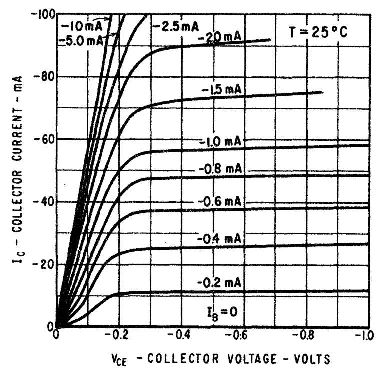
COLLECTOR CHARACTERISTICS

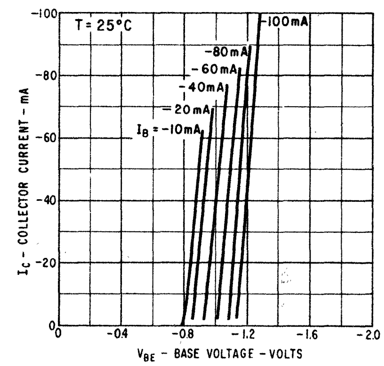


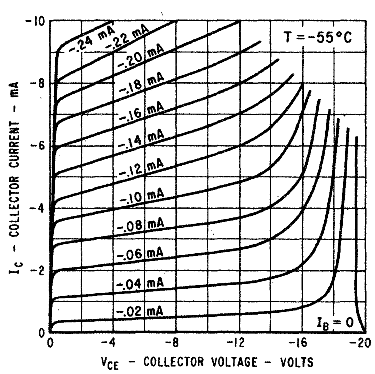
BASE CHARACTERISTICS

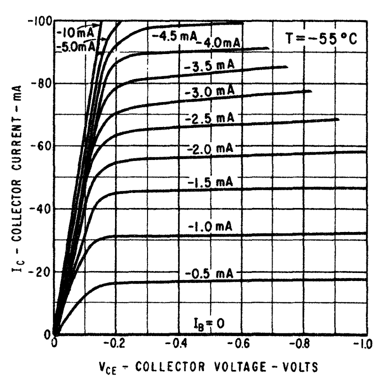


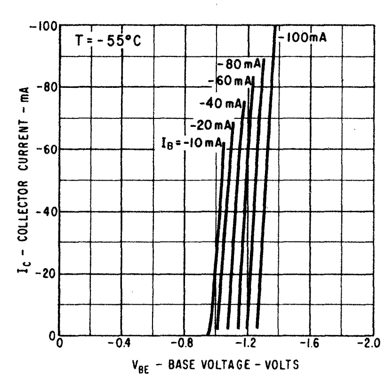






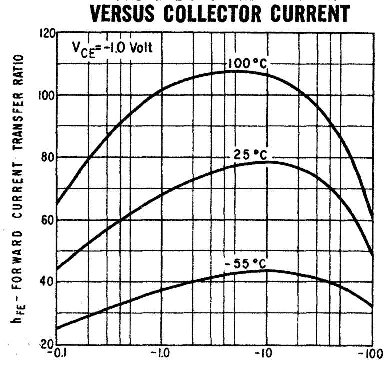




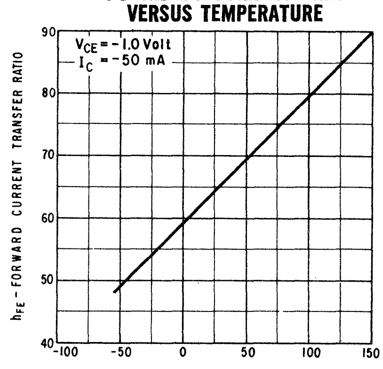


*Single family characteristics on Transistor Curve Tracer.

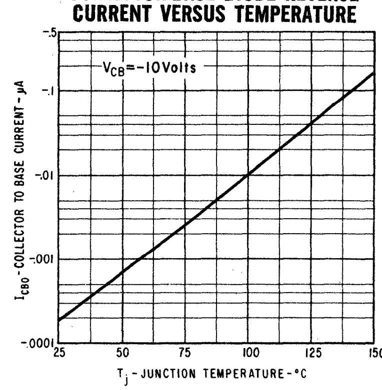
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VERSUS TEMPERATURE

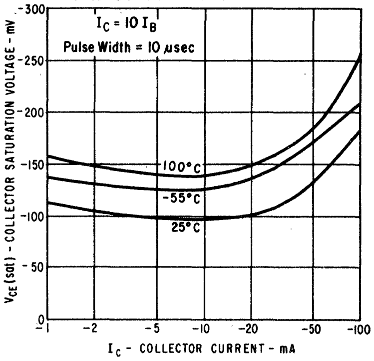


COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE

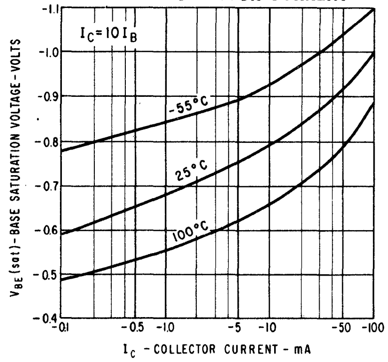


TYPICAL ELECTRICAL CHARACTERISTICS

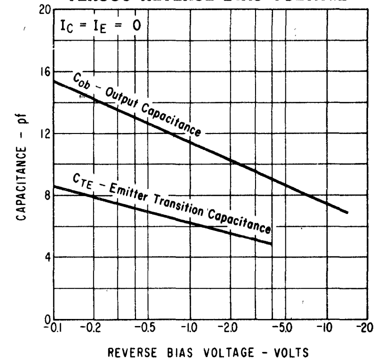
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



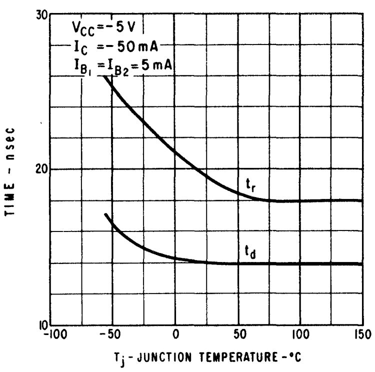
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



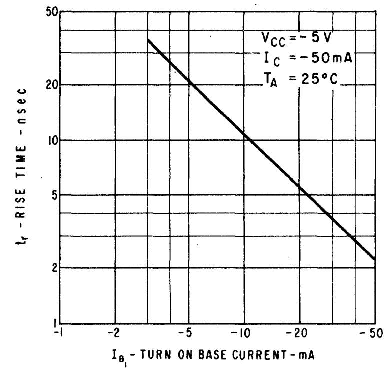
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



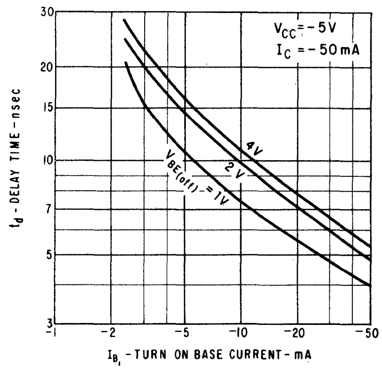
RISE AND DELAY TIMES VERSUS TEMPERATURE



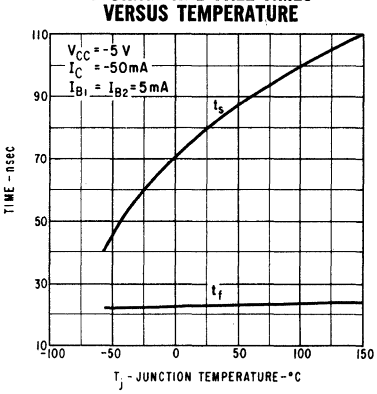
RISE TIME VERSUS TURN ON BASE CURRENT



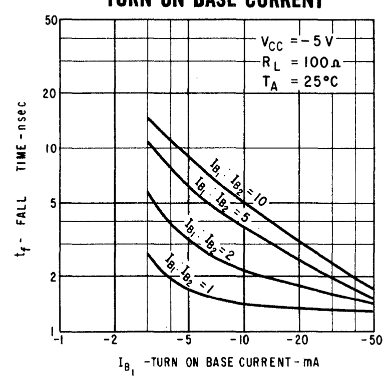
DELAY TIME VERSUS TURN ON BASE CURRENT



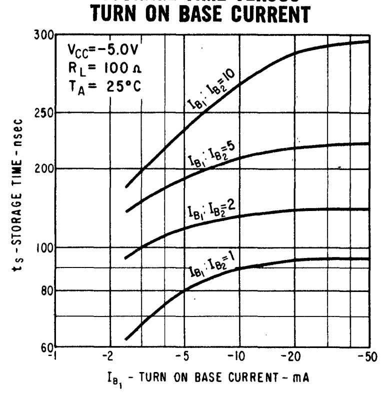
STORAGE AND FALL TIMES VERSUS TEMPERATURE



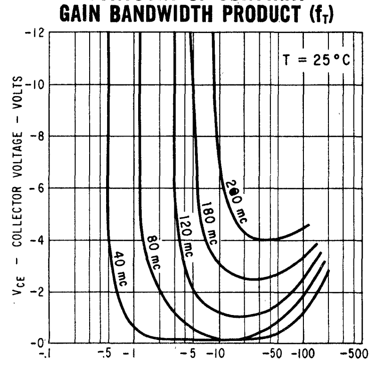
FALL TIME VERSUS TURN ON BASE CURRENT



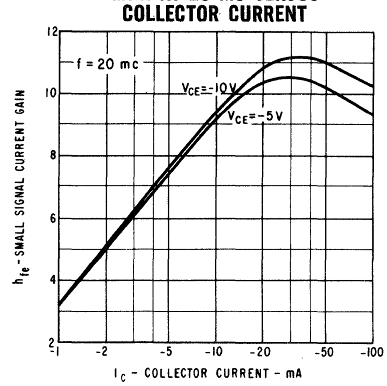
STORAGE TIME VERSUS TURN ON BASE CURRENT



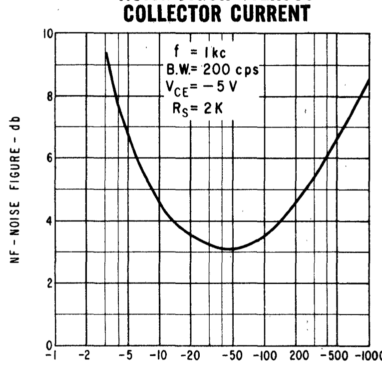
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



SMALL SIGNAL CURRENT GAIN AT 20 MC VERSUS COLLECTOR CURRENT



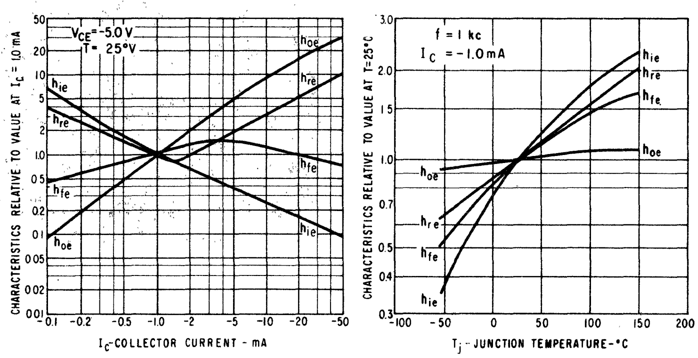
NOISE FIGURE VERSUS COLLECTOR CURRENT



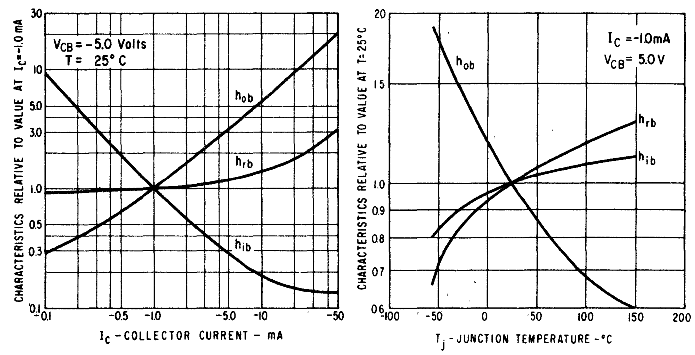
SMALL SIGNAL CHARACTERISTICS (f=1 KC)

SYMBOL	CHARACTERISTIC	TYP.	UNITS	TEST CONDITIONS	
h_{ib}	Input Resistance	27	ohms	$I_C = 1.0$ mA	$V_{CB} = -5.0$ V
		7.0	ohms	$I_C = 5.0$ mA	$V_{CB} = -5.0$ V
h_{ob}	Output Conductance	0.65	μmhos	$I_C = 1.0$ mA	$V_{CB} = -5.0$ V
		5.5	μmhos	$I_C = 5.0$ mA	$V_{CB} = -5.0$ V
h_{rb}	Voltage Feedback Ratio	10	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = -5.0$ V
		14	$x10^{-4}$	$I_C = 5.0$ mA	$V_{CB} = -5.0$ V
h_{ie}	Input Resistance	2.0	K ohms	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
		800	ohms	$I_C = 5.0$ mA	$V_{CE} = -5.0$ V
h_{oe}	Output Conductance	40	μmhos	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
		200	μmhos	$I_C = 5.0$ mA	$V_{CE} = -5.0$ V
h_{re}	Voltage Feedback Ratio	1.4	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
		2.6	$x10^{-4}$	$I_C = 5.0$ mA	$V_{CE} = -5.0$ V
h_{fe}	Small Signal Current Gain	70		$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
		105		$I_C = 5.0$ mA	$V_{CE} = -5.0$ V

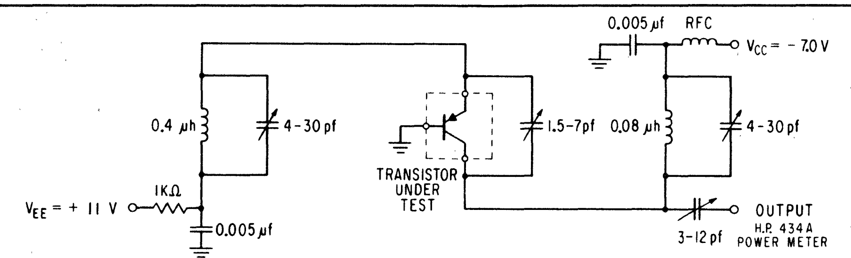
COMMON EMITTER CHARACTERISTICS



COMMON BASE CHARACTERISTICS



100 MC OSCILLATOR EFFICIENCY 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 operation.

(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) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

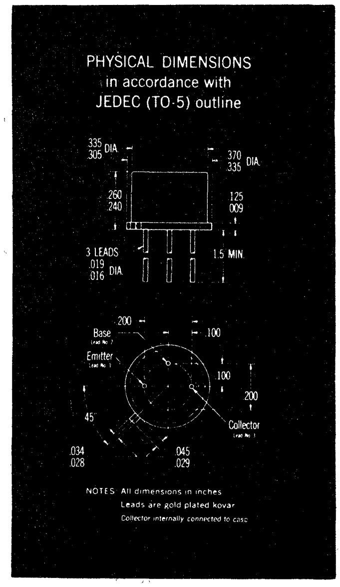
(6) f = 1 Kc; Power Bandwidth of 200 cps, R_G = 2 K.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N1252

NPN LOW STORAGE TYPE

DIFFUSED SILICON TRANSISTOR



LOW STORAGE TIME – Low storage times and low saturation voltage make the 2N1252 ideal for all types of saturated circuitry from low logic levels to ½ ampere core driving levels. These units make 5 mc saturating switching circuits possible. Turn off time at 150 mA is guaranteed less than 150 millimicroseconds. Total switching times are typically 100 millimicroseconds at 500 mA.

BROAD OPERATING RANGE AND HIGH RELIABILITY – Power rating is 2 watts dissipation at 25° C. case temperature. At 150 mA, the base-on voltage is 1.3 volts and maximum saturation resistance is 10 ohms. All production units are stabilized by extended 300° C. storage. The Fairchild structure minimizes the effects of thermal and mechanical shock. These transistors are designed to meet the environmental requirements of MIL-S-19500.

ABSOLUTE MAXIMUM RATINGS (25° C.) [Note 1]

V_{CBO}	—	Collector to base voltage	30v
V_{CER}	—	Collector to emitter voltage ($R_{BE} \leq 10\Omega$) [Note 2]	20v
V_{EBO}	—	Emitter to base voltage	5v
Total dissipation		at case temperature 25° C. [Note 3]	2 watts
		at case temperature 100° C.	1 watt
		at free air temperature 25° C.	0.6 watt

ELECTRICAL CHARACTERISTICS (25° C.)

SYMBOL	CHARACTERISTIC	MIN.	TYPICAL	MAX.	TEST CONDITIONS	
h_{FE}	D. C. pulse current gain [Note 4]	15	35	45	I_C=150mA	V_C=10V
$V_{BE\ SAT.}$	Base saturation voltage		0.9V	1.3V	I_C=150mA	I_B=15mA
$V_{CE\ SAT.}$	Collector saturation voltage		0.6V	1.5V	I_C=150mA	I_B=15mA
h_{fe}	Small signal current gain at f=20mc	2	4		I_C= 50mA	V_C=10V
C_{ob}	Collector capacitance		30$\mu\mu$f	45$\mu\mu$f	I_E= 0mA	V_C=10V
I_{CBO}	Collector cutoff current		0.1μA	10μA	V_C= 20V	T= 25° C.
			100μA	600μA	V_C= 20V	T=150° C.
t_s+t_f	Turn off time		75mμs	150mμs	I_C=150mA	I_{B1}=15mA
					I_{B2}= 5mA	R_L=40Ω
					Pulse width ≥ 10 μsec	

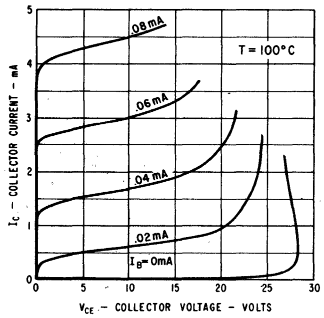
NOTES:
(1) The maximum ratings are limiting absolute values above which life or satisfactory performance may be impaired.
(2) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 75°C/watt (derating factor of 13.3 mw/°C).
(4) Pulse conditions: length = 300 μs.; duty cycle ≤ 1%.

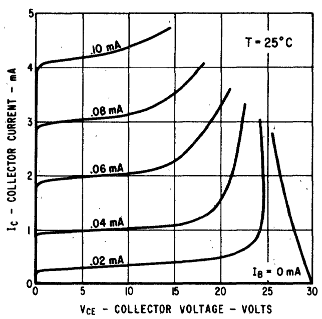
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

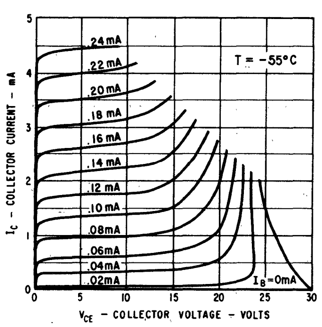
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

HIGH VOLTAGE

COLLECTOR CHARACTERISTICS

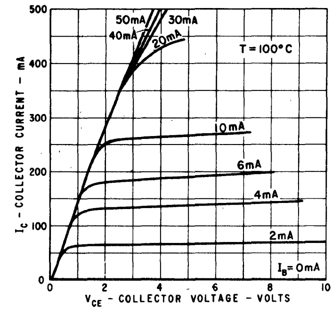


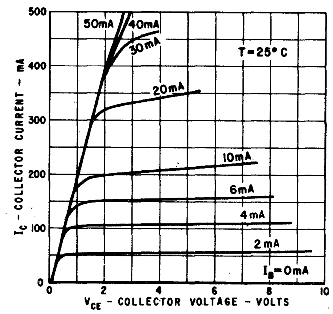


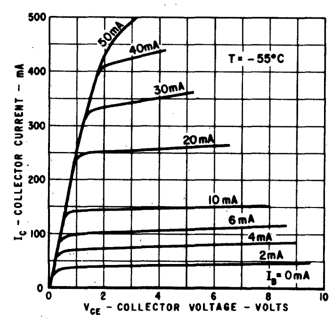


SATURATION REGION

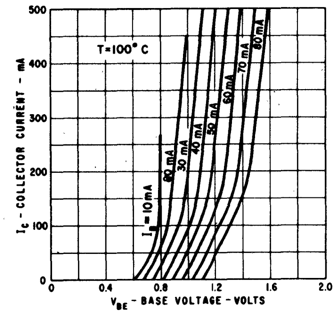
COLLECTOR CHARACTERISTICS

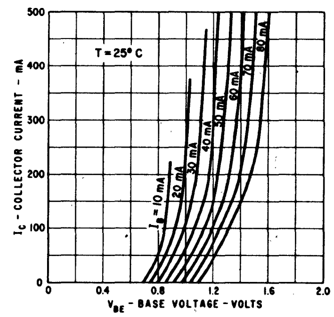


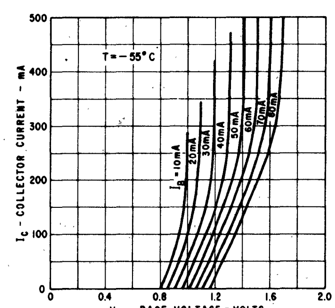




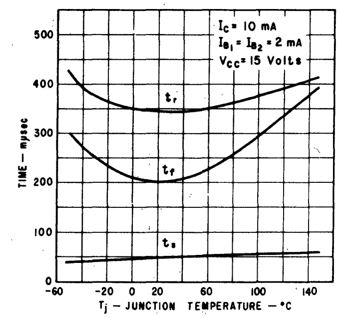
BASE CHARACTERISTICS

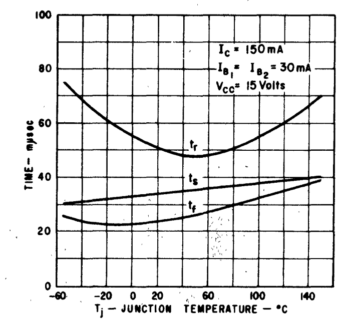


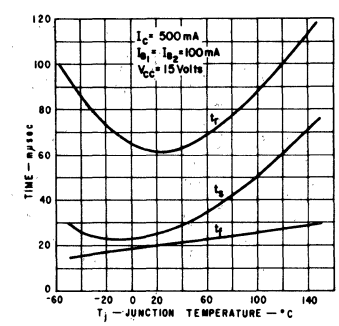




SWITCHING TIMES VS. JUNCTION TEMPERATURE



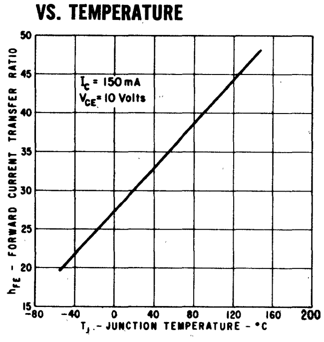




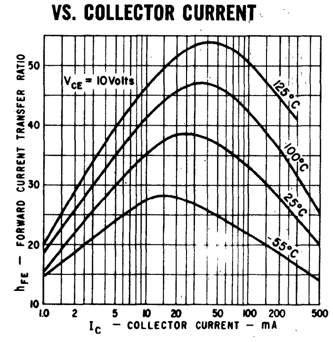
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

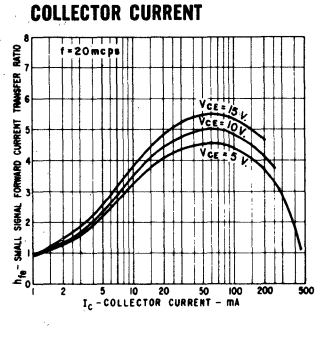
PULSED DC CURRENT GAIN VS. TEMPERATURE



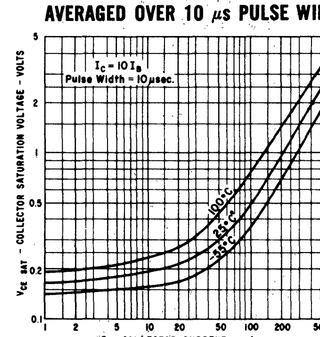
PULSED DC CURRENT GAIN VS. COLLECTOR CURRENT



SMALL SIGNAL FOWARD CURRENT GAIN AT 20 MC VS. COLLECTOR CURRENT

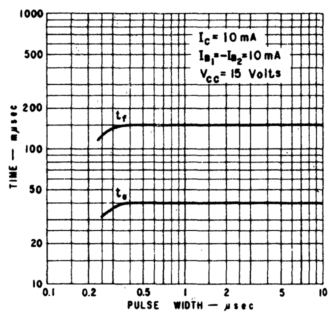


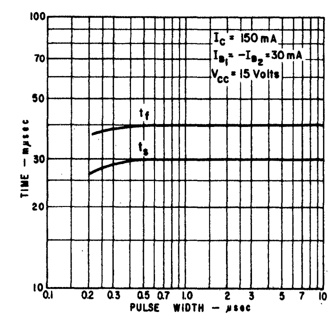
COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT (VOLTAGE AVERAGED OVER 10 μs PULSE WIDTH)

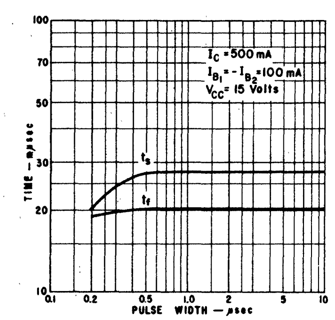


SATURATED SWITCHING TIMES - TYPICAL DELAY, RISE, STORAGE AND FALL**

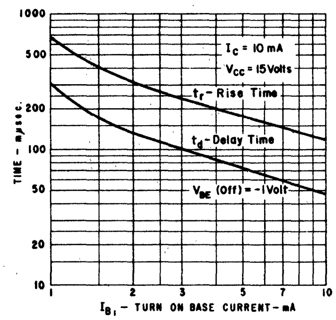
STORAGE AND FALL TIME VS. PULSE WIDTH

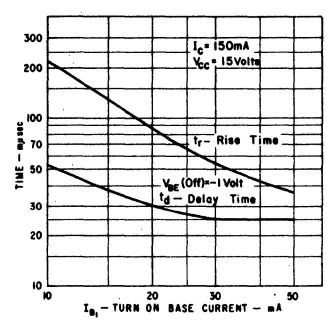


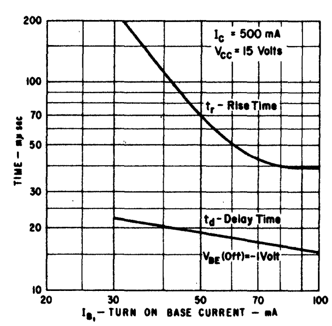




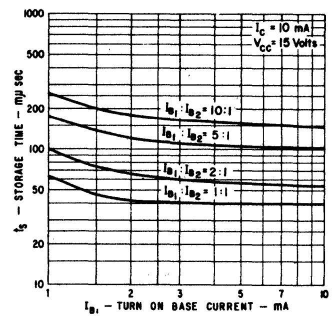
DELAY AND RISE TIME VS. TURN ON BASE CURRENT

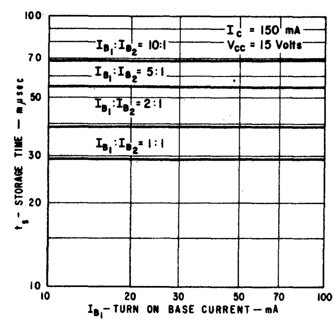


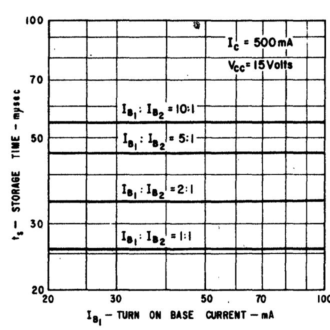




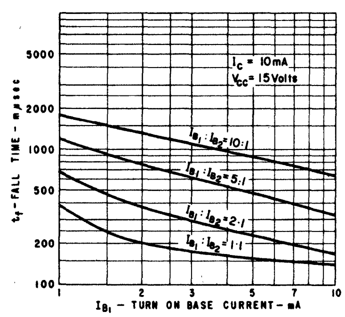
STORAGE TIME VS. TURN ON BASE CURRENT

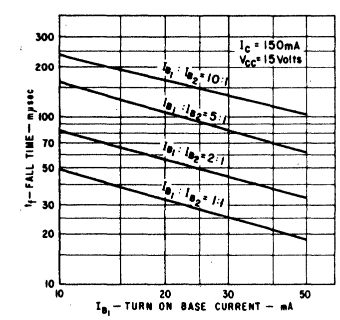


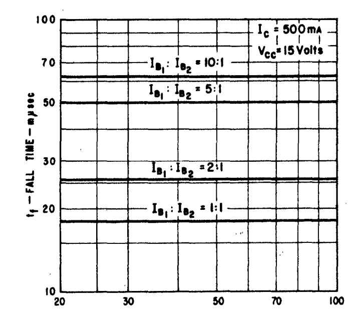




FALL TIME VS. TURN ON BASE CURRENT



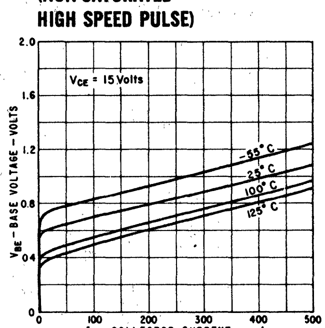




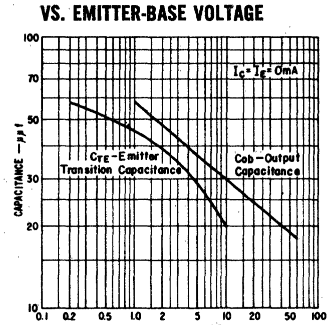
All figures relate to performance with a pulse of 10μsec width unless otherwise noted.

TYPICAL ELECTRICAL CHARACTERISTICS

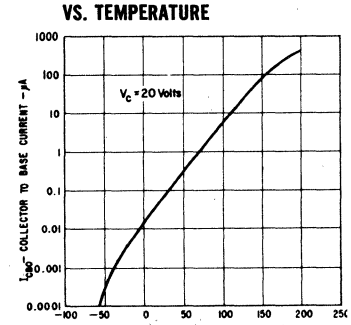
BASE VOLTAGE VS. COLLECTOR CURRENT (NON-SATURATED — HIGH SPEED PULSE)



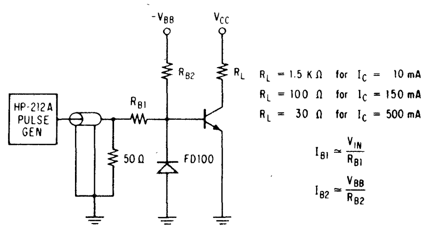
COLLECTOR TRANSITION CAPACITANCE VS. COLLECTOR-BASE VOLTAGE AND EMITTER TRANSITION CAPACITANCE VS. EMITTER-BASE VOLTAGE



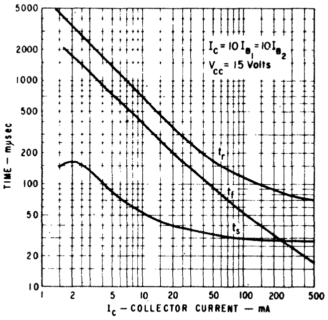
COLLECTOR-BASE DIODE REVERSE CURRENT VS. TEMPERATURE



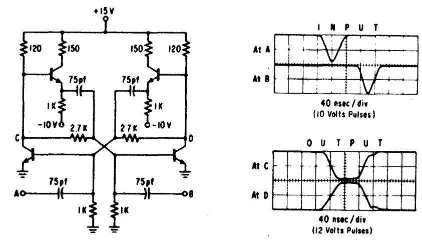
TYPICAL TEST CIRCUIT FOR RESISTIVE LOAD SATURATING SWITCH



SWITCHING TIMES VS. COLLECTOR CURRENT



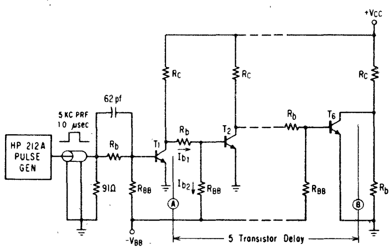
10 MC HIGH POWER FLIP-FLOP FOR DRIVER APPLICATIONS IN SATURATED MODE



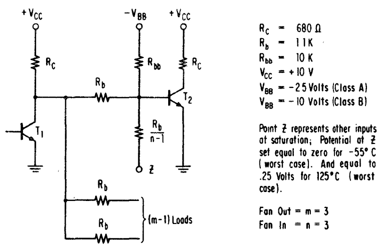
The circuit illustrates fast switching, especially in turn-off, and the high power handling capabilities of the 2N1252. The rise and fall times are each typically 30 to 40 nanoseconds

PROPAGATION DELAY IN SATURATED LOGIC CIRCUITS

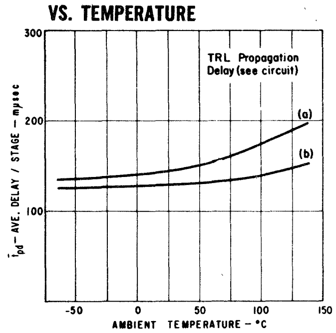
TRL PROPAGATION DELAY MEASUREMENT CIRCUIT (COMPONENT VALUES SAME AS FOR BASIC TRL BUILDING BLOCK)



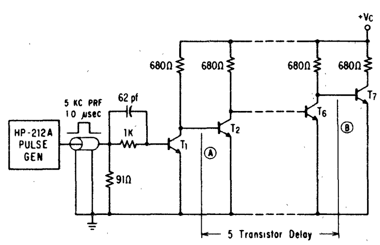
BASIC TRL BUILDING BLOCK (DESIGNED TO OPERATE BETWEEN –55° AND +125°C. FOR HIGHEST & LOWEST β TRANSISTORS FOR LOADING CONDITIONS SHOWN)



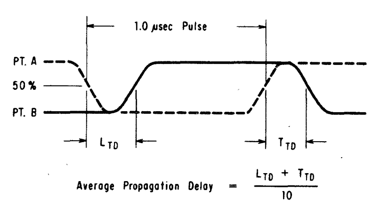
TRL PROPAGATION DELAY VS. TEMPERATURE



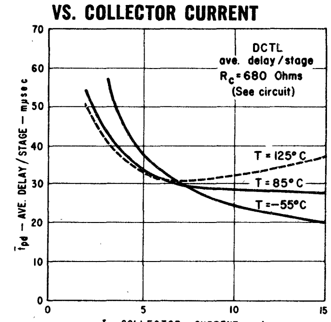
DCTL PROPAGATION DELAY MEASUREMENT CIRCUIT



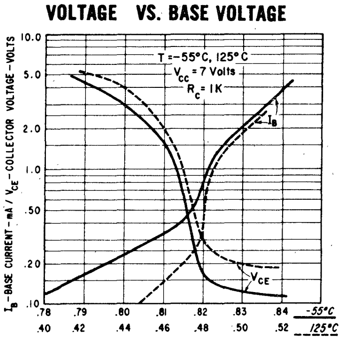
DEFINITION OF PROPAGATION DELAY (SIMILAR FOR DCTL & TRL)



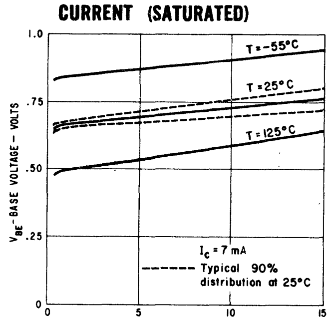
DCTL PROPAGATION DELAY VS. COLLECTOR CURRENT



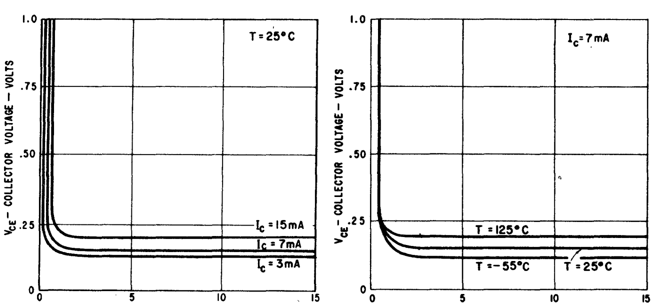
DCTL DESIGN CHARACTERISTICS BASE CURRENT AND COLLECTOR VOLTAGE VS. BASE VOLTAGE



DC INPUT CHARACTERISTICS BASE VOLTAGE VS. BASE CURRENT (SATURATED)



DC COLLECTOR SATURATION CHARACTERISTICS



FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N1253

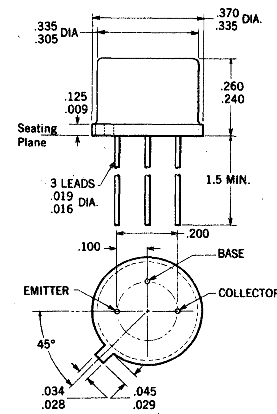
NPN LOW STORAGE TYPE

DIFFUSED SILICON PLANAR* TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2845

LOW STORAGE TIME – Low storage times and low saturation voltage make the 2N1253 ideal for all types of saturated circuitry from low logic levels to ½ ampere core driving levels. These units make 5 MHz saturating switching circuits possible. Turn off time at 150 mA is guaranteed less than 150 ns. Total switching times are typically 100 ns at 500 mA.

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



NOTES: All dimensions in inches
Leads are gold-plated Kovar*
Leads No. 3 internally connected to case
Package weight is 1.23 grams

ABSOLUTE MAXIMUM RATINGS (25° C.) [Note 1]

V_{CBO}	–	Collector to base voltage	30v
V_{CER}	–	Collector to emitter voltage **($R_{BE} \leqq 10\Omega$) [Note 2]**	20v
V_{EBO}	–	Emitter to base voltage	5v
Total dissipation		at case temperature 25° C. [Note 3]	2 watts
		at case temperature 100° C.	1 watt
		at free air temperature 25° C.	0.6 watt

ELECTRICAL CHARACTERISTICS (25° C.)

SYMBOL	CHARACTERISTIC	MIN.	TYPICAL	MAX.	TEST CONDITIONS	
h_{FE}	D. C. pulse current gain [Note 4]	30	45	90	I_C=150mA	V_C=10V
$V_{BE\ SAT.}$	Base saturation voltage		0.9V	1.3V	I_C=150mA	I_B=15mA
$V_{CE\ SAT.}$	Collector saturation voltage		0.6V	1.5V	I_C=150mA	I_B=15mA
h_{fe}	Small signal current gain at f=20MHz	2.5	5.5		I_C= 50mA	V_C=10V
C_{obo}	Collector capacitance		30 pF	45pF	I_E= 0mA	V_C=10V
I_{CBO}	Collector cutoff current		0.1µA	10µA	V_C= 20V	T= 25° C.
			100µA	600µA	V_C= 20V	T=150° C.
t_s+t_f	Turn-off time		75ns	150ns	I_C=150mA	I_{B1}=10mA
					I_{B2}= 5mA	R_L=40Ω
					Pulse width=10 µs	

* Planar is a patented Fairchild process.

NOTES:
(1) The maximum ratings are limiting absolute values above which life or satisfactory performance may be impaired.
(2) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Application note APP 4/2
(3) These ratings give a maximum junction temperature of 175°C. and junction-to-case thermal resistance of 75°C./watt (derating factor of 13.3 mw/°C.).
(4) Pulse conditions: length = 300µs.; duty cycle ≦ 1%.

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SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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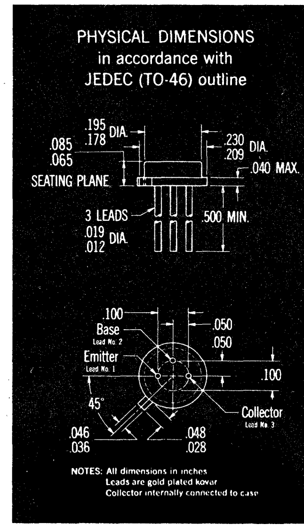
2N1708

NPN HIGH-SPEED SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2368, 2N2369 OR 2N2369A



GENERAL DESCRIPTION - The Fairchild 2N1708 is an NPN silicon PLANAR epitaxial transistor designed specifically for high-speed, low-power saturated switching applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	175°C Maximum
Lead Temperature (Soldering, 10 second time limit)	235°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	1.0 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.3 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	25 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	12 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts
I_C	Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{FE}	DC Current Gain	20			I_C = 10 mA V_{CE} = 1.0 V
V_{BE}(sat)	Base Saturation Voltage	0.7	0.9	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.22	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.35	Volts	I_C = 50 mA I_B = 5.0 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	2.0			I_C = 10 mA V_{CE} = 10 V
I_{CBO}	Collector-Base Cutoff Current		0.025	μA	I_E = 0 V_{CB} = 15 V
I_{CBO}(150°C)	Collector-Base Cutoff Current		15	μA	I_E = 0 V_{CB} = 15 V
I_{CEX}(100°C)	Collector Cutoff Current		15	μA	V_{CE} = 10 V V_{BE} = 0.25 V
BV_{CBO}	Collector to Base Breakdown Voltage	25		Volts	I_E = 0 I_C = 100 μA
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	12		Volts	I_B = 0 I_C = 10 mA (pulsed)
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0		Volts	I_C = 0 I_E = 100 μA
C_{ob}	Output Capacitance (f = 140 kc)		6.0	pf	I_E = 0 V_{CB} = 10 V
τ_s	Charge Storage Time Constant (Note 6)		25	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 10 mA, $I_{B2} \approx$ -10 mA
t_{on}	Turn On Time (Note 6)		40	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 3.0 mA, $I_{B2} \approx$ -1.0 mA
t_{off}	Turn Off Time (Note 6)		75	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 3.0 mA, $I_{B2} \approx$ -1.0 mA

SEE BACK PAGE FOR NOTES.

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NOTES:

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

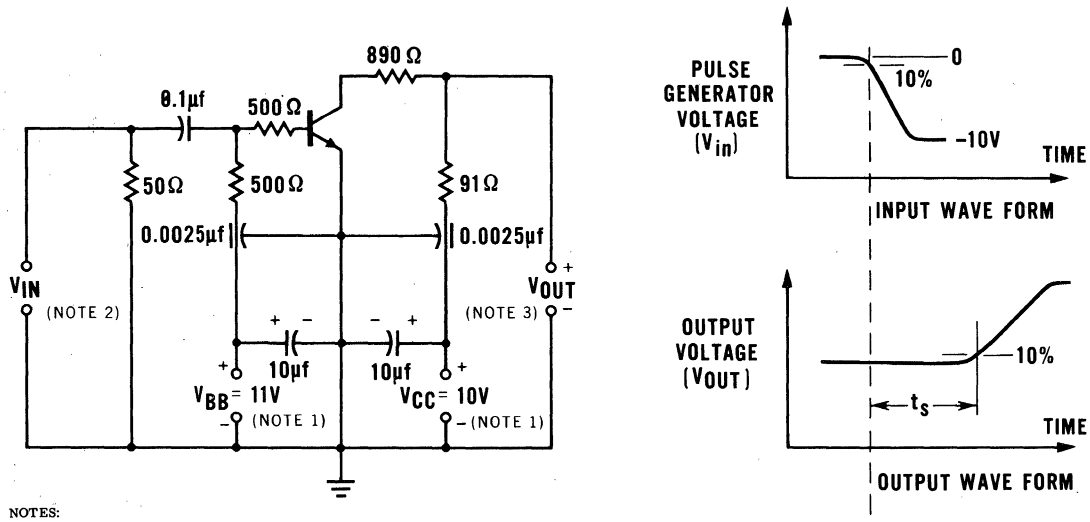
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.67 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. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length <6.0 msec; duty cycle <30%.

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

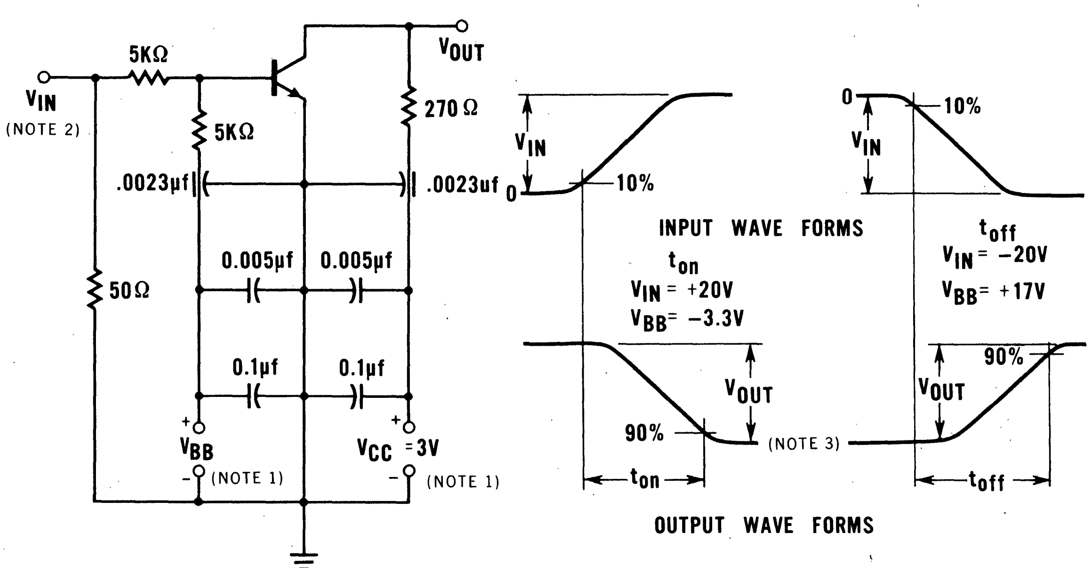


NOTES:

(1) Input voltage (V_{IN}) obtained from a pulse generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec; pulse duration >300 nsec, and duty factor <2%.

(2) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance >1000 ohms.

CIRCUIT USED TO MEASURE STORAGE TIME (τ_s).



NOTES:

(1) With certain types of power supplies, it may be necessary to connect 25-µf decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB}.

(2) Input voltage (V_{IN}) obtained from a generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec; pulse duration >300 nsec, and duty factor <2%.

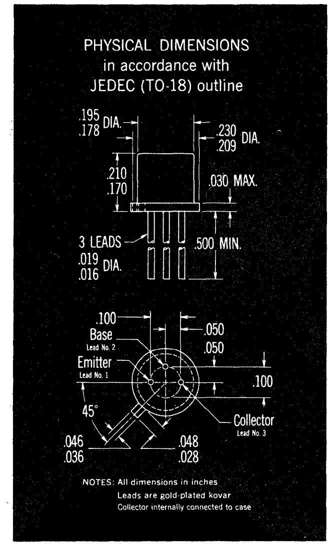
(3) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance >3000 ohms.

CIRCUIT USED TO MEASURE "TURN-ON" TIME (t_{on}) AND "TURN-OFF" TIME (t_{off}).

FT1746

FAIRCHILD PNP SILICON PLANAR EPITAXIAL TRANSISTOR

HIGH-VOLTAGE, HIGH-FREQUENCY SWITCH AND RF AMPLIFIER



GENERAL DESCRIPTION - The FT1746 is a double-diffused silicon PNP PLANAR epitaxial transistor packaged in the JEDEC TO-18 outline. It is specifically designed for digital and analog applications requiring high-voltage and high-frequency characteristics in combination. Typical f_T is 150 mc.

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Soldering Temperature (60 seconds time limit)	300°C Maximum
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	0.36 Watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	-35 Volts
V_{CEO} Collector to Emitter Voltage	-30 Volts
V_{EBO} Emitter to Base Voltage	-4.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain [Note 5]	20			I_C = 10 mA	V_{CE} = -5.0 V
V_{BE}(sat)	Base Saturation Voltage		-1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		-0.4	Volts	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	1.0			I_C = 10 mA	V_{CE} = -10 V
C_{ob}	Output Capacitance		9.0	pf	I_E = 0	V_{CB} = -10 V
C_{TE}	Input Capacitance		11	pf	I_C = 0	V_{EB} = -0.5 V
I_{CBO}	Collector Cutoff Current		5.0	nA	I_E = 0	V_{CB} = -15 V
I_{CBO}(150°C)	Collector Cutoff Current		25	μA	I_E = 0	V_{CB} = -15 V
BV_{CBO}	Collector to Base Breakdown Voltage	-35		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage [Note 4]	-30		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-4.0		Volts	I_C = 0	I_E = 10 μA

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 operation.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 146°C/Watt (derating factor of 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/Watt (derating factor of 2.1 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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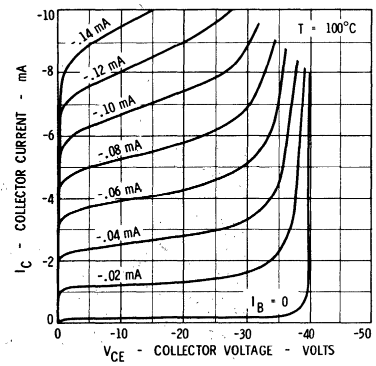
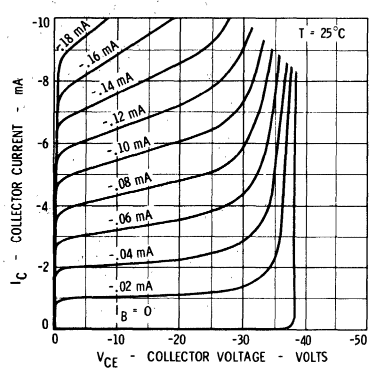
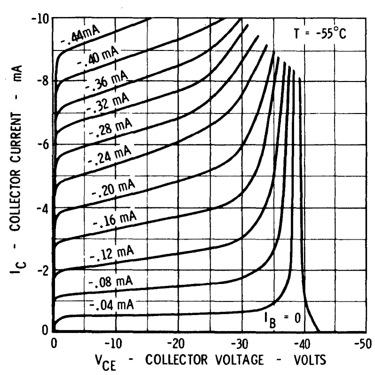
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

HIGH VOLTAGE

COLLECTOR CHARACTERISTICS

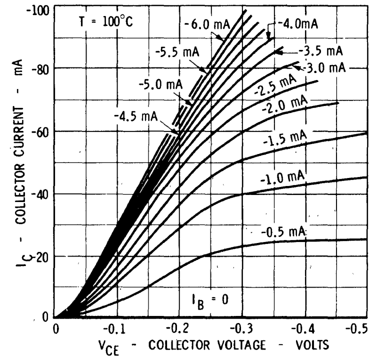


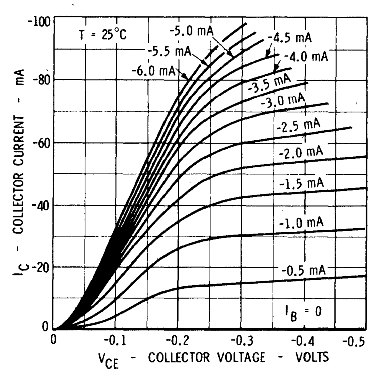


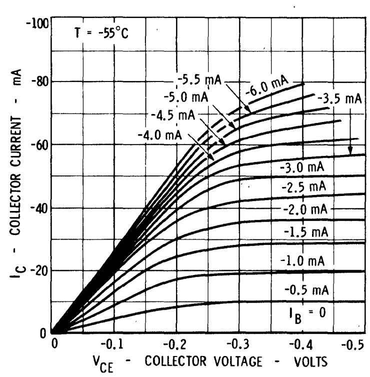


SATURATION REGION

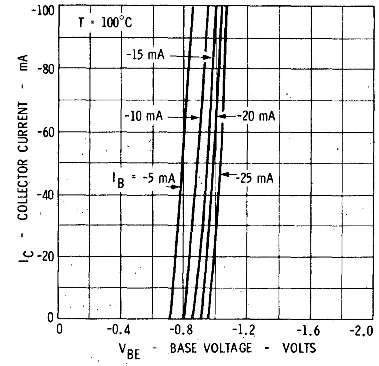
COLLECTOR CHARACTERISTICS

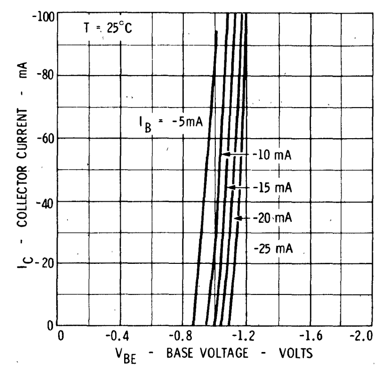


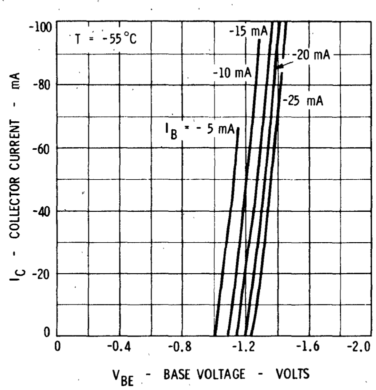




BASE CHARACTERISTICS



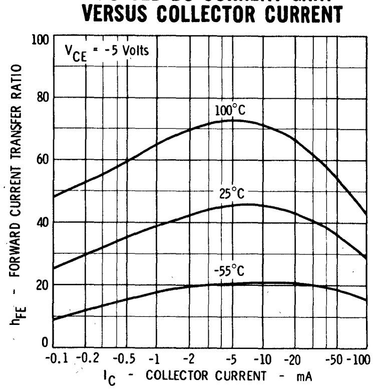




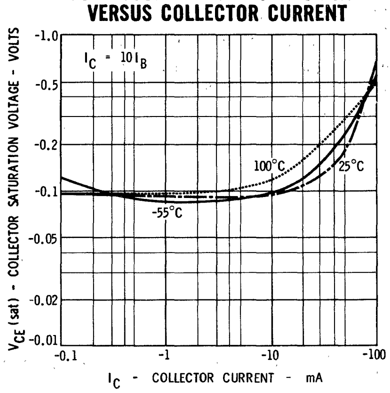
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

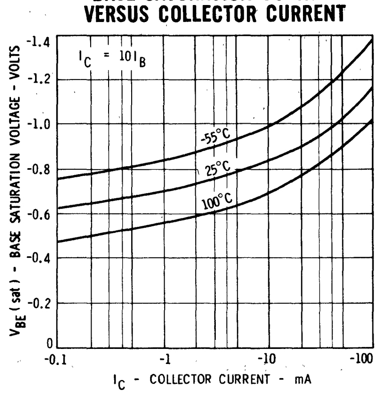
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



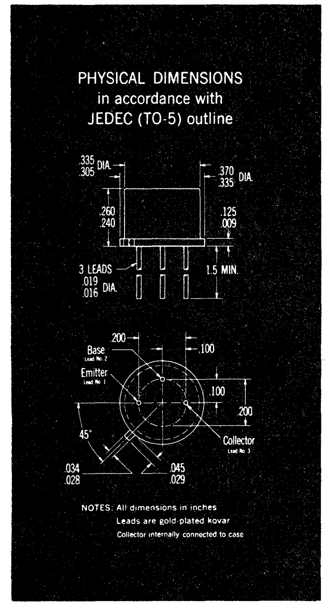
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



2N1983 • 2N1984 • 2N1985

NPN SMALL SIGNAL TYPE

DIFFUSED SILICON TRANSISTORS



GENERAL DESCRIPTION - These transistors: 2N1983, 2N1984, and 2N1985, are double diffused silicon NPN transistors packaged in the popular JEDEC TO-5 outline. They are designed to provide high performance in a wide range of small-signal applications including AF and RF amplifiers, oscillators and special circuits requiring silicon performance and reliability.

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +150°C
Operating Junction Temperature	+150°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Note 2 & 3]	2.0 Watts
at 100°C Case Temperature [Note 2 & 3]	1.0 Watt
at 25°C Ambient Temperature	0.6 Watt

Maximum Voltages

V_{CBO} —	Collector to Base Voltage	50 Volts
V_{CER} —	Collector to Emitter Voltage ($R_{BE} \leq 10\Omega$) [Note 4]	30 Volts
V_{CEO} —	Collector to Emitter Voltage	25 Volts
V_{EBO} —	Emitter to Base Voltage	5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
V_{BE}	Non-Saturated Base Voltage		.85	Volts	I_C = 1.0 mA	V_{CE} = 5.0 V
R_{CS}	Saturation Resistance		50	ohms	I_C = 5.0 mA	I_B = 0.5 mA
h_{fe}	High Frequency Current Gain f = 20 mc	2.0			I_C = 50 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance		45	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		5.0	μA	I_E = 0	V_{CB} = 30 V
I_{CBO}(+150°C)	Collector Cutoff Current		200	μA	I_E = 0	V_{CB} = 30 V
V_{CER}(sust)	Collector to Emitter Sustaining Voltage (Pulsed) [Note 4]	30		Volts	I_C = 100 mA	$R_{BE} \leq$ 10 Ω
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Pulsed) [Note 4]	25		Volts	I_C = 100 mA	I_B = 0
I_{EBO}	Emitter Current		100	μA	I_C = 0	V_{EB} = 2.0 V

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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 operation.

(3) These ratings give a maximum junction temperature of 150°C and junction-to-case thermal resistance of 62.5°C/Watt (derating factor of 16 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

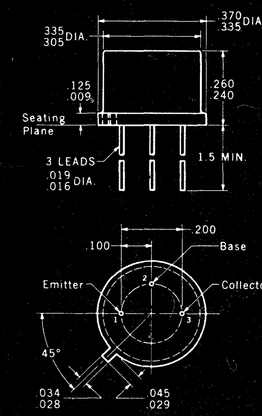
SMALL SIGNAL CHARACTERISTICS (f = 1 kc)

Symbol	Characteristic	2N1983 Min.	2N1983 Max.	2N1984 Min.	2N1984 Max.	2N1985 Min.	2N1985 Max.	Units	Test Conditions	
h_{fe}	Current Gain	70	210	35	100	15	45		I_C = 1.0 mA	V_{CE} = 5.0 V
		80	240	40	120	20	80		I_C = 5.0 mA	V_{CE} = 5.0 V
h_{ib}	Input Resistance	20	30	20	30	20	30	ohms	I_C = 1.0 mA	V_{CB} = 5.0 V
		4.0	8.0	4.0	8.0	4.0	8.0	ohms	I_C = 5.0 mA	V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		7.0		5.0		5.0	$\times 10^{-4}$	I_C = 1.0 mA	V_{CB} = 5.0 V
			7.0		5.0		5.0	$\times 10^{-4}$	I_C = 5.0 mA	V_{CB} = 5.0 V
h_{ob}	Output Conductance		1.0		1.0		1.5	μmho	I_C = 1.0 mA	V_{CB} = 5.0 V
			1.5		1.5		2.0	μmho	I_C = 5.0 mA	V_{CB} = 5.0 V
h_{ie}	Input Resistance		2000		1200		1000	ohms	I_C = 5.0 mA	V_{CE} = 5.0 V
h_{oe}	Output Conductance		200		100		75	μmho	I_C = 5.0 mA	V_{CE} = 5.0 V

2N1986 • 2N1987
NPN SWITCHES
DIFFUSED SILICON PLANAR* TRANSISTORS

GENERAL DESCRIPTION - The 2N1986 and 2N1987 are Double Diffused Silicon NPN Transistors packaged in the JEDEC TO-5 outline. They are designed for high-speed switching, high-frequency amplifier applications, and may be used as core drivers, relay drivers, and pulse generators.

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.11 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +150°C
Operating Junction Temperature	+150°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	2.0 Watts
at 100°C Case Temperature	(Notes 2 and 3)	1.0 Watt
at 25°C Ambient Temperature		0.6 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	50 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\,\Omega$) (Note 4)	40 Volts
V_{CEO}	Collector to Emitter Voltage	25 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts

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

Symbol	Characteristic	2N1986 Min.	2N1986 Max.	2N1987 Min.	2N1987 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	60	240	20	80		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	60		20			I_C = 30 mA V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage		0.9		0.9	Volts	I_C = 30 mA I_B = 3.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.6		0.6	Volts	I_C = 30 mA I_B = 3.0 mA
V_{BE}(sat)	Base Saturation Voltage		1.3		1.3	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage		1.5		1.5	Volts	I_C = 150 mA I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0		2.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Output Capacitance		35		35	pF	I_E = 0 V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		5.0		5.0	μA	I_E = 0 V_{CB} = 30 V
I_{CBO}(+150°C)	Collector Cutoff Current		200		200	μA	I_E = 0 V_{CB} = 30 V
BV_{CBO}	Collector Breakdown Voltage	40		40		Volts	I_C = 100 μA I_E = 0
V_{CER}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	30		30		Volts	I_C = 100 mA (pulsed) $R_{BE} \leq 10\,\Omega$
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	25		25		Volts	I_C = 100 mA (pulsed) I_B = 0
BV_{EBO}	Emitter Breakdown Voltage	5.0		5.0		Volts	I_C = 0 I_E = 1.0 mA

NOTES:

* Planar is a patented Fairchild process.

(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 operation.
(3) These ratings give a maximum junction temperature of 150°C and junction-to-case thermal resistance of 62.5°C/Watt (derating factor of 16 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse conditions: Length = 300 μsec; duty cycle ≤ 1%.

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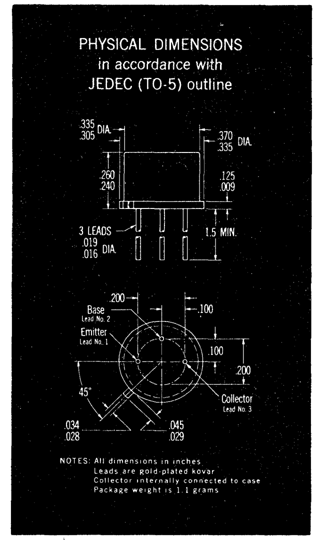
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

2N1988 • 2N1989
NPN HIGH-VOLTAGE
DIFFUSED SILICON PLANAR* TRANSISTORS

GENERAL DESCRIPTION - The 2N1988 and 2N1989 are double diffused silicon NPN transistors packaged in the popular JEDEC TO-5 configuration. They are characterized by high breakdown and sustaining voltages. They are designed for use in AC and DC amplifiers ... RF amplifiers and oscillators ... servo amplifiers ... and as relay, core, and drum memory drivers.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +150°C
Operating Junction Temperature		+150°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 & 3)	2.0 Watts
at 100°C Case Temperature	(Notes 2 & 3)	1.0 Watt
at 25°C Ambient Temperature		0.6 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		100 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\Omega$)	(Note 4)	60 Volts
V_{CEO}	Collector to Emitter Voltage		45 Volts
V_{EBO}	Emitter to Base Voltage		5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C)

Symbol	Characteristics		2N1988 Min.	2N1988 Max.	2N1989 Min.	2N1989 Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 5)	35	120	20	60		I_C = 30 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage			1.0		1.0	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE}(sat)	Collector Saturation Voltage			2.0		2.0	Volts	I_C = 30 mA	I_B = 3.0 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.0		2.0			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance			20		20	pF	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current			5.0		5.0	μA	I_E = 0	V_{CB} = 50 V
I_{CBO}(+150°C)	Collector Cutoff Current			400		400	μA	I_E = 0	V_{CB} = 50 V
V_{CER}(sust)	Collector to Emitter Sustaining Voltage (pulsed)	(Note 4)	60		60		Volts	I_C = 50 mA	$R_{BE} \geq 10\ \Omega$
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (pulsed)	(Note 4)	45		45		Volts	I_C = 50 mA	I_B = 0
I_{EBO}	Emitter Current			100		100	μA	I_C = 0	V_{EB} = 2.0 V

* Planar is a patented Fairchild process.

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SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

Symbol	Characteristics	2N1988 Min.	2N1988 Max.	2N1989 Min.	2N1989 Max.	Units	Test Conditions	
h_{fe}	Small Signal Current Gain	20	100	10			I_C = 1.0 mA	V_{CE} = 5.0 V
h_{ib}	Input Resistance	20	30	20	30	ohms	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		1.5		1.5	$x10^{-4}$	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{ob}	Output Conductance		1.0		1.0	μmho	I_C = 1.0 mA	V_{CB} = 5.0 V

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 operation.
3. These ratings give a maximum junction temperature of 150°C and junction-to-case thermal resistance of 62.5°C/Watt (derating factor of 16 mW/°C).
4. Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
5. Pulse conditions: length = 300 μsec; duty cycle $\leq$1%.

2N1990

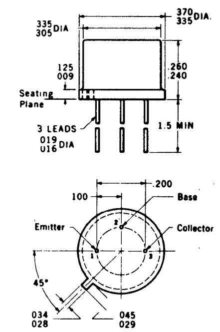
NPN NEON TUBE AND NIXIE® DRIVER

DIFFUSED SILICON PLANAR* TRANSISTOR

GENERAL DESCRIPTION - The 2N1990 is a double diffused silicon NPN transistor packaged in the popular JEDEC TO-5 outline. The high breakdown voltage and low saturation voltage, plus diffused silicon performance and reliability, characterize it as an ideal unit for neon tube and nixie driver applications.

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-5) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +150°C
Operating Junction Temperature		+150°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 & 3)	2.0 Watts
at 100°C Case Temperature	(Notes 2 & 3)	1.0 Watt
at 25°C Ambient Temperature		0.6 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	100 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic		Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 4)	20			I_C = 30 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage			1.0	Volts	I_C = 2.0 mA	I_B = 0.2 mA
V_{CE}(sat)	Collector Saturation Voltage			0.5	Volts	I_C = 2.0 mA	I_B = 0.2 mA
I_{CEX}	Cutoff Current, Reverse Bias			10	μA	I_B = -10 μA	V_{CE} = 75 V
I_{CEX}(+150°C)	Cutoff Current, Reverse Bias			250	μA	I_B = -250 μA	V_{CE} = 75 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 operation.
3. These ratings give a maximum junction temperature of 150°C and junction-to-case thermal resistance of 62.5°C/Watt (derating factor of 16 mW/°C).
4. Pulse Conditions: length = 300 μs ; duty cycle $\leq$ 1%.

NIXIE ® - Registered Trade Mark Burroughs Corporation.

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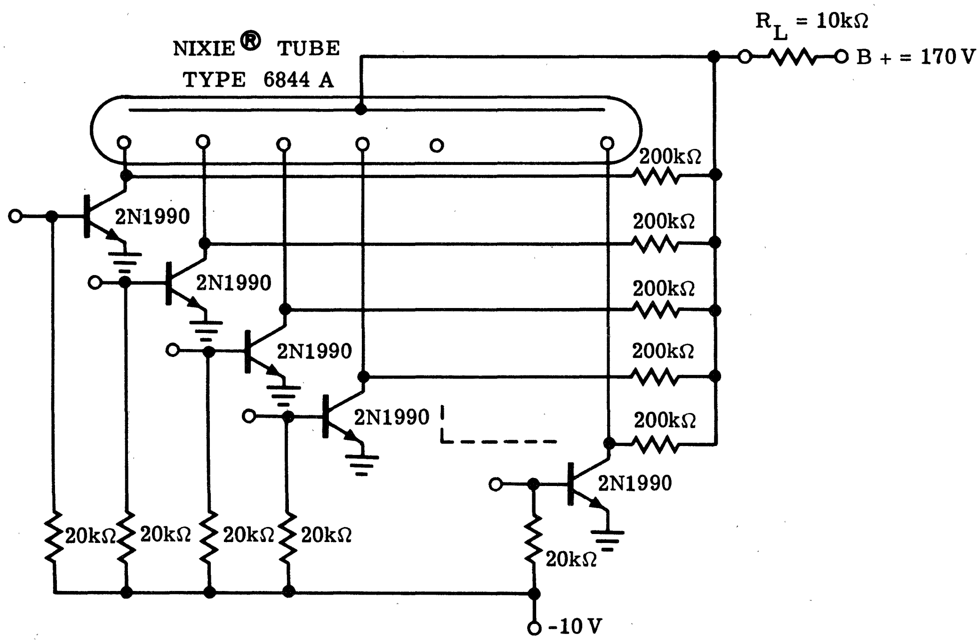
TRANSISTORIZED NIXIE® INDICATOR



2N2008

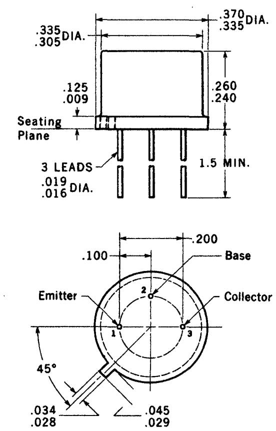
NPN MEDIUM POWER AUDIO AMPLIFIER

SILICON PLANAR* TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3114

GENERAL DESCRIPTION- The Fairchild 2N2008 is an NPN silicon PLANAR transistor designed primarily for large-signal, medium-power audio applications.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures	
Storage Temperature	-65°C to 200°C
Operating Junction Temperature	200°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	3.0 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.8 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	175 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	110 Volts
V_{EBO} Emitter to Base Voltage	8.0 Volts
I_C Collector Current	500 mA

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Unit	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	40	120		I_C = 50 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	30	90		I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	20			I_C = 1.0 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage		1.0	Volts	I_C = 25 mA	I_B = 5.0 mA
V_{CE}(sat)	Collector Saturation Voltage		2.5	Volts	I_C = 25 mA	I_B = 5.0 mA
h_{ib}	Input Resistance (f = 1 kHz)	20	30	Ohms	I_E = 1.0 mA	V_{CB} = 5.0 V
h_{ib}	Input Resistance (f = 1 kHz)	4.0	10	Ohms	I_E = 5.0 mA	V_{CB} = 5.0 V
h_{ob}	Output Conductance (f = 1 kHz)	0.1	0.5	μmhos	I_E = 1.0 mA	V_{CB} = 5.0 V
h_{ob}	Output Conductance (f = 1 kHz)	0.1	0.5	μmhos	I_E = 5.0 mA	V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio (f = 1 kHz)		250	$x10^{-6}$	I_E = 1.0 mA	V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio (f = 1 kHz)		250	$x10^{-6}$	I_E = 5.0 mA	V_{CB} = 5.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	20	100		I_E = 1.0 mA	V_{CE} = 5.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	35	120		I_E = 5.0 mA	V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0			I_E = 50 mA	V_{CE} = 10 V
I_{CBO}	Collector-Base Cutoff Current		50	nA	I_E = 0	V_{CB} = 100 V
I_{CBO}(150°C)	Collector-Base Cutoff Current		50	μA	I_E = 0	V_{CB} = 100 V
C_{obo}	Output Capacitance (f = 1.0 mc)		15	pF	I_E = 0	V_{CB} = 10 V
BV_{CBO}	Collector to Base Breakdown Voltage	175		Volts	I_E = 0	I_C = 100 μA
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	110		Volts	I_B = 0	I_C = 10 mA (pulsed)
BV_{EBO}	Emitter to Base Breakdown Voltage	8.0		Volts	I_C = 0	I_E = 100 μA

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 58.3°C/watt (derating factor of 17.2 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).
(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length ≤ 300 μsec; duty cycle = 1%.

* Planar is a patented Fairchild process.

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

2N2049 • 2N2645

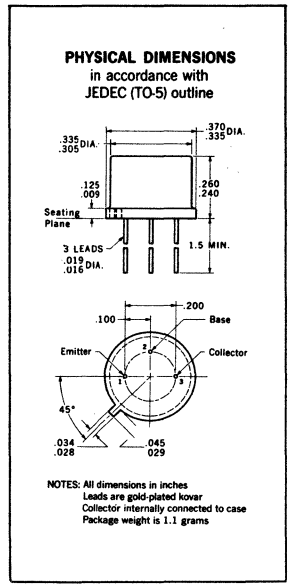
NPN LOW NOISE, HIGH GAIN

DIFFUSED SILICON PLANAR* TRANSISTORS

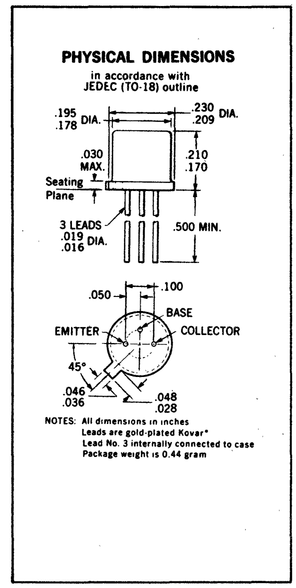
GENERAL DESCRIPTION - The 2N2049 and 2N2645 are designed for use in a broad range of amplifier and oscillator circuits where Planar performance is desirable. These transistors provide useful gain over more than five decades of collector current with low leakage and very low noise. These characteristics together with a 35 megacycle alpha cutoff at one milliampere make them particularly suitable for low-level broad-band input stages such as TV camera preamplifiers, transducer preamplifiers, and null detectors.

The very low corner (typically 220 Hz at 10 μA) substantially reduces 1/f noise in such applications as tape recorder preamplifiers, digital voltmeters, audio systems and servo amplifiers.

The 2N2049 and 2N2645 are designed to meet the environmental requirements of MIL-S-19500 and reflect all of the process improvements resulting from the Minute Man Reliability Program for NPN Silicon Planar Transistors.



2N2049



2N2645

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures			
Storage Temperature		-65°C to +300°C	
Operating Junction Temperature		200°C Maximum	
Maximum Power Dissipation		2N2645	2N2049
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)		1.8 Watts	3.0 Watts
Total Dissipation at 100°C Case Temperature (Notes 2 and 3)		1.0 Watt	1.7 Watts
Total Dissipation at 25°C Ambient Temperature		0.5 Watt	0.8 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	75 Volts	75 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\,\Omega$) (Note 4)	50 Volts	50 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
NF	Narrow-Band Noise Figure (Note 5)		0.6	2.5	dB	I_C = 0.1 mA V_{CE} = 10 V
NF	Narrow-Band Noise Figure (Note 6)		1.4	3.0	dB	I_C = 0.1 mA V_{CE} = 10 V
NF	Broad-Band Noise Figure (Note 7)			3.5	dB	I_C = 0.01 mA V_{CE} = 5 V
NF	Narrow-Band Noise Figure (Note 8)		7.5	12	dB	I_C = 0.1 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 9)	100	130	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	60	80			I_C = 0.1 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	20	55			I_C = 0.01 mA V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage	0.6	0.7	0.8	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.12	0.4	Volts	I_C = 10 mA I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 20MHz)	2.5	4.3			I_C = 10 mA V_{CE} = 10 V
C_{obo}	Output Capacitance		17	25	pF	I_E = 0 V_{CB} = 10 V
C_{ibo}	Input Capacitance		50	80	pF	I_C = 0 V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		0.4	10	nA	I_E = 0 V_{CB} = 60 V
I_{CBO}(150°C)	Collector Cutoff Current		0.4	10	μA	I_E = 0 V_{CB} = 60 V
BV_{CBO}	Collector to Base Breakdown Voltage	75			Volts	I_C = 0.1 mA I_E = 0
V_{CER}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	50			Volts	I_C = 100 mA (pulsed) $R_{BE} \leq$ 10 Ω
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			Volts	I_C = 0 I_E = 0.1 mA
I_{EBO}	Emitter Cutoff Current		0.03	10	nA	I_C = 0 V_{EB} = 5.0 V

(See notes on back page)

*Planar is a patented Fairchild process.

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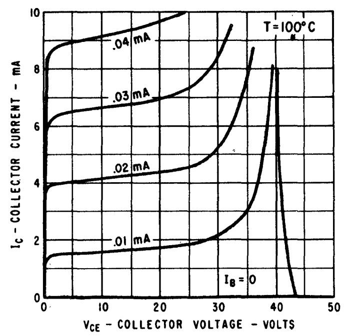
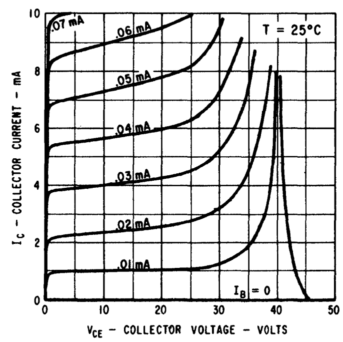
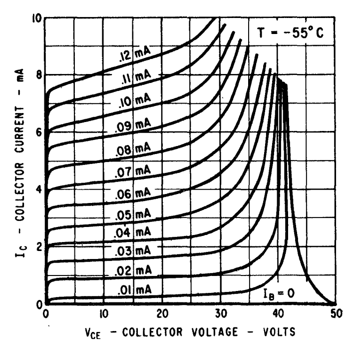
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

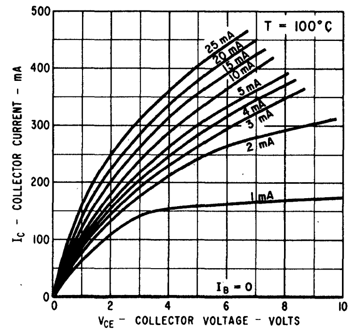
HIGH VOLTAGE REGION

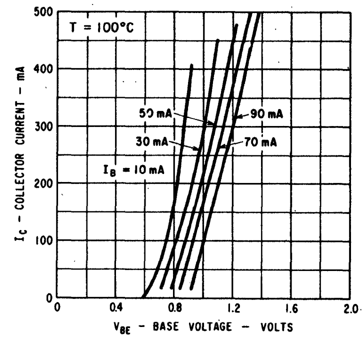


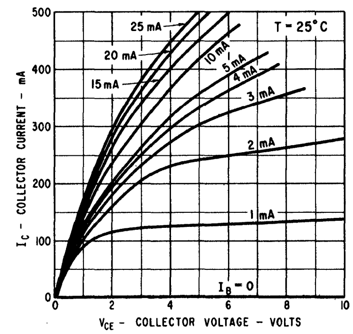


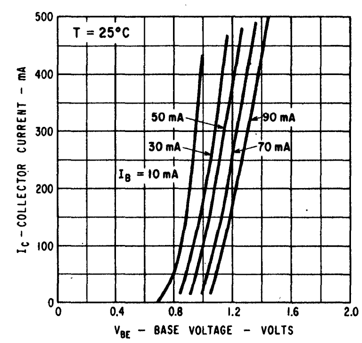


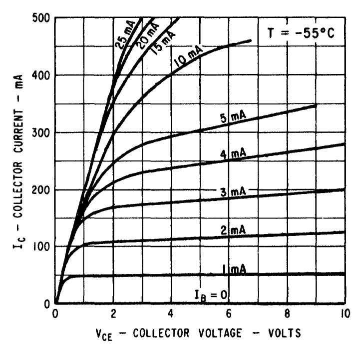
SATURATION REGION

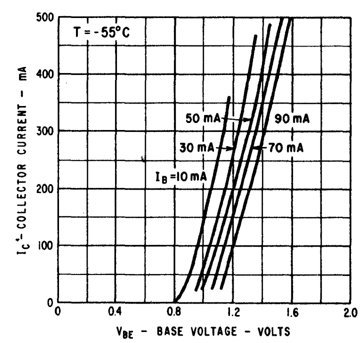








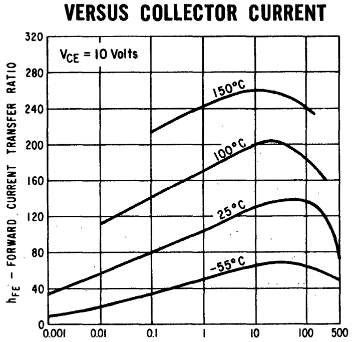




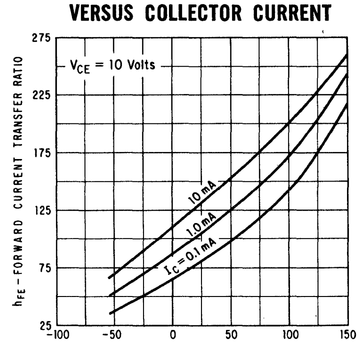
* Single family characteristics on Transistor Curve Tracer

TYPICAL ELECTRICAL CHARACTERISTICS

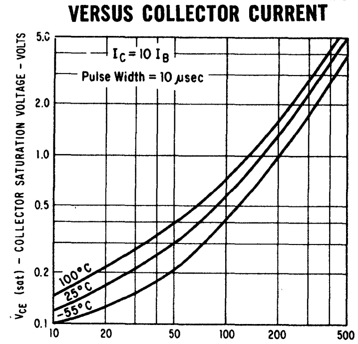
PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT

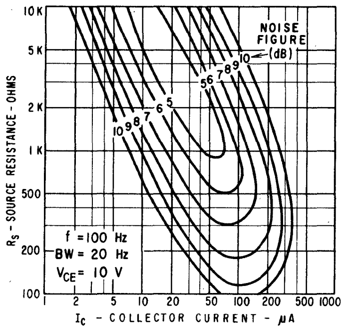


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

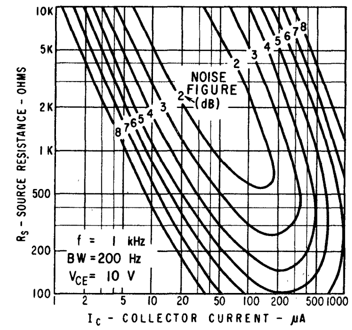


TYPICAL ELECTRICAL CHARACTERISTICS

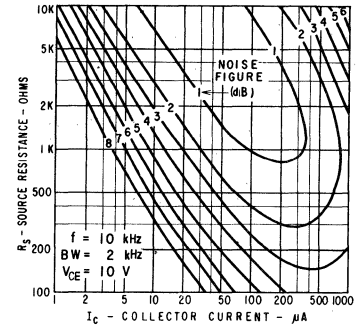
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



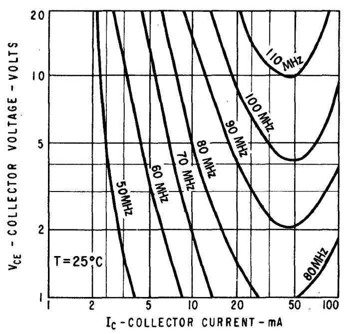
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



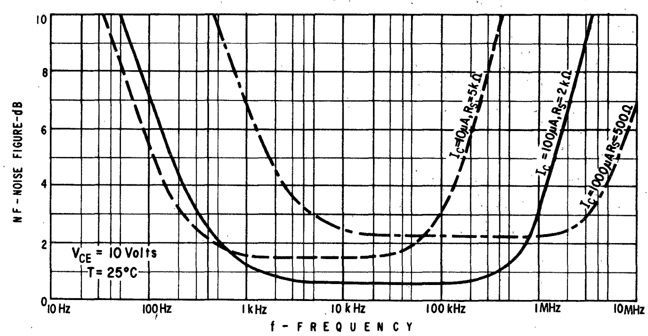
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



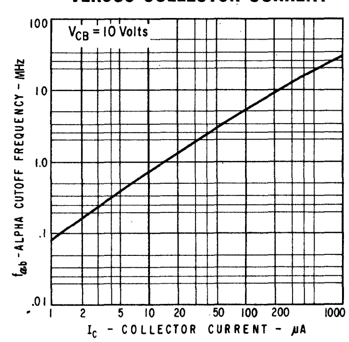
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



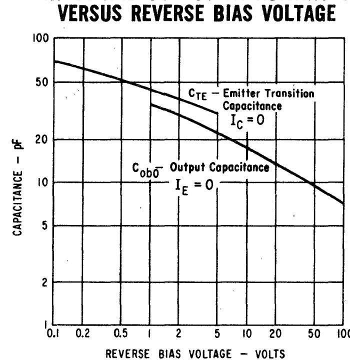
NOISE FIGURE VERSUS FREQUENCY



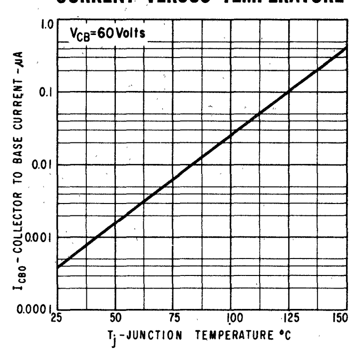
ALPHA CUTOFF FREQUENCY VERSUS COLLECTOR CURRENT



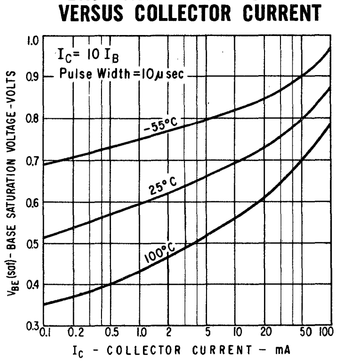
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



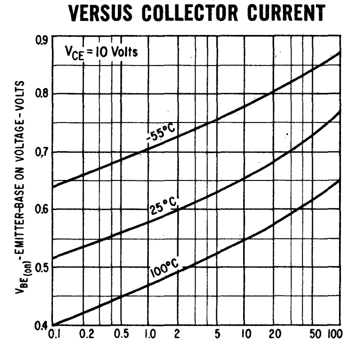
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



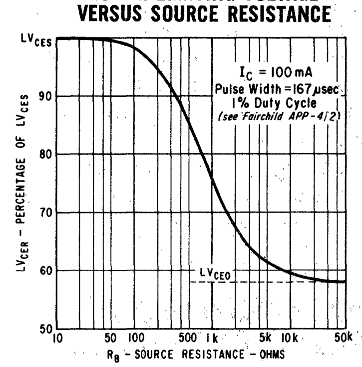
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT



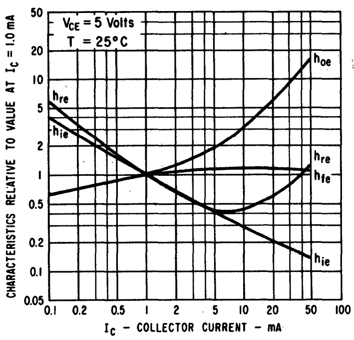
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE

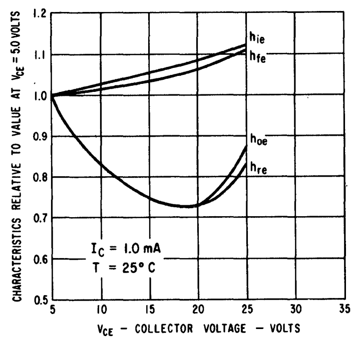


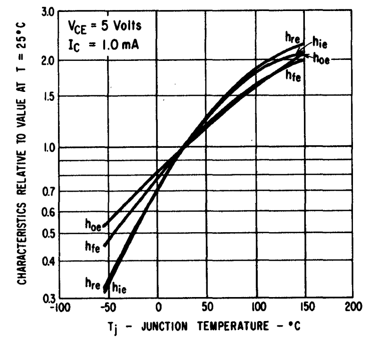
SMALL SIGNAL CHARACTERISTICS (f=1kHz)

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{ib}	Input Resistance	24	27	34	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
h_{ob}	Output Conductance	0.1	0.17	0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
h_{rb}	Voltage Feedback Ratio		1.25	5.0	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
h_{fe}	Small Signal Current Gain	75	110			I_C = 1.0 mA V_{CE} = 5.0 V
h_{ie}	Input Resistance		4.4		kOhms	I_C = 1.0 mA V_{CE} = 5.0 V
h_{oe}	Output Conductance		23.8		μmho	I_C = 1.0 mA V_{CE} = 5.0 V
h_{re}	Voltage Feedback Ratio		7.3		$x10^{-4}$	I_C = 1.0 mA V_{CE} = 5.0 V

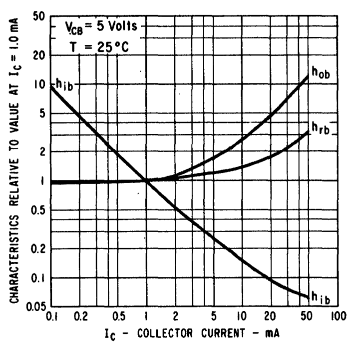
TYPICAL COMMON EMITTER CHARACTERISTICS

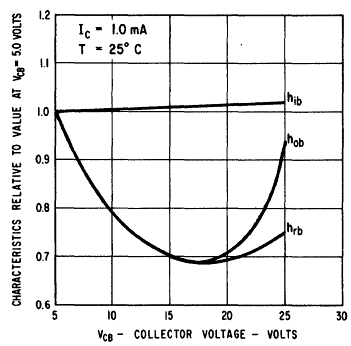


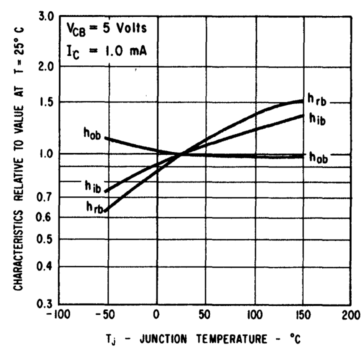




TYPICAL COMMON BASE CHARACTERISTICS







NOTES:

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

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

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N2049 and 97.2°C/Watt (derating factor of 10.3 mW/°C) for the 2N2645.

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication, APP-4/2.

(5) f = 10kHz; R_S = 2 kΩ; Power Bandwidth of 2kHz.

(6) f = 1kHz; R_S = 2 kΩ; Power Bandwidth of 200 Hz.

(7) R_S = 10 kΩ; Power Bandwidth of 15.7kHz with 3-dB points at 10 Hz and 10 kHz.

(8) f = 100 Hz ; R_S = 2 kΩ; Power Bandwidth of 20 Hz .

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

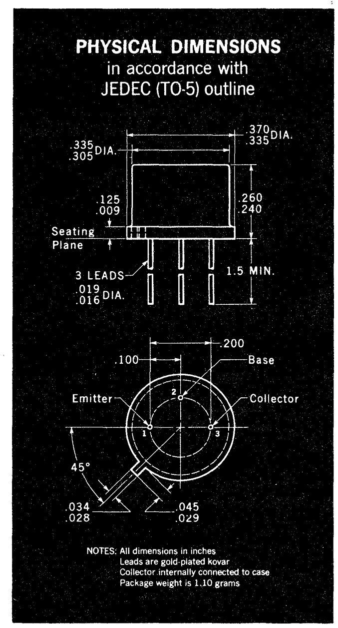
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N2192 • 2N2192A • 2N2192B

NPN HIGH-SPEED, HIGH-CURRENT SWITCHES

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2297



GENERAL DESCRIPTION - The Fairchild 2N2192, 2N2192A, and 2N2192B are NPN silicon PLANAR epitaxial transistors designed for use in high-speed, high-current switching applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures	
Storage Temperature	-65°C to +300°C
Operating Junction Temperature	-65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	2.8 Watts
at 100°C Case Temperature (Notes 2 and 3)	1.6 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.8 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	60 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	40 Volts
V_{EBO} Emitter to Base Voltage	5.0 Volts
I_C Collector Current	1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	100	300		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	75			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	70			I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	35			I_C = 500 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Current Gain	35			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	15			I_C = 1.0 A	V_{CE} = 10 V
h_{FE}	DC Current Gain	15			I_C = 0.1 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage 2N2192		0.35	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage 2N2192A		0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage 2N2192B		0.18	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage		1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 mc)	2.5			I_C = 50 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance (f = 1.0 mc)		20	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0	V_{CB} = 30 V
I_{CBO}(150°C)	Collector Cutoff Current		15	μA	I_E = 0	V_{CB} = 30 V
I_{EBO}	Emitter Cutoff Current		50	nA	I_C = 0	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	40		Volts	I_C = 25 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	I_E = 100 μA	I_C = 0
t_f	Fall Time		50	nsec	See Figure 1	
t_r	Rise Time		70	nsec	See Figure 1	
t_s	Storage Time		150	nsec	See Figure 1	

FAIRCHILD SEMICONDUCTOR
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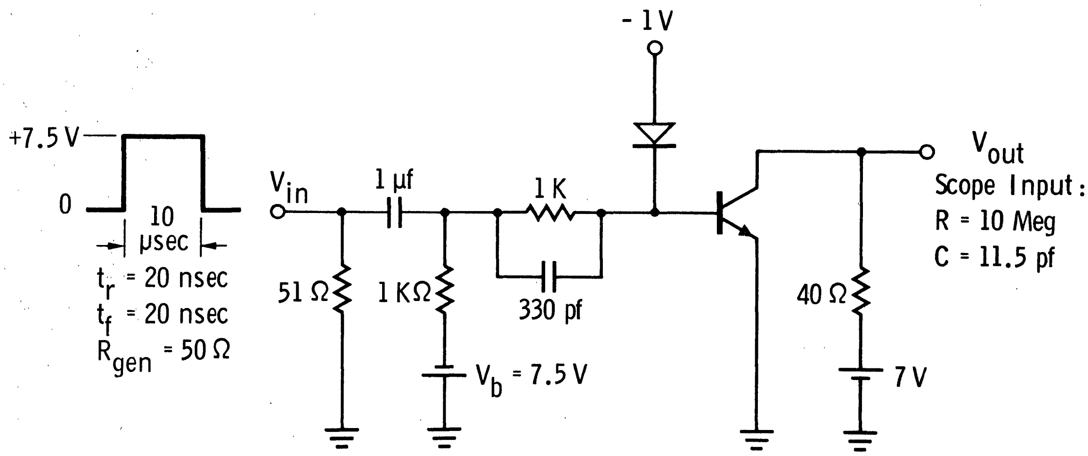


FIGURE 1

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 62.5°C/Watt (derating factor of 16 mW/°C), junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length $\leq$ 300 μsec, duty cycle $\leq$ 2%.

2N2193 · 2N2193A · 2N2193B

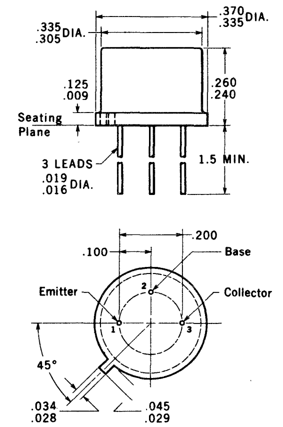
NPN HIGH-SPEED HIGH-CURRENT SWITCHES

SILICON PLANAR* EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3108

GENERAL DESCRIPTION - The Fairchild 2N2193, 2N2193A, and 2N2193B are NPN silicon PLANAR epitaxial transistors designed for use in high-speed, high-current switching applications.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures	
Storage Temperature	-65°C to +300°C
Operating Junction Temperature	-65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	2.8 Watts
at 100°C Case Temperature (Notes 2 and 3)	1.6 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.8 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	80 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	50 Volts
V_{EBO} Emitter to Base Voltage	8.0 Volts
I_C Collector Current	1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic		Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)		40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain		30			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)		30			I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}(-55°C)	DC Current Gain		20			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain		20			I_C = 500 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain		15			I_C = 1.0 A	V_{CE} = 10 V
h_{FE}	DC Current Gain		15			I_C = 0.1 mA	V_{CE} = 10 V.
V_{CE}(sat)	Collector Saturation Voltage	2N2193		0.35	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage	2N2193A		0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage	2N2193B		0.18	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage			1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.5			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance (f = 1.0 MHz)			20	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current			10	nA	I_E = 0	V_{CB} = 60 V
I_{CBO} (150°C)	Collector Cutoff Current			25	μA	I_E = 0	V_{CB} = 60 V
I_{EBO}	Emitter Cutoff Current			50	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage		80		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)		50		Volts	I_C = 25 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		8.0		Volts	I_E = 100 μA	I_C = 0
t_f	Fall Time			50	nsec	See Figure 1	
t_r	Rise Time			70	nsec	See Figure 1	
t_s	Storage Time			150	nsec	See Figure 1	

(See notes on back page)

* Planar is a patented Fairchild process.

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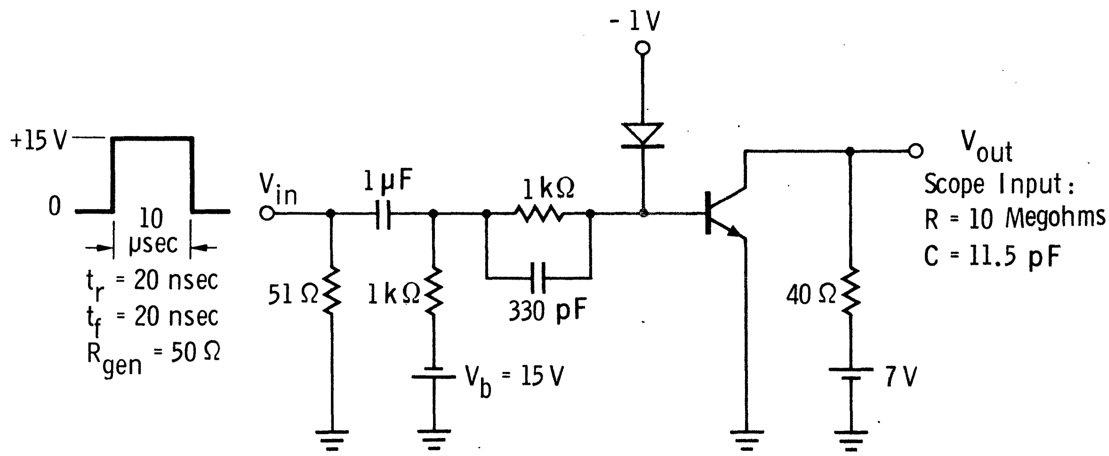


FIGURE 1

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 62.5°C/watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

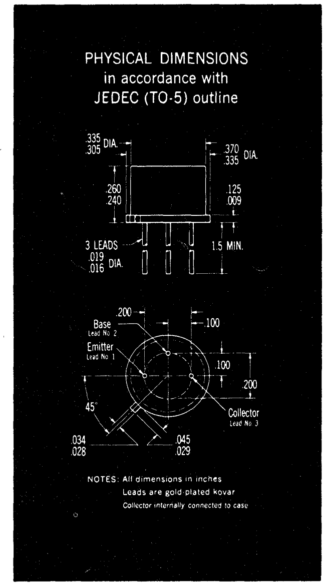
(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

2N2194 • 2N2194A • 2N2194B

NPN HIGH-SPEED, HIGH-CURRENT SWITCHES

SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE
SEE FAIRCHILD 2N2297



GENERAL DESCRIPTION - The Fairchild 2N2194, 2N2194A, and 2N2194B are NPN silicon PLANAR epitaxial transistors designed for use in high-speed, high-current switching applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	-65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	2.8 Watts
at 100°C Case Temperature (Notes 2 and 3)	1.6 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.8 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	40 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	1.0 Amp

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	20	60		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	15			I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	DC Current Gain	15			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	12			I_C = 500 mA	V_{CE} = 10 V
$V_{CE}(sat)$	Collector Saturation Voltage 2N2194		0.35	Volts	I_C = 150 mA	I_B = 15 mA
$V_{CE}(sat)$	Collector Saturation Voltage 2N2194A		0.25	Volts	I_C = 150 mA	I_B = 15 mA
$V_{CE}(sat)$	Collector Saturation Voltage 2N2194B		0.18	Volts	I_C = 150 mA	I_B = 15 mA
$V_{BE}(sat)$	Base Saturation Voltage		1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 mc)	2.5			I_C = 50 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance (f = 1 mc)		20	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0	V_{CB} = 30 V
I_{CBO}(150°C)	Collector Cutoff Current		25	μA	I_E = 0	V_{CB} = 30 V
I_{EBO}	Emitter Cutoff Current		50	nA	I_C = 0	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		Volts	I_C = 100 μA	I_E = 0
$V_{CEO}(sust)$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	40		Volts	I_C = 25 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	I_E = 100 μA	I_C = 0
t_f	Fall Time		50	nsec	See Figure 1	
t_r	Rise Time		70	nsec	See Figure 1	
t_s	Storage Time		150	nsec	See Figure 1	

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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 62.5°C/Watt (derating factor of 16 mW/°C; junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤300 μsec; duty cycle ≤2%.

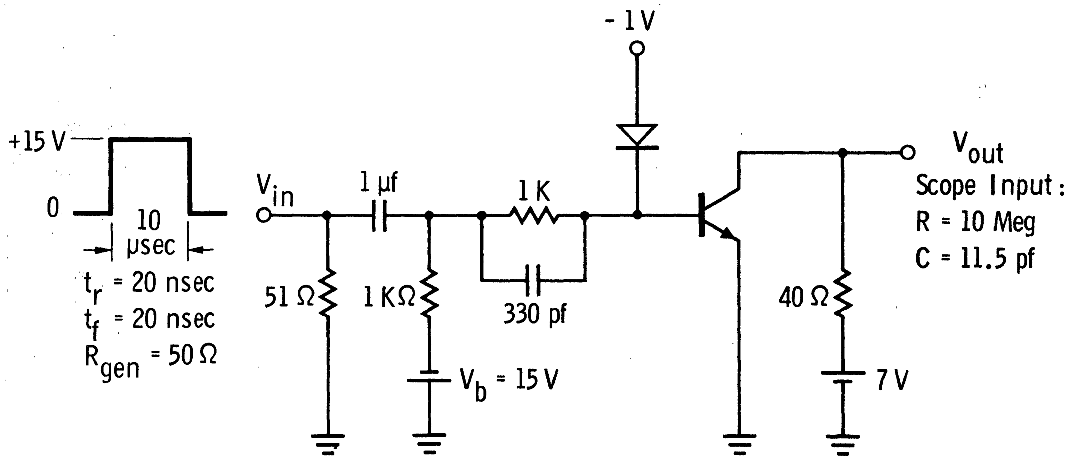


FIGURE 1

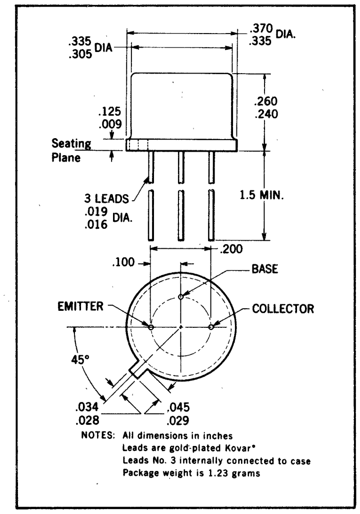
2N2195 • 2N2195A • 2N2195B

GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DIFFUSED SILICON PLANAR*EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The Fairchild 2N2195, 2N2195A, and 2N2195B are NPN silicon PLANAR epitaxial transistors designed for use in general purpose amplifier and switching applications.

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3110



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures	
Storage Temperature	-65°C to +300°C
Operating Junction Temperature	-65°C to +200°C
Lead Temperature (Soldering, No Time Limit)	300°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	2.8 Watts
at 100°C Case Temperature (Notes 2 and 3)	1.6 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.6 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	45 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	25 Volts
V_{EBO} Emitter to Base Voltage	5.0 Volts
I_C Collector Current	1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic		Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)		20			I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)		10			I_C = 150 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage	2N2195		0.35	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage	2N2195A		0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage	2N2195B		0.18	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage			1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.5			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance (f = 1.0 MHz)			20	pF	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current			100	nA	I_E = 0	V_{CB} = 30 V
I_{CBO}(150°C)	Collector Cutoff Current			50	μA	I_E = 0	V_{CB} = 30 V
I_{EBO}	Emitter Cutoff Current			100	nA	I_C = 0	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage		45		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)		25		Volts	I_C = 25 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		5.0		Volts	I_E = 100 μA	I_C = 0

* 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 62.5°C/watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 292°C/watt (derating factor of 3.42 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

(5) Pulse Conditions: length $\leq$ 300 μs ; duty cycle $\leq$ 2%.

FAIRCHILD SEMICONDUCTOR
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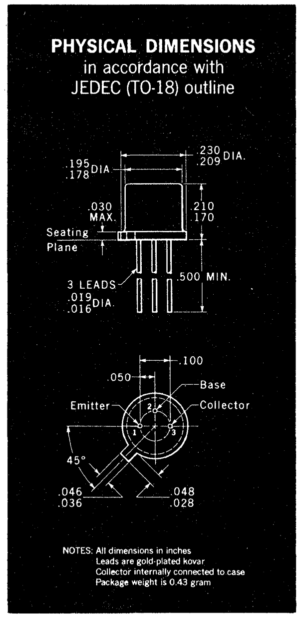
2N2205 • 2N2206

NPN HIGH-SPEED SWITCHES

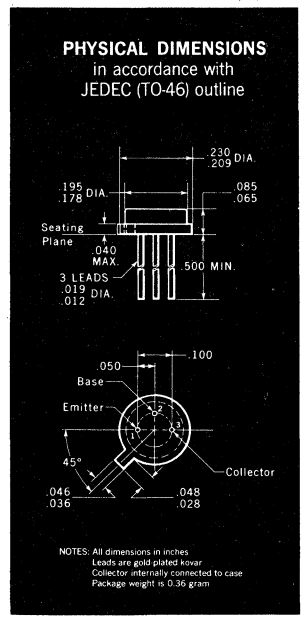
DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2368 • 2N2369 OR 2N2369A

GENERAL DESCRIPTION - The Fairchild 2N2205 and 2N2206 are NPN silicon PLANAR epitaxial transistors designed specifically for high-speed, low-power saturated switching applications.



2N2205



2N2206

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	-65°C to +175°C
Lead Temperature (Soldering, 10 sec time limit)	+235°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Notes 2 & 3)	1.0 Watt
Total Dissipation at 25°C Ambient Temperature (Notes 2 & 3)	0.3 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	25 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	12 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts
I_C	Collector Current	200 mA

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

Symbol	Characteristic	2N2205 Min.	2N2205 Max.	2N2206 Min.	2N2206 Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	20		40	120		I_C = 10 mA	V_{CE} = 1.0 V
V_{BE}(sat)	Base Saturation Voltage	0.7	0.9	0.7	0.9	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.22		0.22	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.35		0.35	Volts	I_C = 50 mA	I_B = 5.0 mA
h_{fe}	Small Signal Current Gain (f = 100 Mc)	2.0		2.0			I_C = 10 mA	V_{CE} = 10 V
C_{obo}	Common-Base, Open-Circuit Output Capacitance		6.0		6.0	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector-Base Cutoff Current		0.025		0.025	μA	I_E = 0	V_{CB} = 15 V
I_{CBO}(150°C)	Collector-Base Cutoff Current		15		15	μA	I_E = 0	V_{CB} = 15 V
I_{CEX}	Collector-Emitter Cutoff Current		15		15	μA	V_{CE} = 10 V	V_{BE} = 0.25 V
I_{EBO}	Emitter Cutoff Current		100		100	μA	I_C = 0	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	25		25		Volts	I_E = 0	I_C = 100 μA
V_{CEO}	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	12		12		Volts	I_B = 0	I_C = 10 mA (pulsed)
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0		3.0		Volts	I_C = 0	I_E = 100 μA
τ_s	Storage Time (Note 6)		25		35	nsec	$I_C \approx 10$ mA, $I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA	
t_{on}	Turn On Time (Note 7)		40		40	nsec	$I_C \approx 10$ mA, $I_{B1} \approx 3.0$ mA, $I_{B2} \approx -1.0$ mA	
t_{off}	Turn Off Time (Note 7)		75		75	nsec	$I_C \approx 10$ mA, $I_{B1} \approx 3.0$ mA, $I_{B2} \approx -1.0$ mA	

(See notes on back page)

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A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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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.

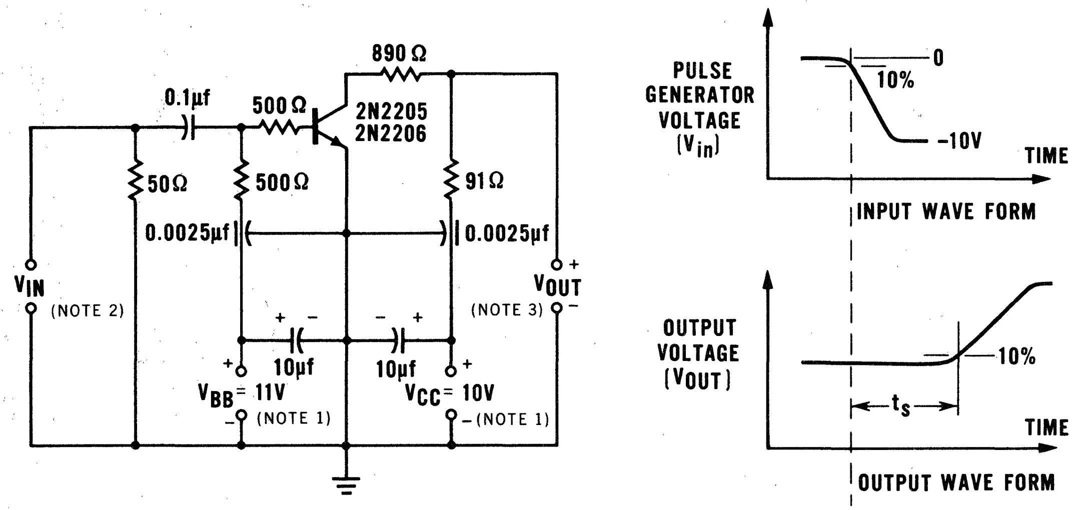
(3) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 150°C/Watt (derating factor of 6.7 mW/°C); junction-to-ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length < 6 msec; duty cycle <30%.

(6) See Fig. 1 for exact value of I_C, I_{B1}, and I_{B2}.

(7) See Fig. 2 for exact value of I_C, I_{B1}, and I_{B2}.



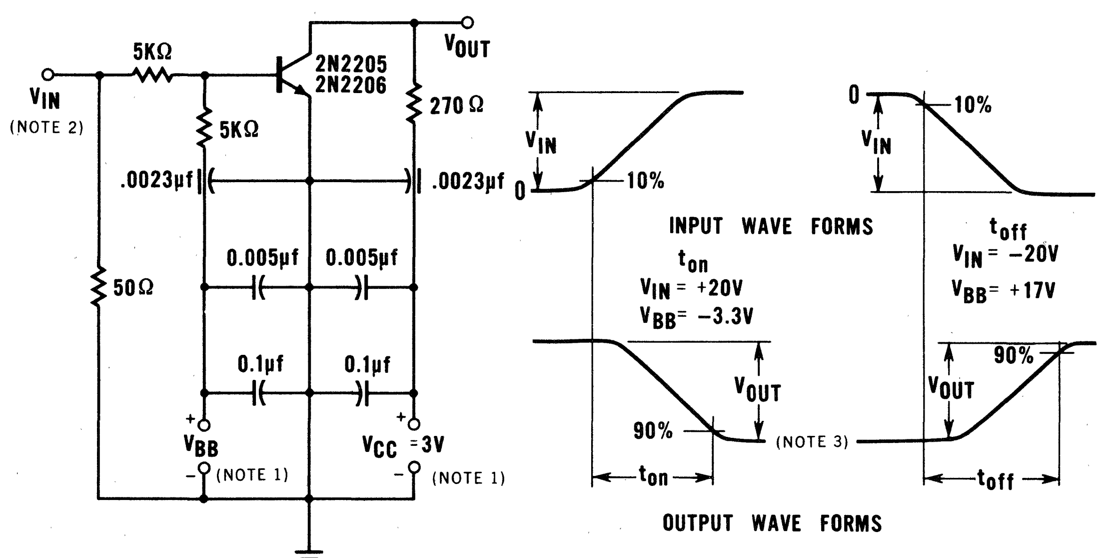
NOTES:

(1) With certain types of power supplies, it may be necessary to connect 25-μf decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB}.

(2) Input voltage (V_{IN}) obtained from a pulse generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec; pulse duration >300 nsec, and duty factor <2%.

(3) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance > 1000 ohms.

FIG. 1. CIRCUIT USED TO MEASURE STORAGE TIME (t_s).



NOTES:

(1) With certain types of power supplies, it may be necessary to connect 25-μf decoupling capacitors across the power-supply terminals for V_{CC} and V_{BB}.

(2) Input voltage (V_{IN}) obtained from a pulse generator having an output impedance of 50 ohms. V_{IN} rise time <1 nsec; pulse duration>300 nsec, and duty factor <2%.

(3) Input and output waveforms, shown above, monitored by means of a sampling oscilloscope or other indicating device having rise time <0.5 nsec, input capacitance of probe <2.5 pf with shunt resistance >3000 ohms.

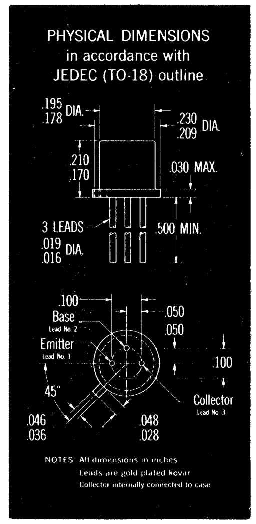
FIG. 2. CIRCUIT USED TO MEASURE "TURN-ON" TIME (t_{on}) AND "TURN-OFF" TIME (t_{off}).

2N2217 THROUGH 2N2222

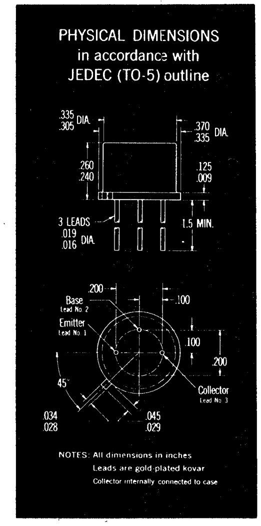
NPN HIGH-SPEED SWITCHES

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The Fairchild 2N2217 through 2N2222 are NPN Silicon Planar Epitaxial Transistors designed for high-speed switching at collector currents up to 500 milliamperes. They feature useful beta over a wide range of collector current, low leakage currents, and low saturation voltages. For improved performance see Fairchild 2N3299, 2N3300, 2N3301, and 2N3302.



2N2220 • 2N2221 • 2N2222



2N2217 • 2N2218 • 2N2219

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	-65°C to +175°C

Maximum Power Dissipation

	2N2217 2N2218 2N2219	2N2220 2N2221 2N2222
Total Dissipation at 25°C Case Temperature	3.0 Watts	1.8 Watts
at 25°C Ambient Temperature	0.8 Watt	0.5 Watt

Maximum Voltages and Current

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
I_C	Collector Current	800 mA

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

Symbol	Characteristics	2N2217 2N2220 Min.	Max.	2N2218 2N2221 Min.	Max.	2N2219 2N2222 Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	20	60	40	120	100	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	10		20		50			I_C = 150 mA V_{CE} = 1.0 V
h_{FE}	DC Current Gain	17		35		75			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	12		25		50			I_C = 1.0 mA V_{CE} = 10 V
h_{FE}	DC Current Gain			20		35			I_C = 0.1 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)			20		30			I_C = 500 mA V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage (pulsed, Note 5)		0.4		0.4		0.4	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (pulsed, Note 5)		1.6		1.6		1.6	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Base Saturation Voltage (pulsed, Note 5)		1.3		1.3		1.3	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage (pulsed, Note 5)		2.6		2.6		2.6	Volts	I_C = 500 mA I_B = 50 mA
h_{fe}	High Frequency Current Gain (f = 100 Mc)	2.5		2.5		2.5			I_C = 20 mA V_{CE} = 20 V
f_T	Gain-Bandwidth Product (f = 100 Mc)	250		250		250		Mc	I_C = 20 mA V_{CE} = 20 V

Additional Electrical Characteristics on page 2

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

Symbol	Characteristics	2N2217 2N2220 2N2218 2N2221 Min.	Max.	2N2219 2N2222 Min.	Max.	Units	Test Conditions
I_{CBO}	Collector Cutoff Current		10		10	nA	I_E = 0 V_{CB} = 50 V
I_{CBO}(150°C)	Collector Cutoff Current		10		10	μA	I_E = 0 V_{CB} = 50 V
I_{EBO}	Emitter Cutoff Current		10		10	nA	I_C = 0 V_{EB} = 3.0 V
C_{obo}	Output Capacitance		8.0		8.0	pf	I_E = 0 V_{CB} = 10 V
$R_{e(hie)}$	Real Part of Common-Emitter, High-Frequency Input Impedance (f = 300 Mc)		60		60	Ohms	I_C = 20 mA V_{CE} = 20 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		60		Volts	I_C = 10 μA I_E = 0
V_{CEO}	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	30		30		Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		5.0		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 175°C and junction-to-case thermal resistance of 50°C/Watt (derating factor of 20 mW/°C); junction-to-ambient thermal resistance of 188°C/Watt (derating factor of 5.33 mW/°C) for the 2N2217, 2N2218, and 2N2219. For the 2N2220, 2N2221, and 2N2222 junction-to-case thermal resistance of 83.5°C/Watt (derating factor of 12 mW/°C); junction-to-ambient thermal resistance of 300°C/Watt (derating factor of 3.33 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length = 300 μsec; duty cycle ≤ 2%.

2N2218A • 2N2219A • 2N2221A • 2N2222A

NPN HIGH SPEED SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - These Fairchild devices are NPN silicon PLANAR epitaxial transistors designed for high-speed switching at collector currents up to 500 mA. They feature useful beta over a wide range of collector current, low leakage currents, and low saturation voltages.

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	+175°C Maximum

Maximum Power Dissipation

		2N2218A 2N2219A	2N2221A 2N2222A
Total Dissipation at 25°C Case Temperature	(Notes 2 & 3)	3.0 Watts	1.8 Watt
at 25°C Ambient Temperature	(Notes 2 & 3)	0.8 Watt	0.5 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		75 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	40 Volts
V_{EBO}	Emitter to Base Voltage		6.0 Volts
I_C	Collector Current		800 mA

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

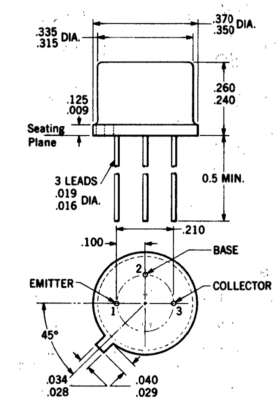
Symbol	Characteristic	2N2218A 2N2221A Min.	Max.	2N2219A 2N2222A Min.	Max.	Units	Test Conditions
h_{FE}	DC Current Gain	20		35			I_C = 100 μA V_{CE} = 10 V
h_{FE}	DC Current Gain	25		50			I_C = 1.0 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	35		75			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	100	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	25		40			I_C = 500 mA V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	15		35			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20		50			I_C = 150 mA V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage (Pulsed, Note 5)		0.3		0.3	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (Pulsed, Note 5)		1.0		1.0	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Base Saturation Voltage (Pulsed, Note 5)	0.6	1.2	0.6	1.2	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage (Pulsed, Note 5)		2.0		2.0	Volts	I_C = 500 mA I_B = 50 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5		3.0			I_C = 20 mA V_{CE} = 20 V
f_T	Gain-Bandwidth Product (f = 100 MHz)	250		300		MHz	I_C = 20 mA V_{CE} = 20 V

Additional Electrical Characteristics on page 2

*Planar is a patented Fairchild process.

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-5) outline

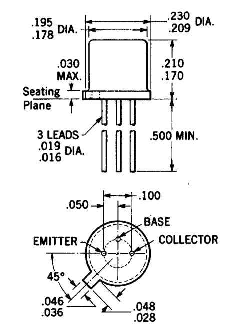


NOTES: All dimensions in inches
Leads are gold-plated Kovar
Lead No. 3 internally connected to case
Package weight is 1.23 grams

2N2218A • 2N2219A

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated Kovar*
Lead No. 3 internally connected to case
Package weight is 0.44 gram

2N2221A • 2N2222A

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

SYMBOL	CHARACTERISTIC	2N2218A 2N2221A MIN.	MAX.	2N2219A 2N2222A MIN.	MAX.	UNITS	TEST CONDITIONS	
I_{CEX}	Collector Reverse Current		10		10	nA	V_{EB} = 3.0 V	V_{CE} = 60 V
I_{CBO}	Collector Reverse Current		10		10	nA	I_E = 0	V_{CB} = 60 V
I_{CBO} (+150°C)	Collector Reverse Current		10		10	μA	I_E = 0	V_{CB} = 60 V
I_{EBO}	Base Current		10		10	nA	I_C = 0	V_{EB} = 3.0 V
C_{obo}	Common Base, Open Circuit Output Capacitance (f = 100 kHz)		8.0		8.0	pF	I_E = 0	V_{CB} = 10 V
C_{ibo}	Common Base, Open Circuit Input Capacitance (f = 100 kHz)		25		25	pF	I_C = 0	V_{EB} = 0.5 V
$Re(h_{ie})$	Real Part of Common-Emitter High Frequency Input Impedance (f = 300 MHz)		60		60	Ohms	I_C = 20 mA	V_{CE} = 20 V
BV_{CBO}	Collector to Base Breakdown Voltage	75		75		Volts	I_C = 10 μA	I_E = 0
BV_{CEO}	Collector to Emitter Breakdown Voltage (Notes 4 & 5)	40		40		Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		6.0		Volts	I_C = 0	I_E = 10 μA
I_{BL}	Base Current		20		20	nA	V_{EB} = 3.0 V	V_{CE} = 60 V
t_d	Turn-on Delay Time		10		10	ns	I_{CS} = 150 mA	V_{CC} = 30 V
							I_{B1} = 15 mA,	V_{BE}(off) = 0.5 V
t_r	Rise Time		25		25	ns	I_{CS} = 150 mA	V_{CC} = 30 V
							I_{B1} = 15 mA,	V_{BE}(off) = 0.5 V
t_s	Storage Time		225		225	ns	I_{CS} = 150 mA	V_{CC} = 30 V
							I_{B1} = 15 mA,	I_{B2} = 15 mA
t_f	Fall Time		60		60	ns	I_{CS} = 150 mA	V_{CC} = 30 V
							I_{B1} = 15 mA,	I_{B2} = 15 mA
τ_A	Active Region Time Constant		2.5		2.5	ns	I_C = 150 mA	V_{CE} = 30 V
$r_b'C_c$	Collector Base Time Constant (f = 31.8 MHz)		150		150	ps	I_C = 20 mA	V_{CE} = 20 V
NF	Noise Figure (f = 1.0 kHz)		4.0		4.0		I_C = 100 μA	V_{CE} = 10 V
							R_g = 1.0 kΩ	BW = 1.0 Hz

SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

SYMBOL	CHARACTERISTIC	2N2218A 2N2221A MIN.	MAX.	2N2219A 2N2222A MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance	1.0	3.5	2.0	8.0	kΩ	I_C = 1.0 mA	V_{CB} = 10 V
		0.2	1.0	0.25	1.25	kΩ	I_C = 10 mA	V_{CB} = 10 V
h_{oe}	Output Conductance	3.0	15	5.0	35	μmhos	I_C = 1.0 mA	V_{CB} = 10 V
		10	100	25	200	μmhos	I_C = 10 mA	V_{CB} = 10 V
h_{re}	Voltage Feedback Ratio		500		800	$x10^{-6}$	I_C = 1.0 mA	V_{CB} = 10 V
			250		400	$x10^{-6}$	I_C = 10 mA	V_{CB} = 10 V
h_{fe}	Forward Current Transfer Ratio	30	150	50	300		I_C = 1.0 mA	V_{CB} = 10 V
		50	300	75	375		I_C = 10 mA	V_{CB} = 10 V

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 175°C and junction-to-case thermal resistance of 50°C/Watt (derating factor of 20 mW/°C); junction-to-ambient thermal resistance of 188°C/Watt (derating factor of 5.33 mW/°C) for the 2N2218A and 2N2219A. For the 2N2221A and 2N2222A, junction-to-case thermal resistance of 83.5°C/Watt (derating factor of 12 mW/°C; junction-to-ambient thermal resistance of 300°C/Watt (derating factor of 3.33 mW/°C).

(4) 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.

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

2N2297

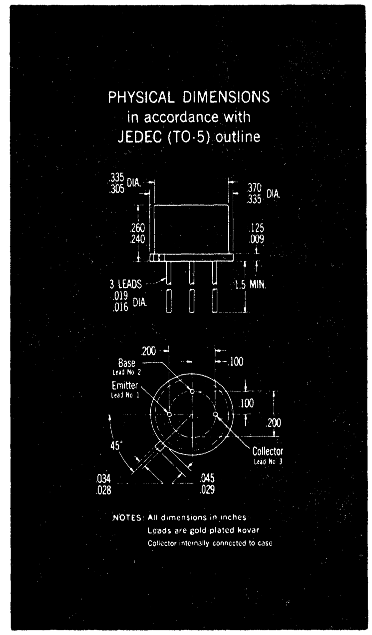
NPN HIGH-CURRENT GENERAL PURPOSE TYPE

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

The 2N2297 is an NPN double-diffused silicon PLANAR epitaxial transistor with very low saturation resistance, high current capabilities, typical gain-bandwidth product of 90 megacycles, low C_{ob} and low leakage currents.

This transistor is designed for use in high-performance dc-dc converters, oscillators, high current memory drivers and computer clock distribution circuits. The 2N2297 is suitable in particular for output stages of servo amplifiers and transceivers where several watts output at high efficiency is required.

The 2N2297 is designed to meet the environmental requirements of MIL-S-19500.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, no time limit	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	5.0 Watts
at 100°C Case Temperature [Notes 2 and 3]	2.8 Watts
at 25°C Ambient Temperature [Notes 2 and 3]	0.8 Watt

Maximum Voltages and Current

V_{CBO} Collector to Base Voltage	80 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	35 Volts
V_{EBO} Emitter to Base Voltage	7.0 Volts

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**	**55**	**120**		$I_C = 150$ mA	$V_{CE} = 10$ V
V_{CE} (sat)	Collector Saturation Voltage		**0.15**	**0.2**	Volts	$I_C = 150$ mA	$I_B = 15$ mA
V_{CE} (sat)	Collector Saturation Voltage [Note 6]		**0.8**	**1.0**	Volts	$I_C = 1000$ mA	$I_B = 100$ mA
V_{BE} (sat)	Base Saturation Voltage		**1.4**	**1.6**	Volts	$I_C = 1000$ mA	$I_B = 100$ mA
I_{CBO}	Collector Cutoff Current		**0.1**	**10**	nA	$I_E = 0$	$V_{CB} = 60$ V
I_{EBO}	Emitter Cutoff Current			**10**	nA	$I_C = 0$	$V_{EB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	**80**			Volts	$I_E = 0$	$I_C = 100$ μA
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**35**			Volts	$I_B = 0$	$I_C = 30$ mA (pulsed)

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 aplications 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 35°C/watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 218°C/watt (derating factor of 4.6 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle ≤1%.
(6) Measured at a point on the leads ≤ ½ inch from the seating plane of transitor case.

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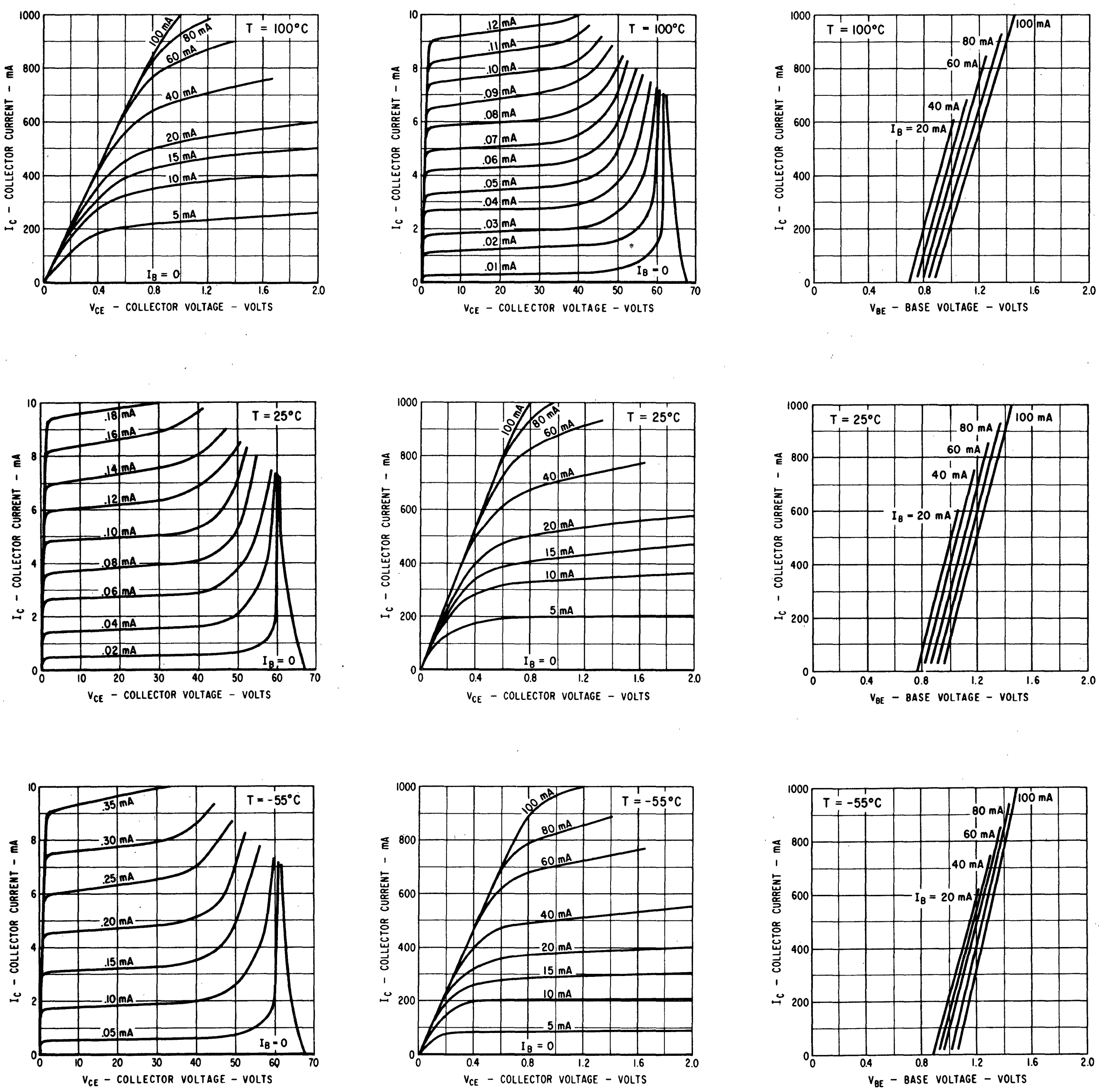
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	30	50			$I_C = 10$ mA	$V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain [Note 5]	15	30			$I_C = 1.0$ A	$V_{CE} = 10$ V
I_{CBO} (150°C)	Collector Cutoff Current		0.2	10	μA	$V_{CB} = 60$ V	$I_E = 0$
f_T	Gain Bandwidth Product (f = 20 mc)	60	95		mc	$I_C = 50$ mA	$V_{CE} = 10$ V
C_{ob}	Output Capacitance		8.0	12	pf	$V_{CB} = 10$ V	$I_E = 0$
C_{TE}	Emitter Transition Capacitance		53	80	pf	$V_{EB} = 0.5$ V	$I_C = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			Volts	$I_E = 100$ μA	$I_C = 0$
$r_b'C_c$	Collector to Base Time Constant (f = 4 mc)			800	psec	$I_C = 10$ mA	$V_{CB} = 10$ V

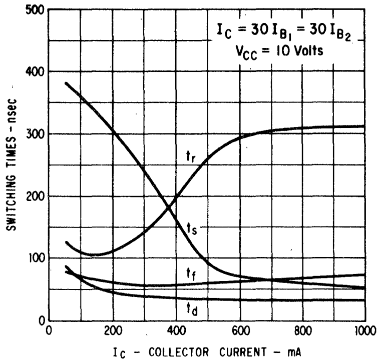
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*



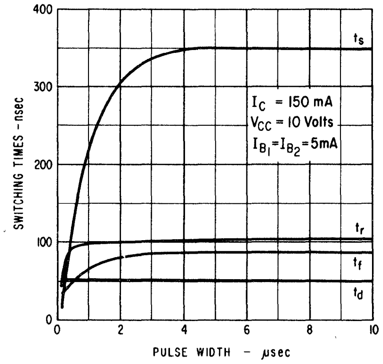
* Single family characteristics on Transistor Curve Tracer

TYPICAL ELECTRICAL CHARACTERISTICS*

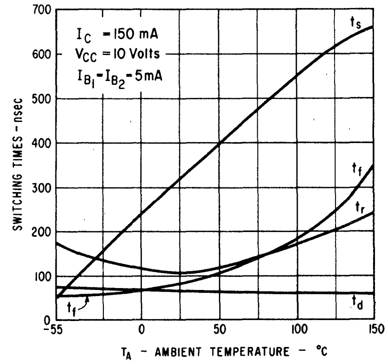
SWITCHING TIMES VS. COLLECTOR CURRENT



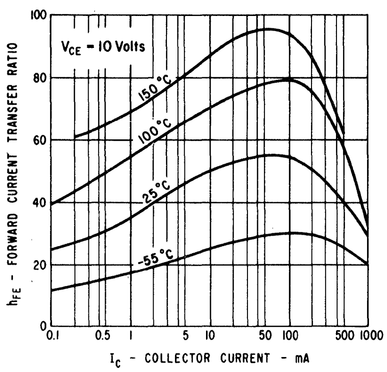
SWITCHING TIMES VERSUS PULSE WIDTH



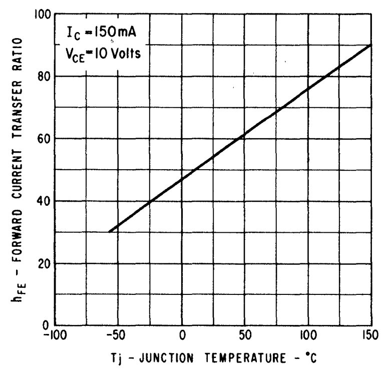
SWITCHING TIMES VS. TEMPERATURE



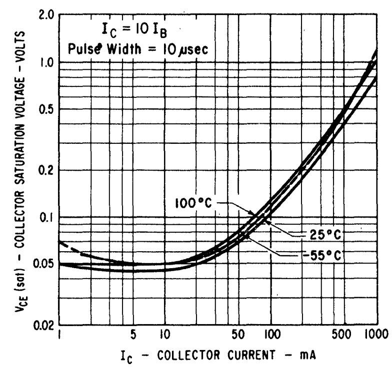
PULSED DC CURRENT GAIN VS. COLLECTOR CURRENT



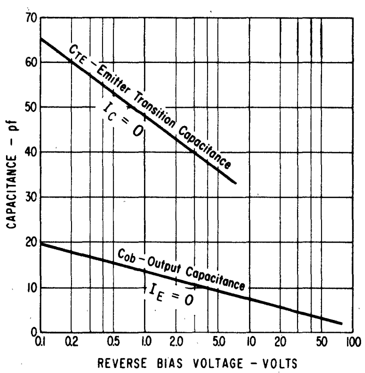
PULSED DC CURRENT GAIN VS. TEMPERATURE



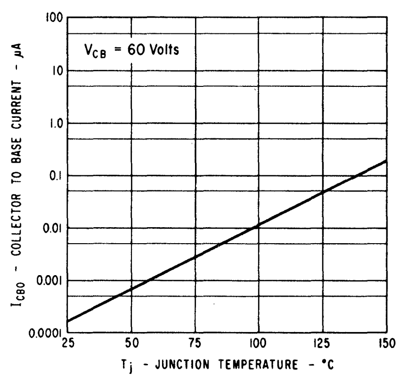
COLLECTOR SATURATION VOLTAGE VS. COLLECTOR CURRENT (VOLTAGE AVERAGED OVER 10 μs PULSE WIDTH)



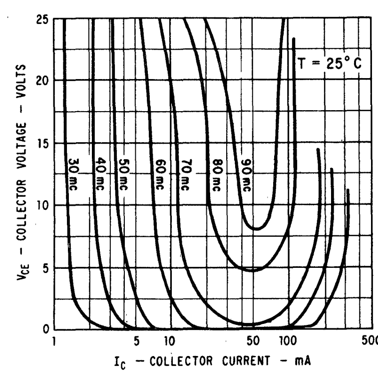
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



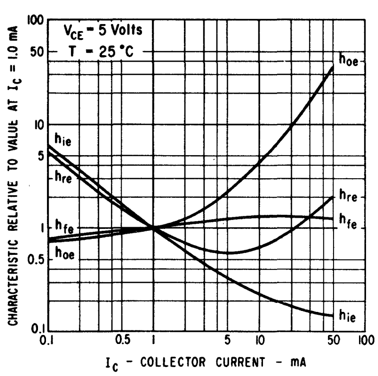
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

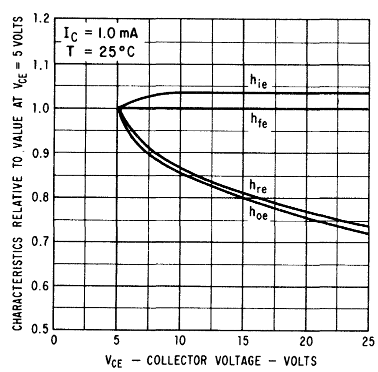


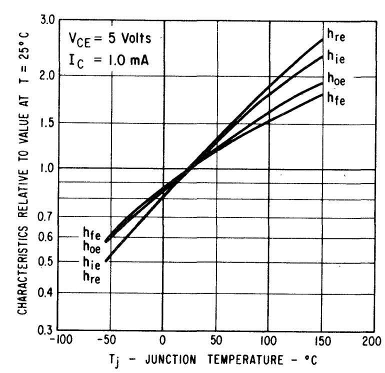
SMALL SIGNAL CHARACTERISTICS (f = 1 KC)

SYMBOL	CHARACTERISTIC	TYP.	UNITS	TEST CONDITIONS	
h_{ib}	Input Resistance	26	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
		6	Ohms	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{rb}	Voltage Feedback Ratio	0.5	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
		0.7	$x10^{-4}$	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{fe}	Small Signal Current Gain	60		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
		70		$I_C = 5.0$ mA	$V_{CE} = 10$ V
h_{ob}	Output Conductance	0.09	μmho	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
		0.17	μmho	$I_C = 5.0$ mA	$V_{CB} = 10$ V
h_{ie}	Input Resistance	1.3	K ohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio	1.0	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance	3.5	μmho	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

TYPICAL COMMON EMITTER CHARACTERISTICS

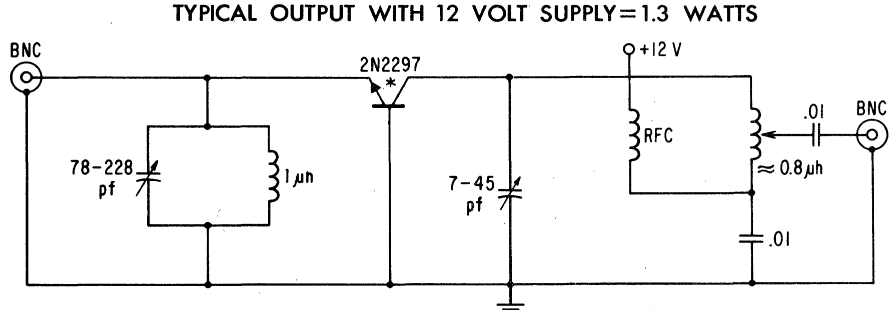






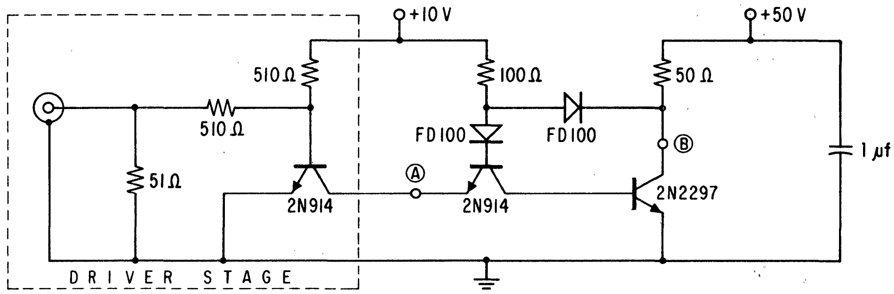
27 MEGACYCLE CITIZENS BAND OUTPUT STAGE

TYPICAL OUTPUT WITH 12 VOLT SUPPLY=1.3 WATTS



NOTES:
* NO HEAT SINK REQUIRED
RF INPUT: 300 mW
DC INPUT: 150 mA at 12V (typically)

ONE AMPERE SWITCHING CIRCUIT

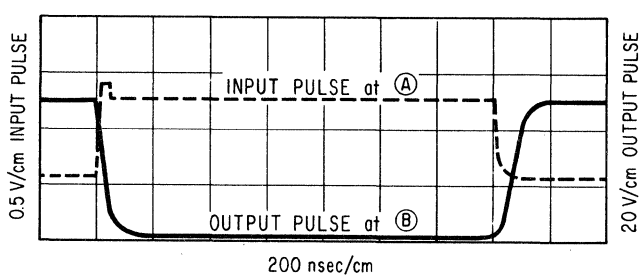


NOTES:
T_{on} – 75 nsec (typical)
T_{off} – 150 nsec (typical)

RF CHARACTERISTICS

SYMBOL	CHARACTERISTIC	TYPICAL VALUE	TEST CONDITIONS	
P_G	Power Gain (f = 30 mc)	16 db	I_C = 20 mA	V_{CE} = 20 V
η	Oscillator Efficiency (f = 70 mc)	28%	I_C = 50 mA	V_{CB} = 20 V

INPUT AND OUTPUT PULSES

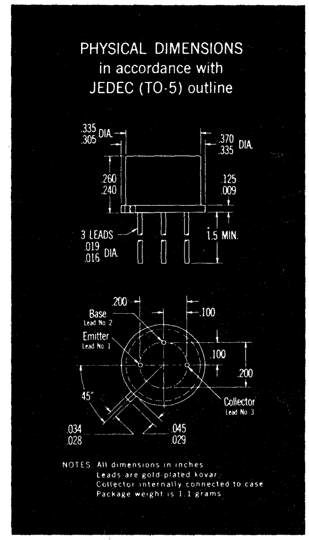


2N2303

PNP MEDIUM FREQUENCY AMPLIFIER

DIFFUSED SILICON TRANSISTOR

GENERAL DESCRIPTION - This PNP double diffused silicon transistor is designed primarily for use in high performance medium frequency amplifier applications.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature			-65°C to +200°C
Operating Junction Temperature			175°C Maximum

Maximum Power Dissipation

Total Dissipation	at 25°C Case Temperature	(Notes 2 & 3)	2.0 Watts
	at 100°C Case Temperature	(Notes 2 & 3)	1.0 Watt
	at 25°C Ambient Temperature		0.6 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		-50 Volts
V_{CER}	Collector to Emitter Voltage ($R_{BE} \leq 10\Omega$)	(Note 4)	-50 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-35 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic		Min.	Max.	Units	Test Conditions	
*h_{FE}	1a	DC Pulse Current Gain	(Note 5)	75	200		I_C = -150 mA	V_{CE} = -10 V
h_{FE}	4	DC Pulse Current Gain	(Note 5)	75			I_C = -5.0 mA	V_{CE} = -10 V
*V_{BE}(sat)	1a	Base Saturation Voltage			-1.3	Volts	I_C = -150 mA	I_B = -15 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage			-1.5	Volts	I_C = -150 mA	I_B = -15 mA
h_{fe}	4	Small Signal Current Gain (f = 20 mc)		3.0			I_C = -50 mA	V_{CE} = -10 V
C_{ob}	4	Output Capacitance			45	pf	I_E = 0	V_{CB} = -10 V
*I_{CBO}	1b	Collector Cutoff Current			1.0	μA	I_E = 0	V_{CB} = -30 V
I_{CBO}(150°C)	4	Collector Cutoff Current			100	μA	I_E = 0	V_{CB} = -30 V
V_{CER}(sust)	4	Collector to Emitter Sustaining Voltage (pulsed)		-50		Volts	I_C = -100 mA	$R_{BE} \leq 10\ \Omega$
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (pulsed)		-35		Volts	I_C = -100 mA	I_B = 0

†NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

NOTES:

1. These ratings are limiting values above which the serviceability of any 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 175°C and junction-to-case thermal resistance of 75°C/Watt (derating factor of 13.3 mW/°C).
4. Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
5. Pulse Conditions: length = 300 μsec; duty cycle = 1%.

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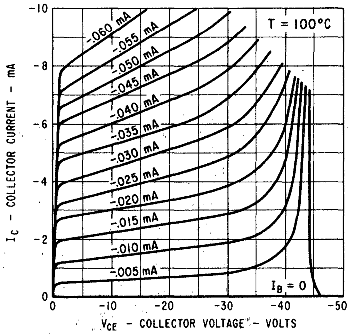
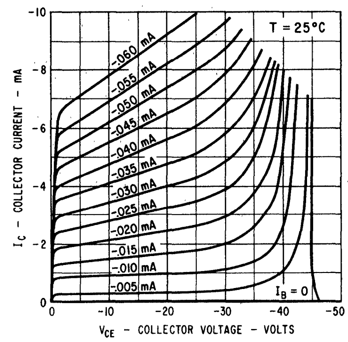
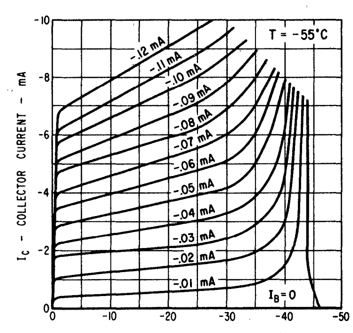
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

HIGH VOLTAGE

COLLECTOR CHARACTERISTICS

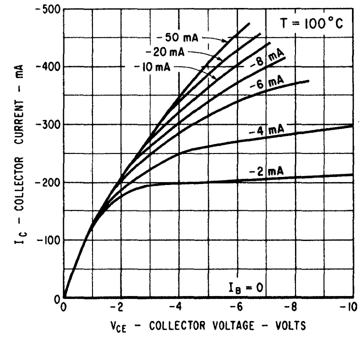


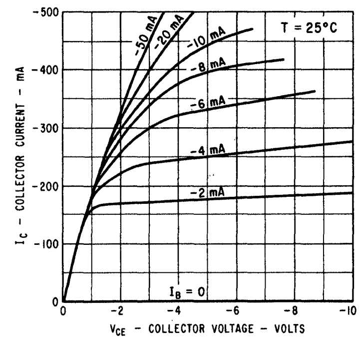


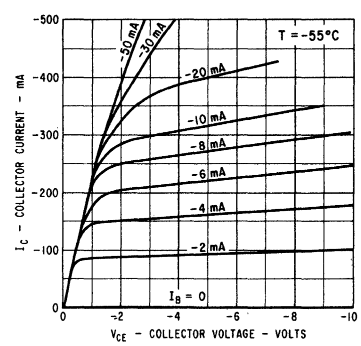


SATURATION REGION

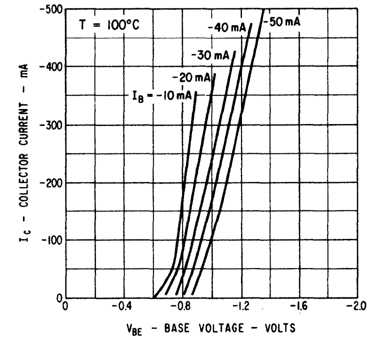
COLLECTOR CHARACTERISTICS

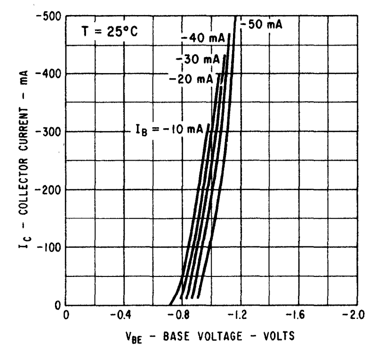


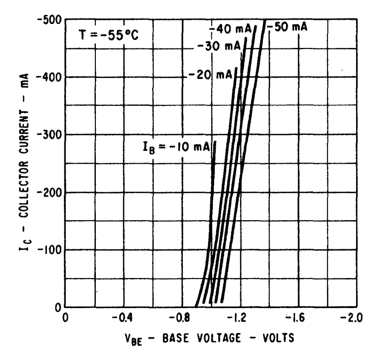




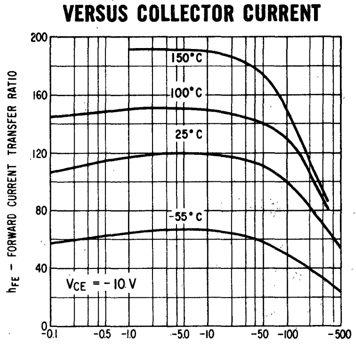
BASE CHARACTERISTICS



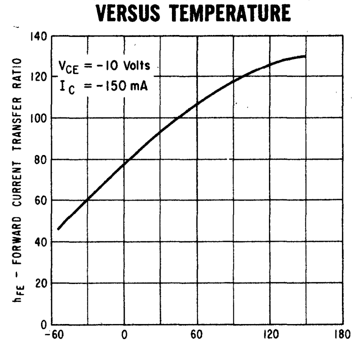




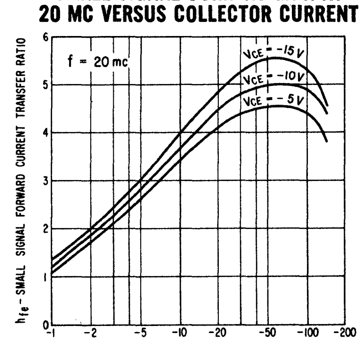
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VERSUS TEMPERATURE



SMALL SIGNAL CURRENT GAIN AT 20 MC VERSUS COLLECTOR CURRENT



*Single family characteristics on Transistor Curve Tracer.

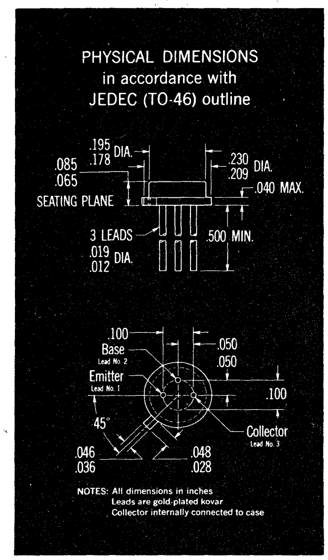
2N2351 • 2N2351A

NPN HIGH-SPEED, HIGH-CURRENT SWITCHES

SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3108, 2N3110

GENERAL DESCRIPTION - The Fairchild 2N2351 and 2N2351A are NPN silicon PLANAR epitaxial transistors designed primarily for use in high speed high current switching applications.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +300°C
Operating Junction Temperature		-65°C to +200°C
Lead Temperature (Soldering, no time limit)		300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	5.0 Watts
at 100°C Case Temperature	(Notes 2 and 3)	2.85 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.4 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		80 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	50 Volts
V_{EBO}	Emitter to Base Voltage		8.0 Volts
I_C	Collector Current		1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic		2N2351 Min.	2N2351 Max.	2N2351A Min.	2N2351A Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 5)	40	120	40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	30		30			I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	DC Current Gain		30		30			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	20		20			I_C = 500 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Current Gain		20		20			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	15		15			I_C = 1.0 A	V_{CE} = 10 V
h_{FE}	DC Current Gain		15		15			I_C = 0.1 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage			0.35		0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage			1.3		1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 mc)		2.5		2.5			I_C = 50 mA	V_{CE} = 5.0 V
I_{CBO}	Collector Cutoff Current			10		10	nA	V_{CB} = 60 V	I_E = 0
I_{CBO}(150°C)	Collector Cutoff Current			25		25	μA	V_{CB} = 60 V	I_E = 0
I_{EBO}	Emitter Cutoff Current			50		50	nA	V_{EB} = 5.0 V	I_C = 0
C_{ob}	Output Capacitance (f = 1.0 mc)			20		20	pf	V_{CB} = 10 V	I_E = 0
τ_b	Base Stored Charge			2.1		2.1	μsec	See Figure I	
BV_{CBO}	Collector to Base Breakdown Voltage		80		80		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage	(Notes 4 and 5)	50		50		Volts	I_C = 25 mA (Pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		8.0		8.0		Volts	I_E = 100 μA	I_C = 0

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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 35°C/Watt (derating factor of 28.5 mW/°C); junction-to-ambient thermal resistance of 438°C/Watt (derating factor of 2.3 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

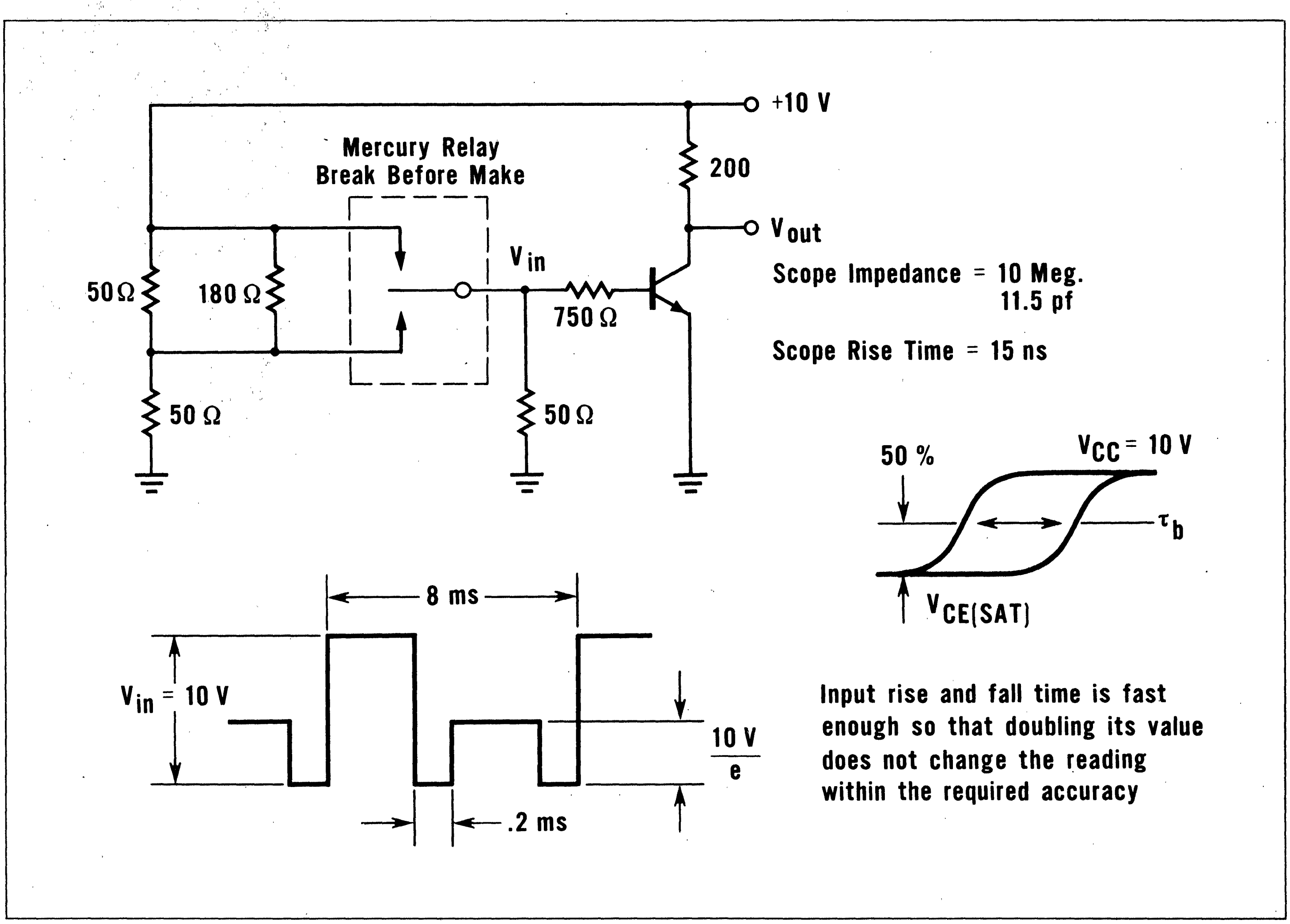


FIGURE 1

2N2368 • 2N2369

NPN HIGH FREQUENCY SATURATED SWITCHING TYPE

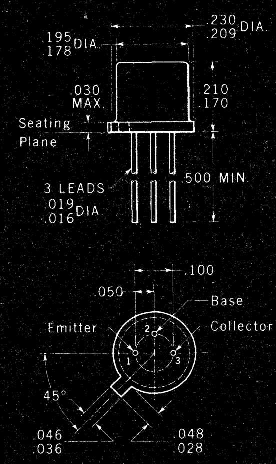
DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION- The 2N2368 and 2N2369 are NPN silicon Planar epitaxial transistors designed specifically for high-speed saturated switching applications in the 50-100MHz range at current levels from 100 microamps to 100 milliamps. They are suitable for most satellite and conventional, small signal, RF and digital type circuits.

A typical gain bandwidth product of 650 MHz, typical τ_s of 6 ns and C_{obo} of 4pF maximum along with Planar structure give high performance and proven reliability.

These transistors are designed to meet the environmental requirements of MIL-S-19500.

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 Maximum
Lead Temperature (Soldering, No 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 Current

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	Collector Current (10 μsec pulse)		500 mA

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

Symbol	Characteristic	2N2368 Min.	2N2368 Typ.	2N2368 Max.	2N2369 Min.	2N2369 Typ.	2N2369 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	20		60	40		120		I_C = 10 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	10			20				I_C = 100 mA V_{CE} = 2.0 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	10			20				I_C = 10 mA V_{CE} = 1.0 V
V_{BE}(sat)	Base Saturation Voltage	0.7	0.75	0.85	0.7	0.75	0.85	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.2	0.25		0.2	0.25	Volts	I_C = 10 mA I_B = 1.0 mA

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 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) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions; length = 300 μsec; duty cycle $\leq$ 2%.
(6) Measured on Sampling Scope. PW $\geq$ 200 nsec.

* Planar is a patented Fairchild process.

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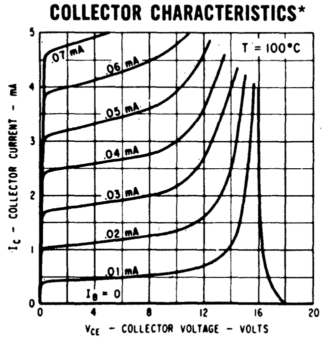
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Characteristic	2N2368 Min.	2N2368 Typ.	2N2368 Max.	2N2369 Min.	2N2369 Typ.	2N2369 Max.	Units	Test Conditions
h_{fe}	High Frequency Current Gain (f=100 MHz)	4.0	5.5		5.0	6.5			I_C = 10 mA V_{CE} = 10 V
C_{obo}	Open Circuit Output Capacitance		2.5	4.0		2.5	4.0	pF	I_E = 0 V_{CB} = 5.0 V
I_{CBO}	Collector Cutoff Current		0.1	0.4		0.1	0.4	µA	I_E = 0 V_{CB} = 20 V
I_{CBO}(150°C)	Collector Cutoff Current		10	30		10	30	µA	I_E = 0 V_{CB} = 20 V
BV_{CBO}	Collector to Base Breakdown Voltage	40			40				I_C = 10 µA I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	40			40			Volts	I_C = 10 µA I_B = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	15			15			Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5			4.5			Volts	I_C = 0 I_E = 10 µA
τ_s	Charge Storage Time Constant (Note 6) (see Figure 1)		5.0	10		6.0	13	nsec	I_C = I_{B1} ≈ 10 mA, I_{B2} ≈ -10 mA
t_{on}	Turn On Time (see Figure 2)		9.0	12		9.0	12	nsec	I_C ≈ 10 mA, I_{B1} ≈ 3.0 mA
t_{off}	Turn Off Time (see Figure 2)		10	15		13	18	nsec	I_C ≈ 10 mA, I_{B1} ≈ 3.0 mA, I_{B2} ≈ -1.5 mA

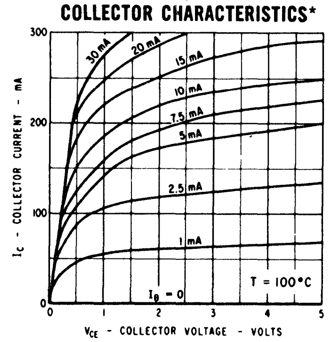
TYPICAL ELECTRICAL CHARACTERISTICS

HIGH VOLTAGE — **SATURATION REGION**

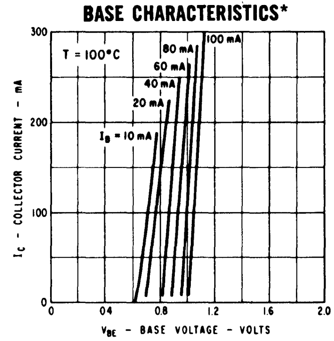
COLLECTOR CHARACTERISTICS*



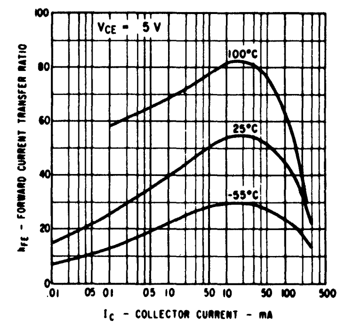
COLLECTOR CHARACTERISTICS*

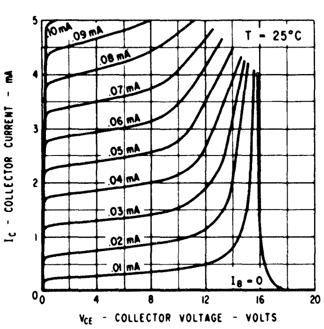


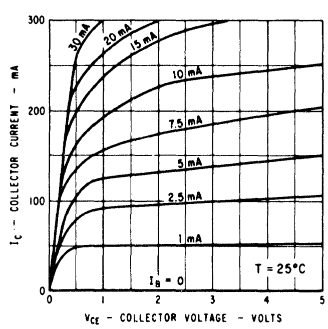
BASE CHARACTERISTICS*

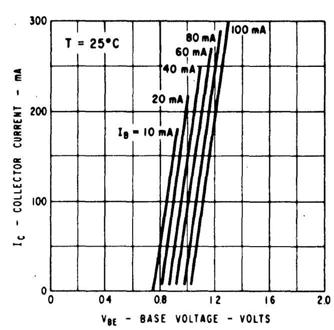


PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT

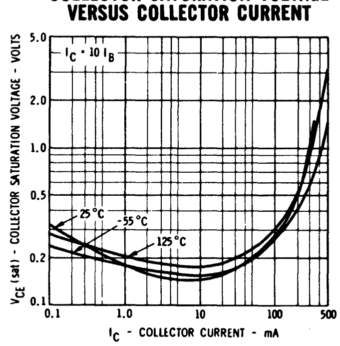


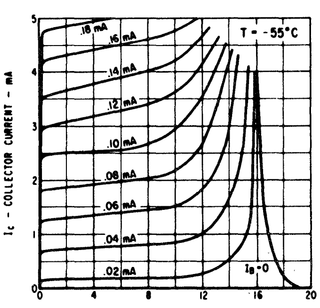


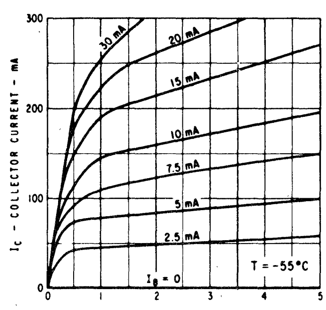


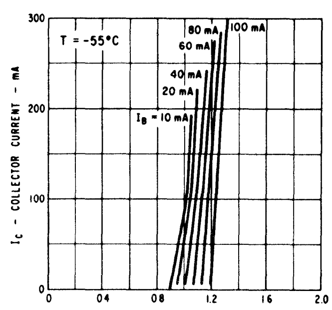


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

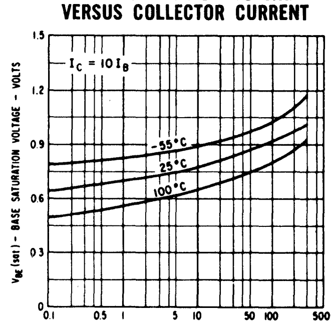






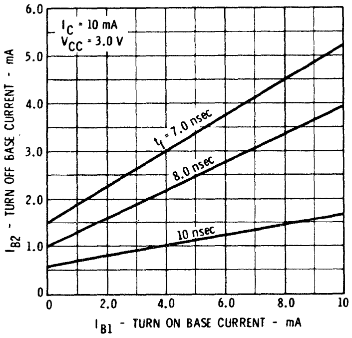


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

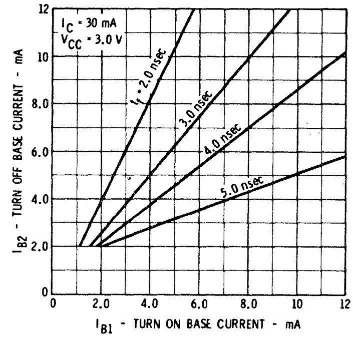


* Single family characteristics on Transistor Curve Tracer

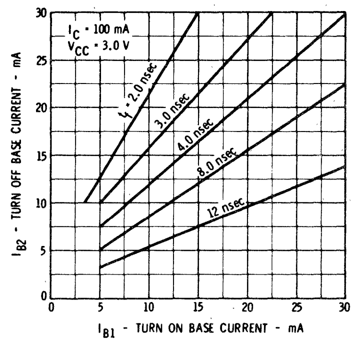
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



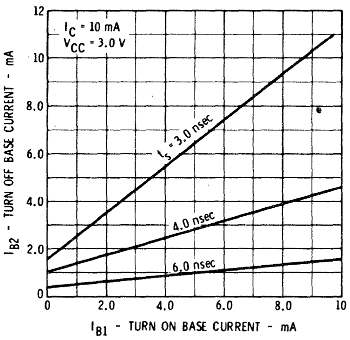
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



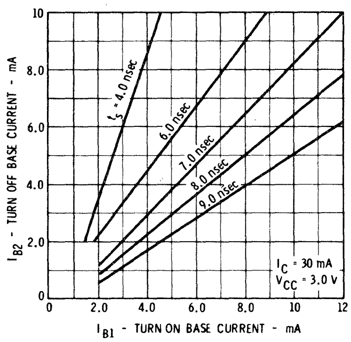
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



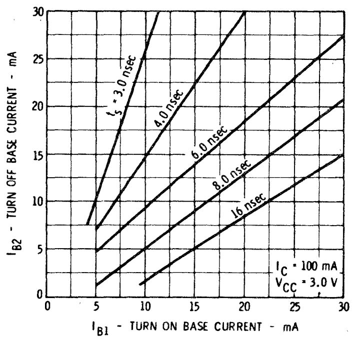
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



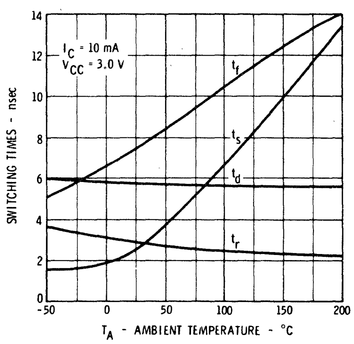
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



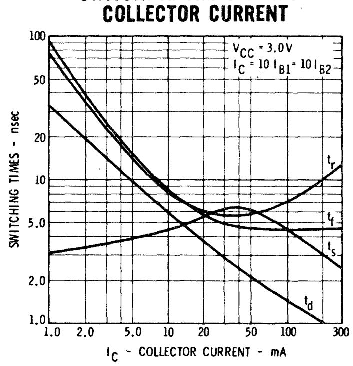
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



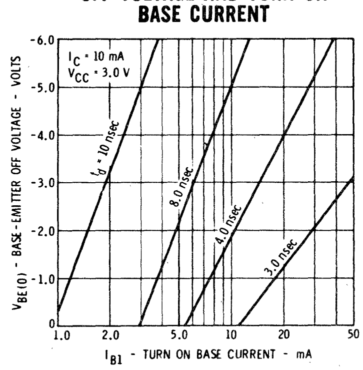
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



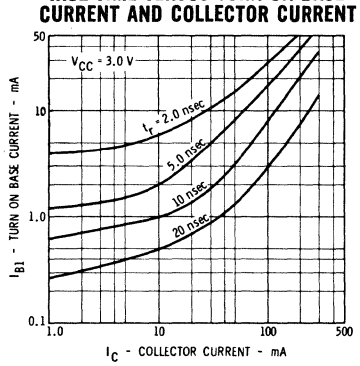
SWITCHING TIMES VERSUS COLLECTOR CURRENT



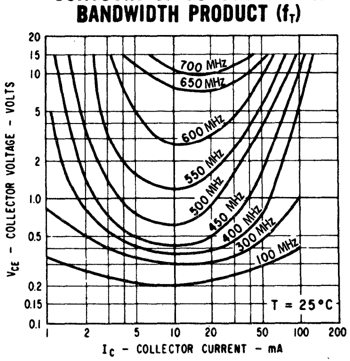
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



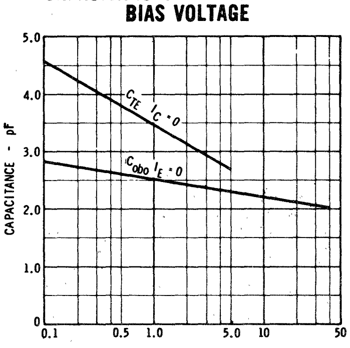
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



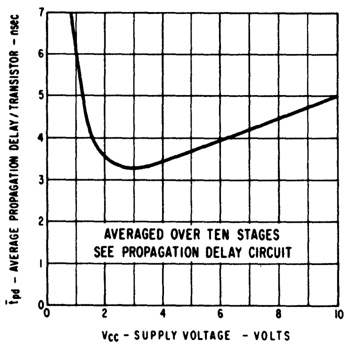
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



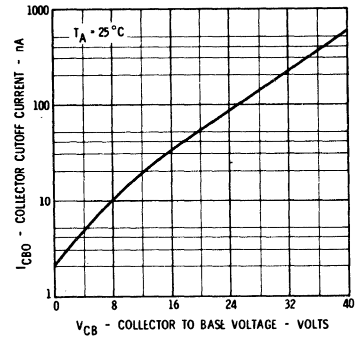
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE

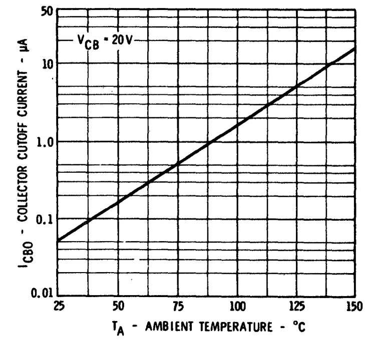


FIG. 1

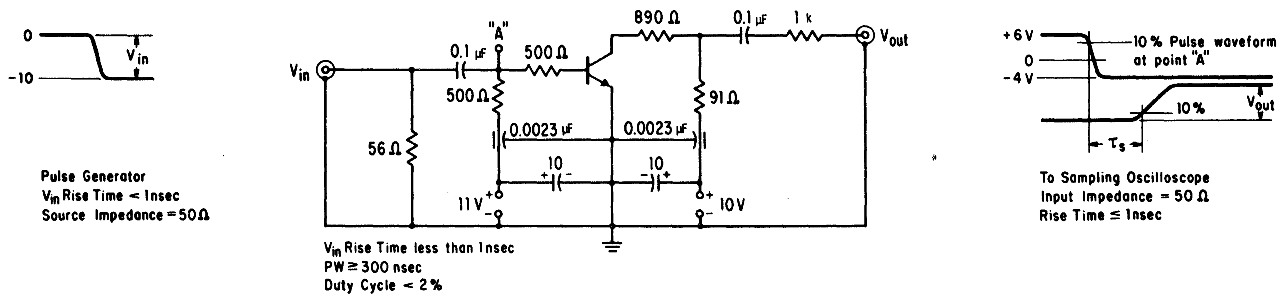
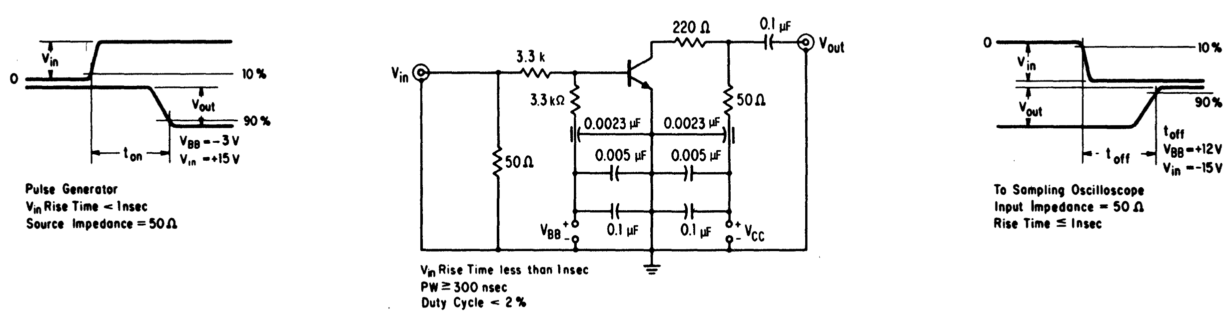
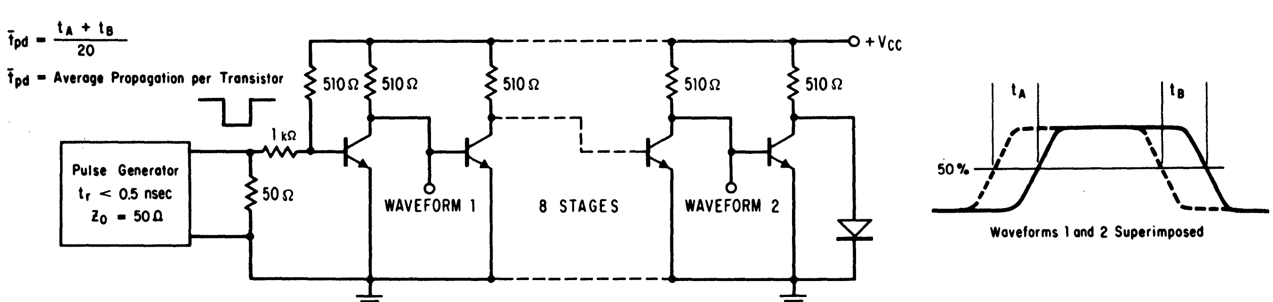


FIG. 2



CIRCUIT FOR MEASUREMENT OF PROPAGATION DELAY



FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

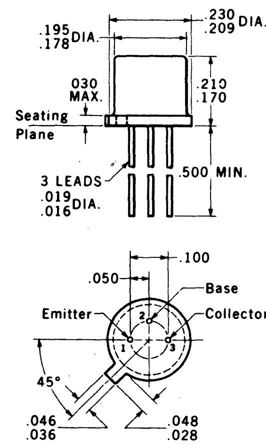
2N2369A

NPN HIGH-SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

- **HIGH SPEED - - $\tau_S = 13$ ns (MAX) AT 10 mA**
  - - $t_{on} = 12$ ns (MAX) AT 10 mA
  - - $t_{off} = 18$ ns (MAX) AT 10 mA
- **MEDIUM VOLTAGE - - $LV_{CEO} = 15$ V (MIN)**
- **HIGH FREQUENCY - - $f_T = 500$ MHz (MIN) AT 10 mA**
- **LOW CAPACITANCE - - $C_{obo} = 4.0$ pF (MAX) AT 5.0 V**

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 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 second time limit)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.2 Watts
at 100°C Case Temperature	0.68 Watt
at 25°C Ambient Temperature	0.36 Watt

Maximum Voltages and Current

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	Collector Current (10 μs Pulse)	500 mA
I_C	DC Collector Current	200 mA

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

SYMBOL	CHARACTERISTICS	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
$V_{BE(sat)}$	Base Saturation Voltage	0.72	0.8	0.85	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{BE(sat)}$	Base Saturation Voltage (−55°C to +125°C)	0.59		1.02	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{BE(sat)}$	Base Saturation Voltage		0.9	1.15	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
$V_{BE(sat)}$	Base Saturation Voltage		1.1	1.6	Volts	$I_C = 100$ mA	$I_B = 10$ mA
$V_{CE(sat)}$	Collector Saturation Voltage (+125°C)		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	$I_C = 10\ \mu$A	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	$I_C = 10\ \mu$A	$I_E = 0$
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**15**			**Volts**	**$I_C = 10$ mA** (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5			Volts	$I_E = 10\ \mu$A	$I_C = 0$

*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) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle $\leq 2\%$.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

FAIRCHILD
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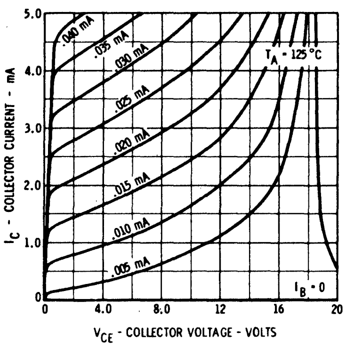
FAIRCHILD TRANSISTOR 2N2369A

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

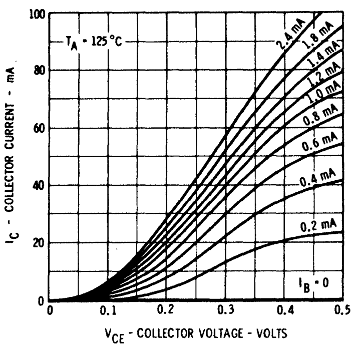
SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 5)	40	63	120		$I_C = 10$ mA	$V_{CE} = 0.35$ V
h_{FE}	DC Pulse Current Gain (Note 5)	30	71			$I_C = 30$ mA	$V_{CE} = 0.4$ V
h_{FE}	DC Pulse Current Gain (Note 5)	20				$I_C = 100$ mA	$V_{CE} = 1.0$ V
$V_{CE(sat)}$	Collector Saturation Voltage		0.14	0.2	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{CE(sat)}$	Collector Saturation Voltage		0.17	0.25	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
$V_{CE(sat)}$	Collector Saturation Voltage		0.28	0.5	Volts	$I_C = 100$ mA	$I_B = 10$ mA
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**5.0**	**6.75**			**$I_C = 10$ mA**	**$V_{CE} = 10$ V**
C_{obo}	**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**	**ns**	**$I_C = I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA**	
t_{on}	**Turn On Time** (Note 6)		**9.0**	**12**	**ns**	**$I_C \approx 10$ mA**	**$I_{B1} \approx 3.0$ mA**
t_{off}	**Turn Off Time** (Note 6)		**13**	**18**	**ns**	**$I_C \approx 10$ mA, $I_{B1} \approx 3.0$ mA, $I_{B2} \approx -1.5$ mA**	

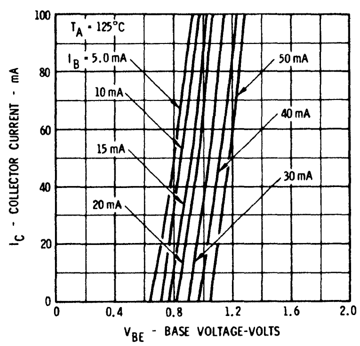
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

ACTIVE REGION

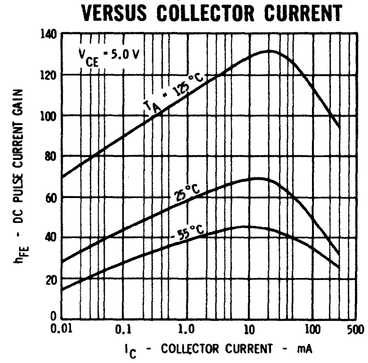


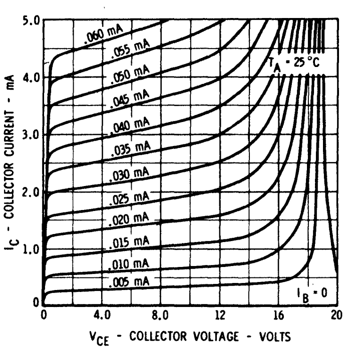
SATURATION REGION

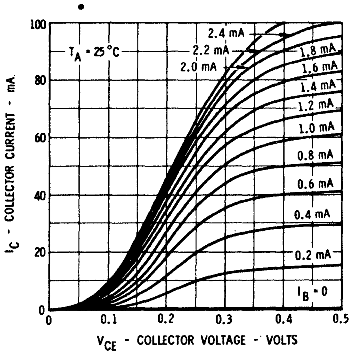


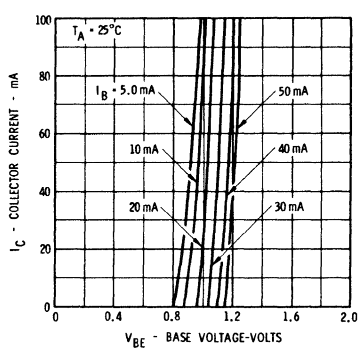


D.C. PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

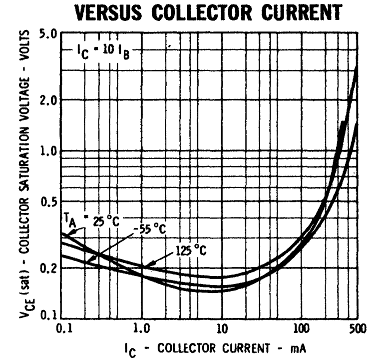


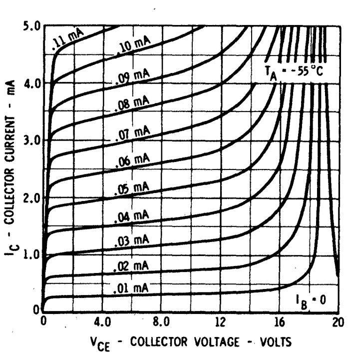


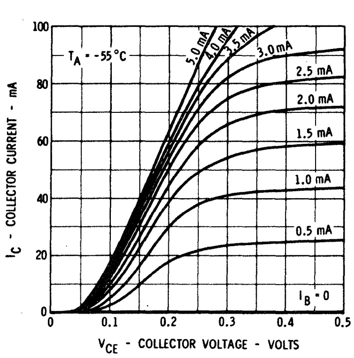


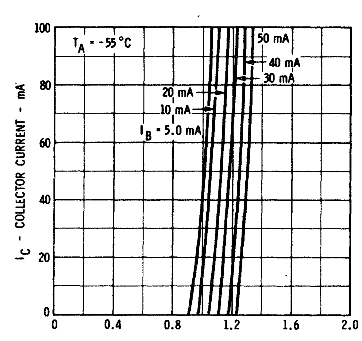


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

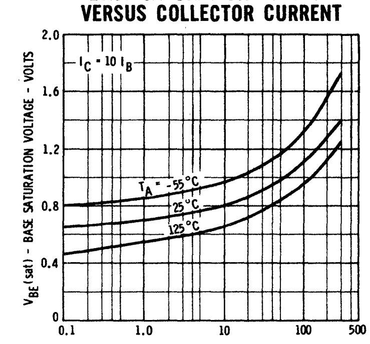








BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

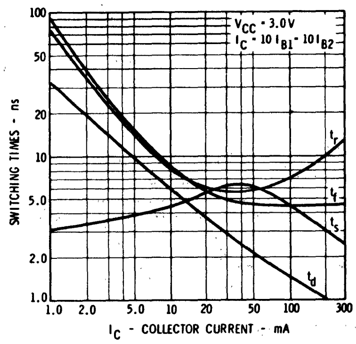


* Single family characteristics on Transistor Curve Tracer.

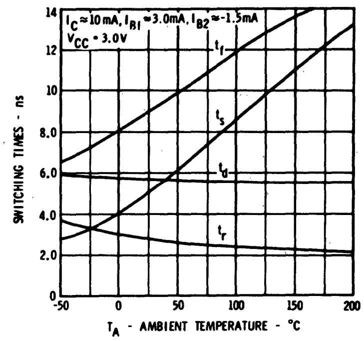
FAIRCHILD TRANSISTOR 2N2369A

TYPICAL ELECTRICAL CHARACTERISTICS

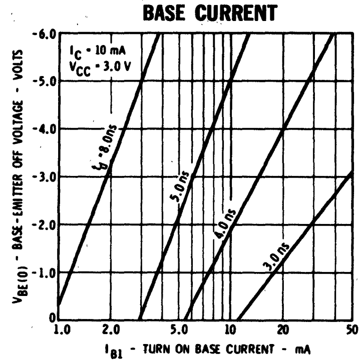
SWITCHING TIMES VERSUS COLLECTOR CURRENT



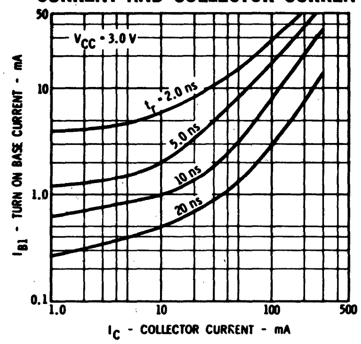
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



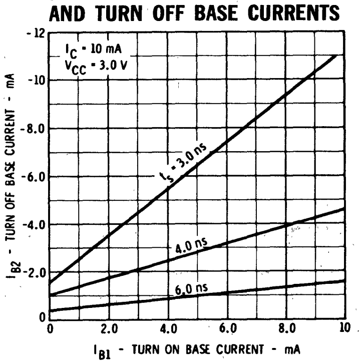
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



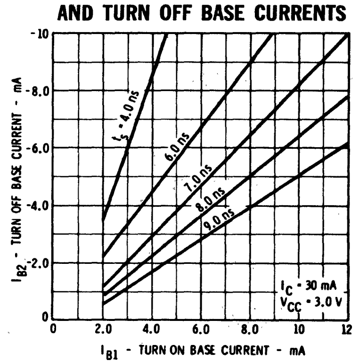
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



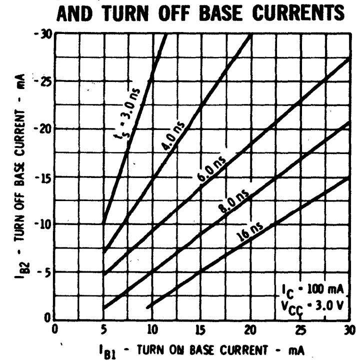
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



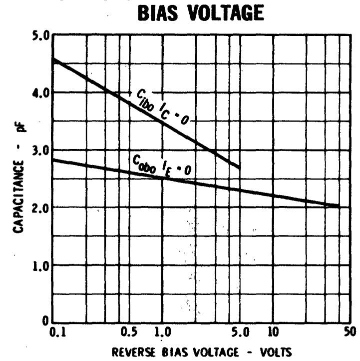
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



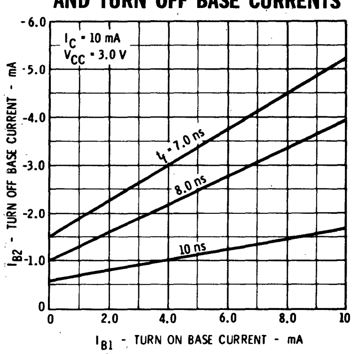
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



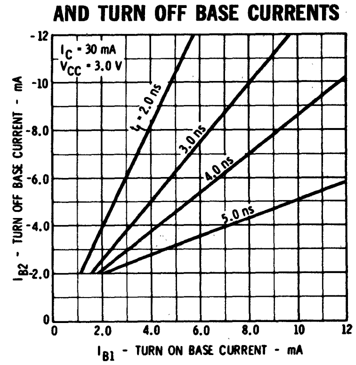
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



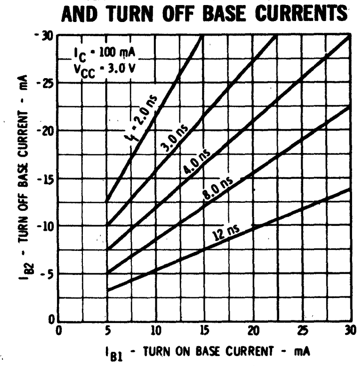
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



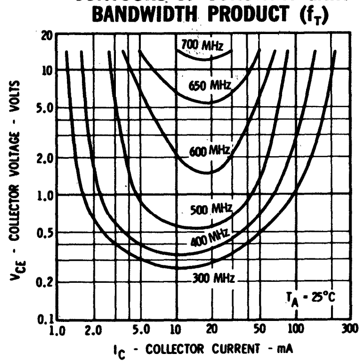
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



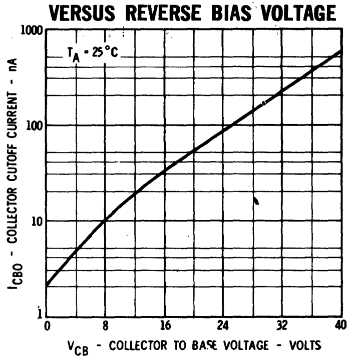
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



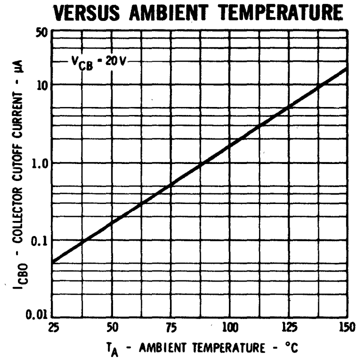
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



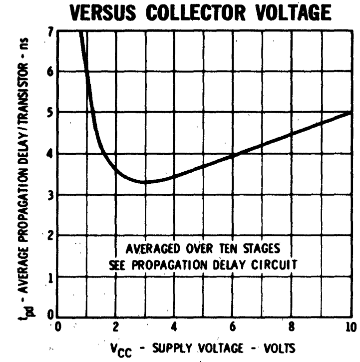
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



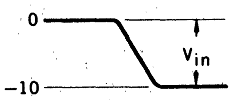
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



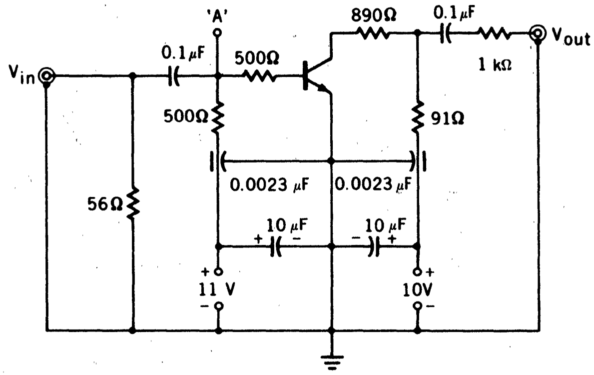
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE

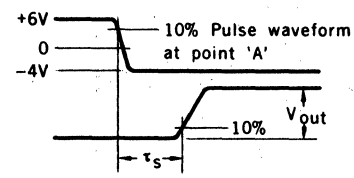


CHARGE STORAGE TIME MEASUREMENT CIRCUIT



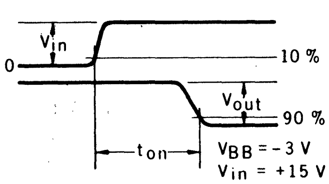
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %



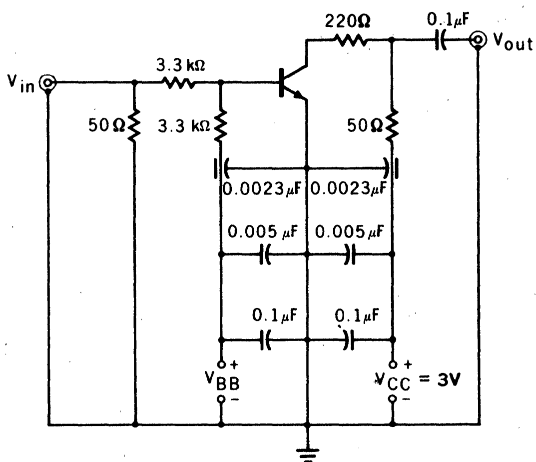


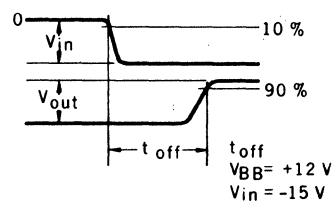
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

t_{ON} — t_{OFF} MEASUREMENT CIRCUIT



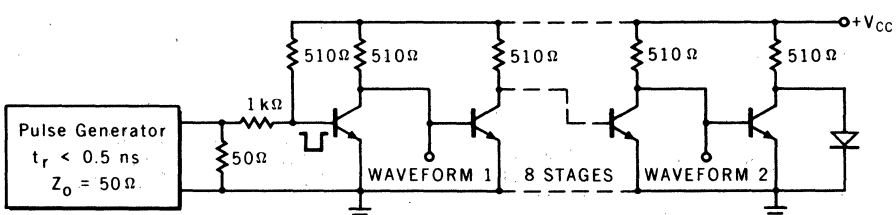
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %





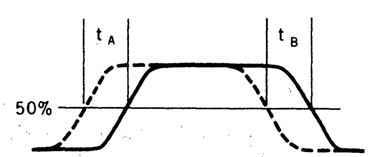
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

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

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N2443

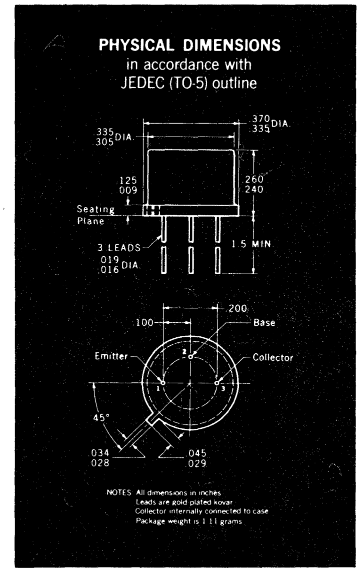
NPN HIGH-VOLTAGE AMPLIFIER AND OSCILLATOR

SILICON PLANAR TRANSISTOR

GENERAL DESCRIPTION The 2N2443 is designed for high-voltage amplifier and oscillator circuits where Planar performance and reliability are essential. A guaranteed LV_{CEO} of 100 volts, BV_{CBO} of 120 volts and 4 watt rating (see below for conditions) permit higher bias voltages and larger voltage swings as encountered in series and shunt regulators for power supplies and in servo amplifiers.

A typical gain-bandwidth product of 80 megacycles and low output capacitance makes this device useful for high-voltage video amplifiers, deflection plate drivers for oscilloscopes and output stages of operational amplifiers.

This device is designed to meet the environmental requirements of MIL-S-19500.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature			-65°C to +300°C
Operating Junction Temperature			200°C Maximum

Maximum Power Dissipation

Total Dissipation	at 25°C Case Temperature	(Notes 2 and 3)	4.0 Watts
	at 100°C Case Temperature	(Notes 2 and 3)	2.28 Watts
	at 25°C Ambient Temperature		0.8 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		120 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	100 Volts
V_{EBO}	Emitter to Base Voltage		7.0 Volts

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

Symbol	†FACT Subgroup	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{FE}	4	DC Pulse Current Gain (Note 5)	50	85	150		I_C = 50 mA V_{CE} = 10 V
*h_{FE}	1a	DC Pulse Current Gain (Note 5)	40	80	120		I_C = 150 mA V_{CE} = 10 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	35	80			I_C = 10 mA V_{CE} = 10 V
h_{FE}	4	DC Current Gain	20	55			I_C = 0.1 mA V_{CE} = 10 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 5)	20	35			I_C = 10 mA V_{CE} = 10 V
V_{BE}(sat)	4	Base Saturation Voltage	0.6	0.7	0.8	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	4	Collector Saturation Voltage		0.25	0.4	Volts	I_C = 10 mA I_B = 1.0 mA
*V_{BE}(sat)	1a	Base Saturation Voltage		0.8	0.9	Volts	I_C = 50 mA I_B = 5.0 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage		0.7	1.2	Volts	I_C = 50 mA I_B = 5.0 mA
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.5	4.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	4	Output Capacitance		12	15	pf	I_E = 0 V_{CB} = 10 V
C_{ibo}	4	Input Capacitance		57	85	pf	I_C = 0 V_{EB} = 0.5 V
*I_{CBO}	1b	Collector Cutoff Current		0.4	10	nA	I_E = 0 V_{CB} = 90 V
I_{CBO}(150°C)	4	Collector Cutoff Current		1.0	15	μA	I_E = 0 V_{CB} = 90 V
NF	4	Noise Figure (Note 6)		5.0	15	db	I_C = 0.3 mA V_{CE} = 10 V
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Note 4)	100			Volts	I_C = 30 mA (pulsed) I_B = 0
BV_{CBO}	1a	Collector to Base Breakdown Voltage	120			Volts	I_C = 0.1 mA I_E = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	7.0			Volts	I_C = 0 I_E = 0.1 mA
*I_{EBO}	1b	Emitter Cutoff Current		0.04	10	nA	I_C = 0 V_{EB} = 5.0 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

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 43.8°C/watt (derating factor of 22.8 mW/°C).
(4) Rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) Frequency = 1000 cps, Power Bandwidth = 200 cps, R_G = 510 Ω.

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

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPICAL COLLECTOR AND BASE CHARACTERISTICS

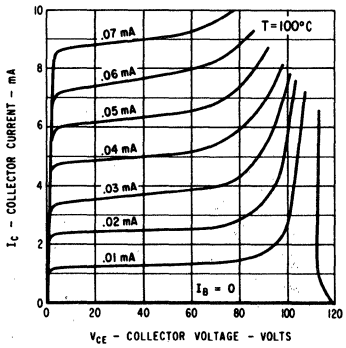
HIGH VOLTAGE

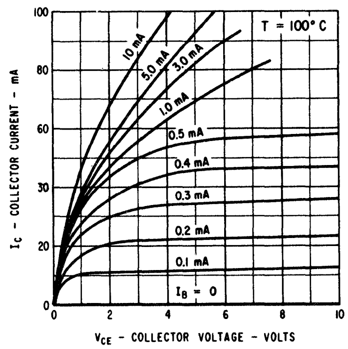
COLLECTOR CHARACTERISTICS*

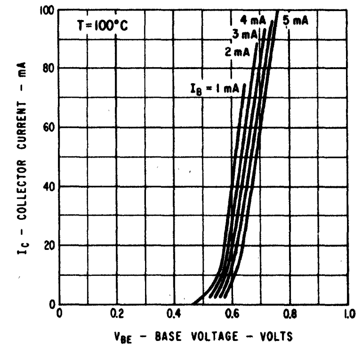
SATURATION REGION

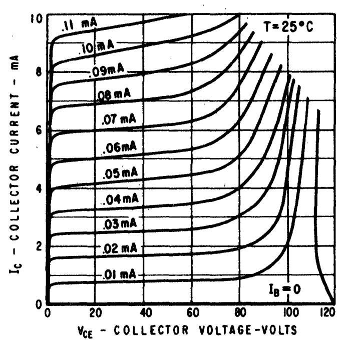
COLLECTOR CHARACTERISTICS*

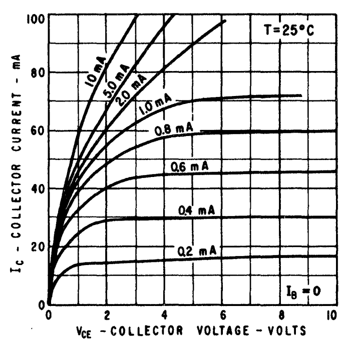
BASE CHARACTERISTICS*

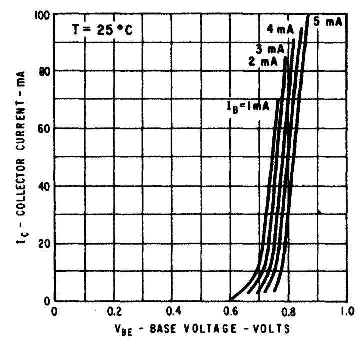


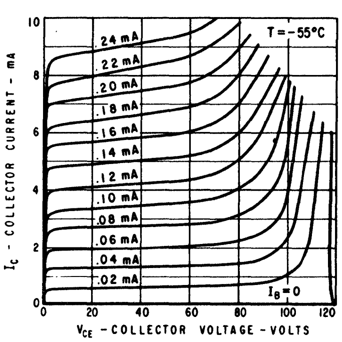


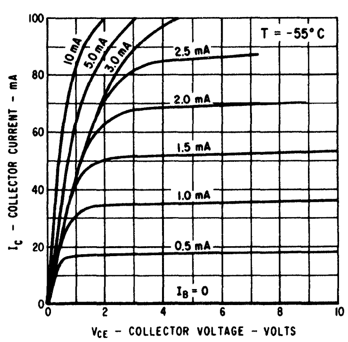


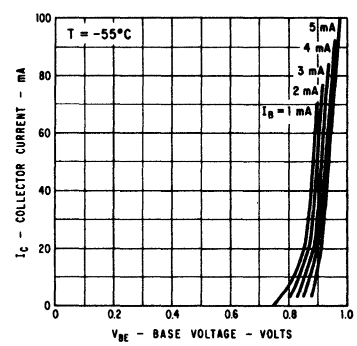






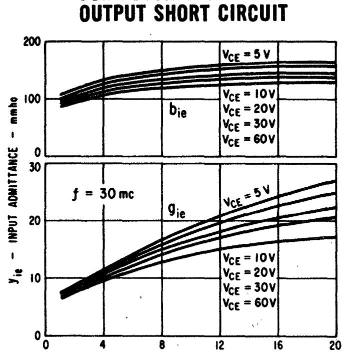




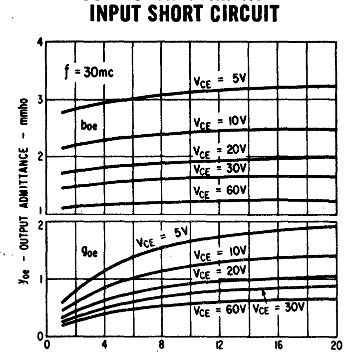


TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

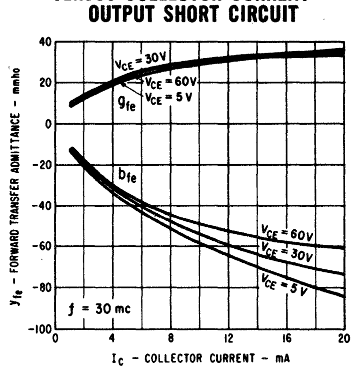
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



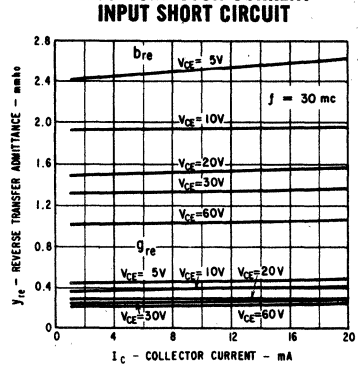
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT

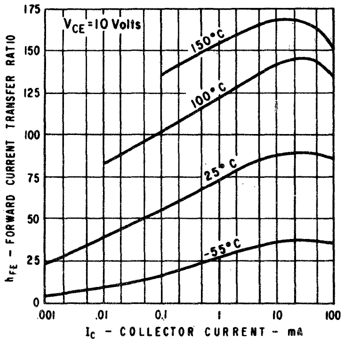


* Single family characteristic on Transistor Curve Tracer.

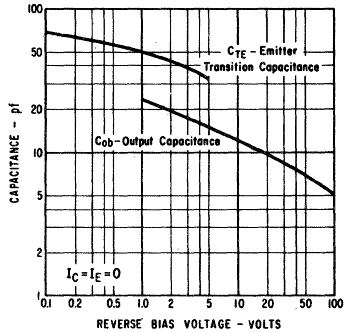
FAIRCHILD TRANSISTOR 2N2443

TYPICAL ELECTRICAL CHARACTERISTICS

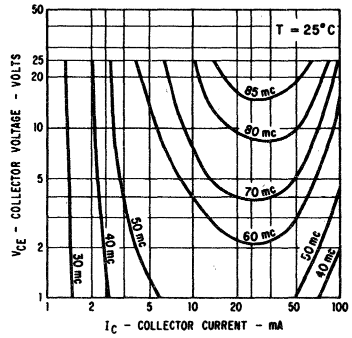
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



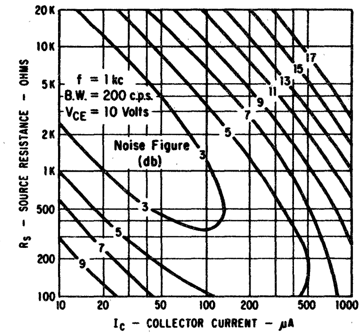
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



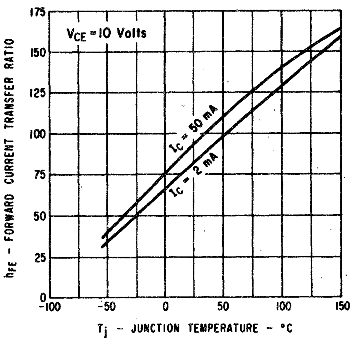
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



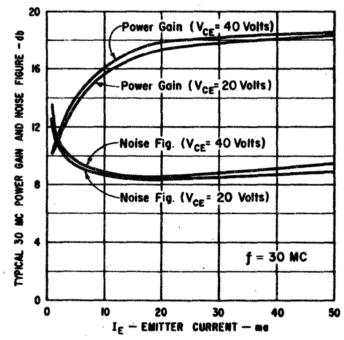
CONTOURS OF NARROW BAND NOISE FIGURE



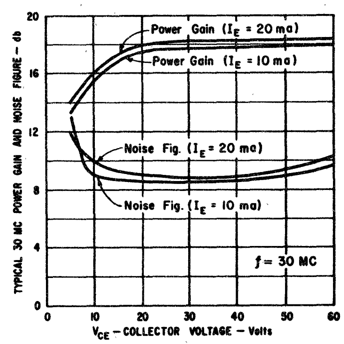
PULSED DC CURRENT GAIN VERSUS TEMPERATURE



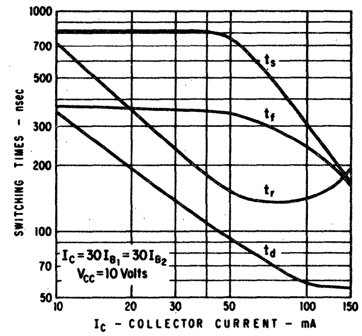
30 MC POWER GAIN AND NOISE FIGURE VERSUS EMITTER CURRENT



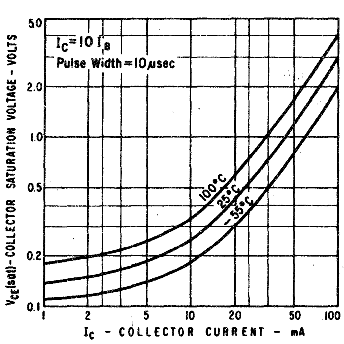
30 MC POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR VOLTAGE



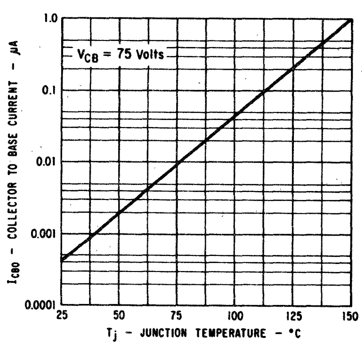
SWITCHING TIMES VERSUS COLLECTOR CURRENT



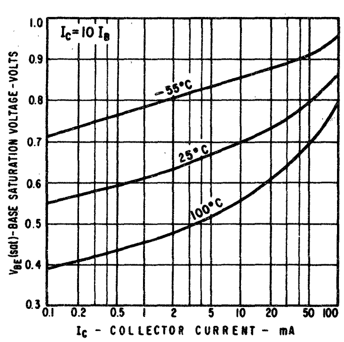
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



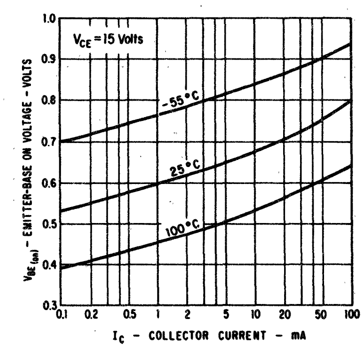
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

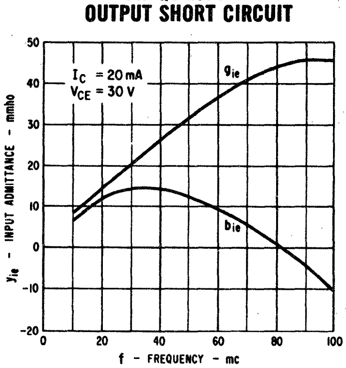


EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT

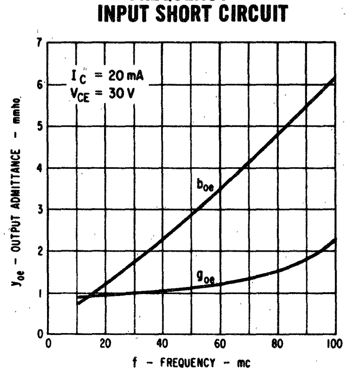


TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

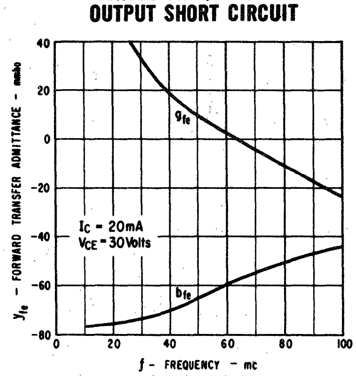
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



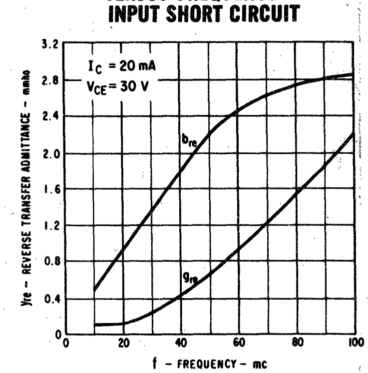
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT

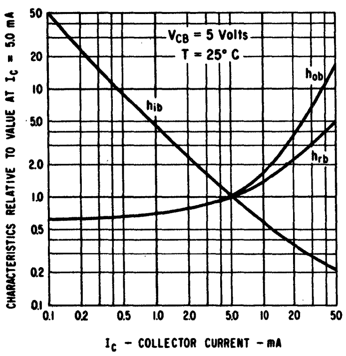


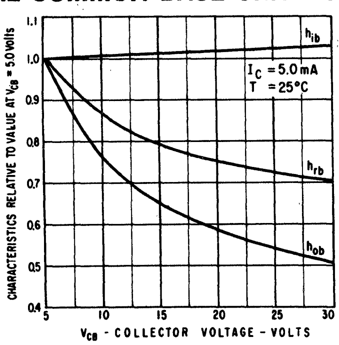
SMALL SIGNAL CHARACTERISTICS (f = 1 KC)

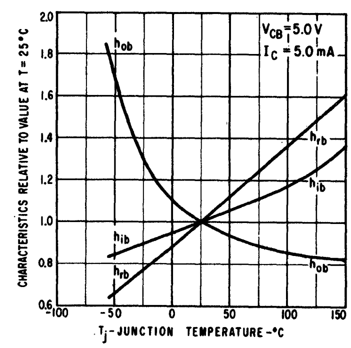
Symbol	† FACT Subgroup	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{ib}	4	Input Resistance	20	27	30	Ohms	I_C = 1.0 mA V_{CB} = 5.0 V
			4.0	6.3	8.0	Ohms	I_C = 5.0 mA V_{CB} = 5.0 V
h_{ob}	4	Output Conductance		0.11	0.5	μmho	I_C = 1.0 mA V_{CB} = 5.0 V
				0.16	1.0	μmho	I_C = 5.0 mA V_{CB} = 5.0 V
h_{rb}	4	Voltage Feedback Ratio		0.36	1.25	$x10^{-4}$	I_C = 1.0 mA V_{CB} = 5.0 V
				0.55	1.75	$x10^{-4}$	I_C = 5.0 mA V_{CB} = 5.0 V
h_{fe}	4	Small Signal Current Gain	30	62	120		I_C = 1.0 mA V_{CE} = 5.0 V
			45	68	150		I_C = 5.0 mA V_{CE} = 5.0 V
h_{ie}	4	Input Resistance		510	1000	Ohms	I_C = 5.0 mA V_{CE} = 5.0 V
h_{oe}	4	Output Conductance		12	50	μmho	I_C = 5.0 mA V_{CE} = 5.0 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.

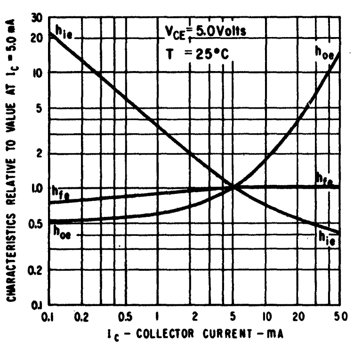
TYPICAL COMMON BASE CHARACTERISTICS

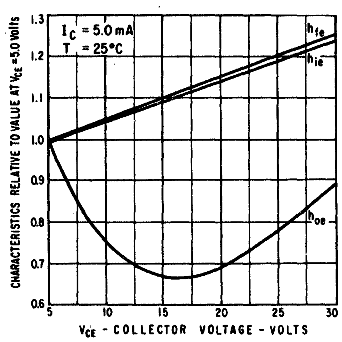


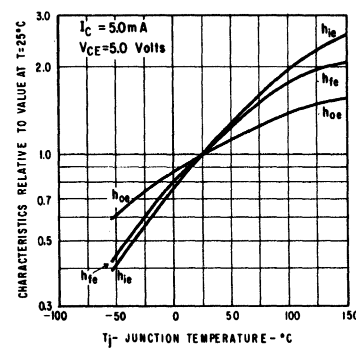




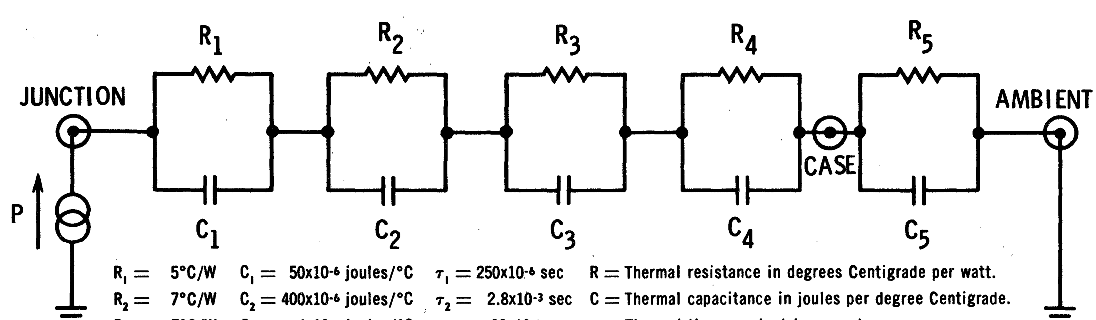
TYPICAL COMMON EMITTER CHARACTERISTICS







TYPICAL THERMAL EQUIVALENT CIRCUIT



R_1 = 5°C/W C_1 = 50x10⁻⁶ joules/°C τ_1 = 250x10⁻⁶ sec R = Thermal resistance in degrees Centigrade per watt.

R_2 = 7°C/W C_2 = 400x10⁻⁶ joules/°C τ_2 = 2.8x10⁻³ sec C = Thermal capacitance in joules per degree Centigrade.

R_3 = 7°C/W C_3 = 4x10⁻³ joules/°C τ_3 = 28x10⁻³ sec τ = Thermal time constant in seconds.

R_4 = 5°C/W C_4 = 40x10⁻³ joules/°C τ_4 = 200x10⁻³ sec P = Power in watts.

R_5 = 120°C/W C_5 = 625x10⁻³ joules/°C τ_5 = 75 sec For explanation of temperature rise calculation see APP-53.

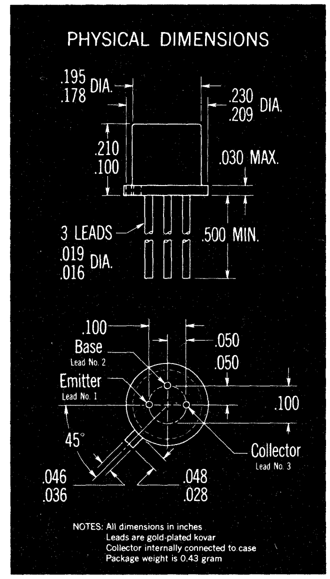
2N2475

NPN HIGH-SPEED SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION – The Fairchild 2N2475 is an NPN silicon PLANAR* epitaxial transistor designed specifically for high-speed, low-power saturated switching applications.

*Planar is a patented Fairchild process.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 10 sec time limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Free Air Temperature	[Notes 2 and 3]	0.3 Watt
at 100°C Case Temperature	[Notes 2 and 3]	0.5 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	15 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	6.0 Volts
V_{EBO}	Emitter to Base Voltage	4.0 Volts
I_C	Collector Current	Limited by power dissipation

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

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS
h_{FE}	DC Current Gain	30	150		I_C = 20 mA V_{CE} = 0.4 V
h_{FE}	DC Current Gain	20			I_C = 50 mA V_{CE} = 0.5 V
h_{FE}	DC Current Gain	20			I_C = 1.0 mA V_{CE} = 0.3 V
h_{FE} (-55°C)	DC Current Gain	15			I_C = 20 mA V_{CE} = 0.4 V
V_{BE}	Base-Emitter Voltage	0.8	1.0	Volt	I_C = 20 mA I_B = 0.66 mA
V_{CE}(sat)	Collector Saturation Voltage		0.4	Volt	I_C = 20 mA I_B = 0.66 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz.)	6.0			I_C = 20 mA V_{CE} = 2.0 V
C_{ob}	Output Capacitance		3.0	pF	I_E = 0 V_{CB} = 5.0 V
C_{ib}	Input Capacitance		2.5	pF	I_C = 0 V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		50	nA	I_E = 0 V_{CB} = 5.0 V
I_{CBO} (150°C)	Collector Cutoff Current		5.0	μA	I_E = 0 V_{CB} = 5.0 V
I_{EBO}	Emitter Cutoff Current		10	μA	I_C = 0 V_{EB} = 4.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	15		Volts	I_C = 10 μA I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	6.0		Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0		Volts	I_E = 10 μA I_C = 0
τ_s	Charge Storage Time Constant (see Figure 1)		6.0	nsec	I_C=5.0 mA, I_{B_1}=5.0 mA, I_{B_2}=-5.0 mA
T_{on}	Turn On Time (see Figure 2)		20	nsec	I_C=20 mA, I_{B_1}=1.0 mA, I_{B_2}=-1.0 mA
T_{off}	Turn Off Time (see Figure 2)		15	nsec	I_C=20 mA, I_{B_1}=1.0 mA, I_{B_2}=-1.0 mA

(See notes on back page)

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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-ambient thermal resistance of 583° C/watt (derating factor of 1.71 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

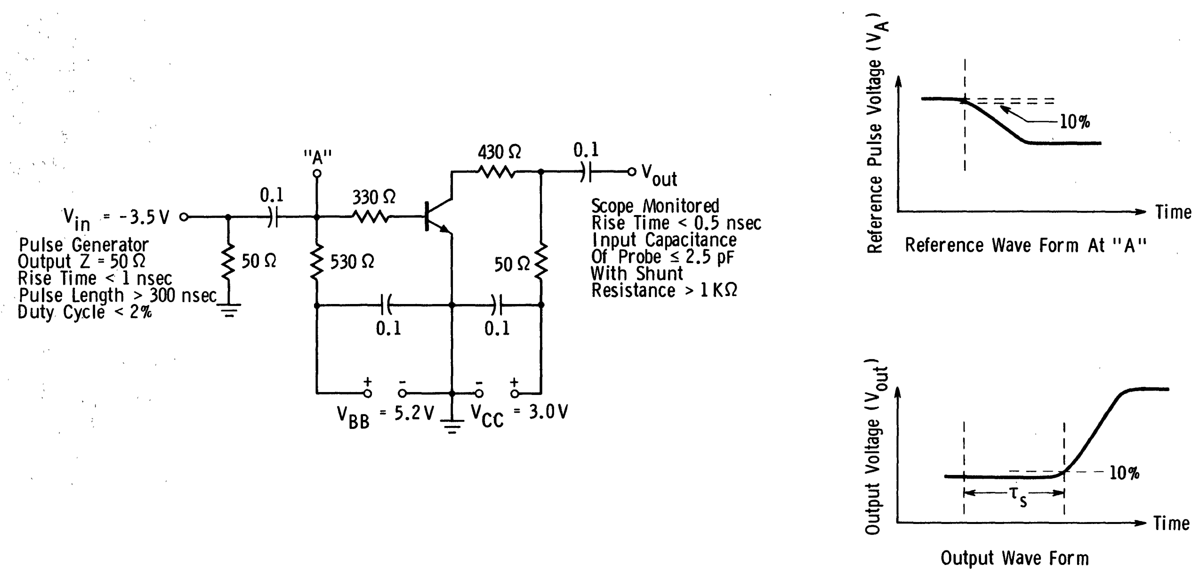
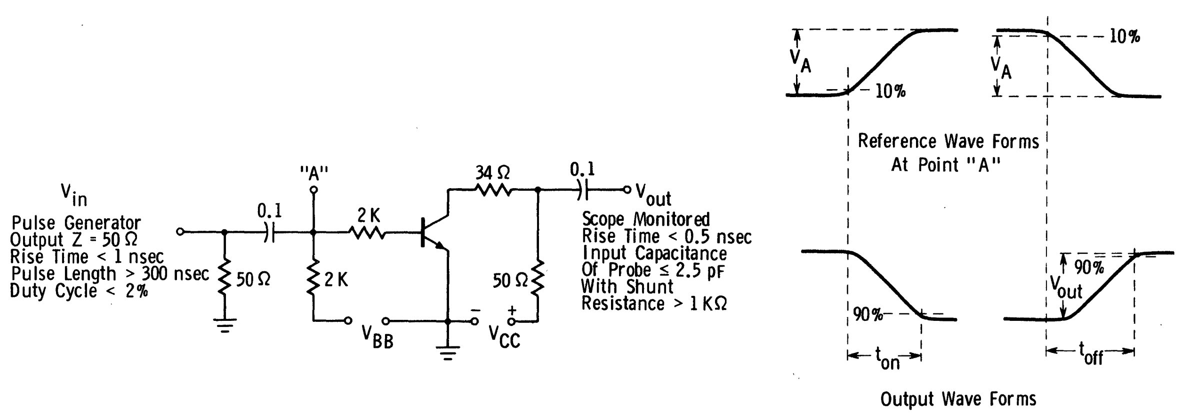


Figure 1



t_{on}	t_{off}
V_{BB} = - 1.0V	V_{BB} = +5.0V
V_{in} = +4.0V	V_{in} = - 4.0V
V_{CC} = +1.8V	V_{CC} = +1.8V

Figure 2

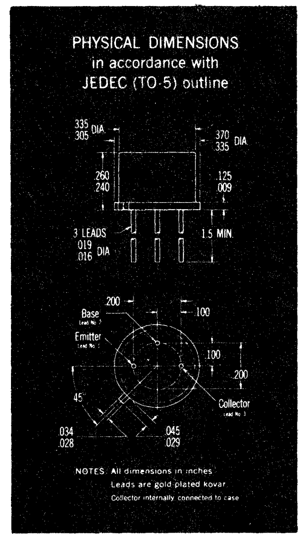
2N2476 • 2N2477

FAIRCHILD NPN SILICON PLANAR EPITAXIAL TRANSISTORS

HIGH-SPEED SWITCHES

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N2848

GENERAL DESCRIPTION - The Fairchild 2N2476 and 2N2477 are NPN silicon PLANAR epitaxial transistors designed specifically for high-speed saturated switching applications.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		-65°C to +300°C
Operating Junction Temperature		200°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)		2.0 Watts
at 25°C Ambient Temperature (Notes 2 and 3)		0.6 Watt
Maximum Voltages and Current		
V_{CBO}	Collector to Base Voltage	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	20 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	Limited by power dissipation only

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	2N2476 Min.	2N2476 Max.	2N2477 Min.	2N2477 Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	20		40			I_C = 150 mA	V_{CE} = 0.4 V
V_{BE}	Base-Emitter Voltage		1.0			Volts	I_C = 150 mA	I_B = 7.5 mA
V_{BE}	Base-Emitter Voltage				0.95	Volts	I_C = 150 mA	I_B = 3.75 mA
V_{CE}(sat)	Collector Saturation Voltage		0.4			Volts	I_C = 150 mA	I_B = 7.5 mA
V_{CE}(sat)	Collector Saturation Voltage				0.4	Volts	I_C = 150 mA	I_B = 3.75 mA
V_{CE}(sat)	Collector Saturation Voltage		0.75		0.65	Volts	I_C = 500 mA	I_B = 50 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	2.5		2.5			I_C = 50 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance		10		10	pf	I_E = 0	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		0.2		0.2	μA	I_E = 0	V_{CB} = 30 V
I_{CBO}(150°C)	Collector Cutoff Current		200		200	μA	I_E = 0	V_{CB} = 30 V
I_{EBO}	Emitter Cutoff Current		100		100	μA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		60		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	20		20		Volts	I_C = 50 mA(pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		5.0		Volts	I_E = 100 μA	I_C = 0
t_s	Storage Time (Note 6)		25		25	nsec	$I_C \approx$ 150 mA, $I_{B1} \approx$ 15 mA, $I_{B2} \approx$ -15 mA	
t_{on}	Turn On Time (Note 7)		25		25	nsec	$I_C \approx$ 150 mA	$I_{B1} \approx$ 15 mA
t_{off}	Turn Off Time (Note 6)		45		45	nsec	$I_C \approx$ 150 mA, $I_{B1} \approx$ 15 mA, $I_{B2} \approx$ -15 mA	

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 87.5°C/watt (derating factor of 11.4 mW/°C; junction-to-ambient thermal resistance of 292°C/watt (derating factor of 3.42 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length ≤ 400 μsec; duty cycle ≤ 3%.
(6) See Figure 2 for exact values of I_C, I_{B1}, and I_{B2}.
(7) See Figure 1 for exact values of I_C and I_{B1}.

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FIGURE 1 — Turn-On Test Circuit

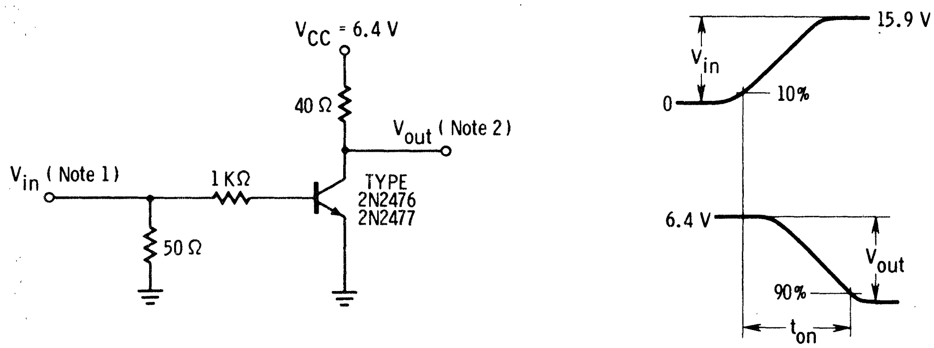
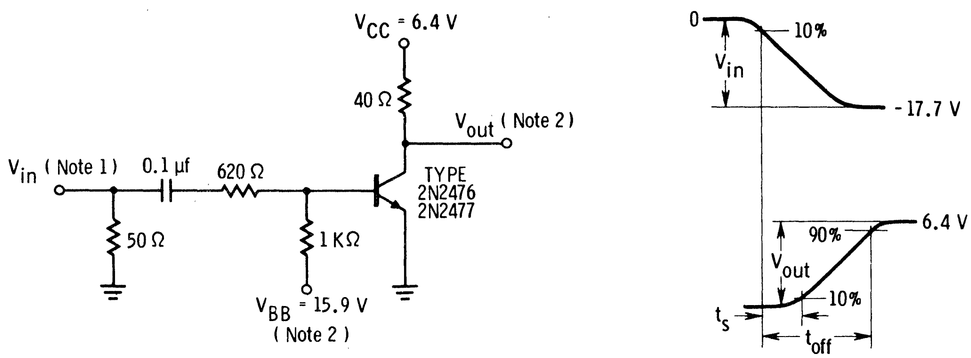


FIGURE 2 — Turn-Off and Storage Time Test Circuit



Note 1: Input voltage (V_{IN}) obtained from mercury-relay type pulse generator having an output impedance of 50 ohms. V_{IN} rise time <2 nsec; pulse duration >150 nsec; and duty factor <2%.

Note 2: Input and output waveforms monitored by means of a sampling oscilloscope or other indicating device having a rise time <0.5 nsec; input capacitance of probe <2.5 pf with shunt resistance of 1 megohm.

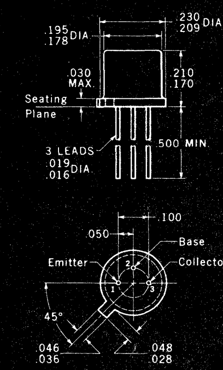
2N2483 • 2N2484

NPN LOW LEVEL, LOW NOISE TYPE

DIFFUSED SILICON PLANAR TRANSISTORS

The 2N2483 and 2N2484 are NPN double-diffused silicon PLANAR transistors designed for use in high-performance, low-level, low-noise amplifier circuits from audio through high-frequency ranges.

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 +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum
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	
V_{CBO} Collector to Base Voltage	60 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	60 Volts
V_{EBO} Emitter to Base Voltage	6.0 Volts
I_C Collector Current	50 mA

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

SYMBOL	FACT † SUBGROUP	CHARACTERISTICS	2N2483 MIN.	2N2483 TYP.	2N2483 MAX.	2N2484 MIN.	2N2484 TYP.	2N2484 MAX.	UNITS	TEST CONDITIONS
h_{FE}	4	DC Pulse Current Gain [Note 5]		280	500		430	800		I_C = 10 mA V_{CE} = 5.0 V
h_{FE}	4	DC Current Gain	175	230		250	450			I_C = 1.0 mA V_{CE} = 5.0 V
h_{FE}	4	DC Current Gain	100	200		200	430			I_C = 500 μA V_{CE} = 5.0 V
h_{FE}	4	DC Current Gain	75	140		175	375			I_C = 100 μA V_{CE} = 5.0 V
* h_{FE}	1a	DC Current Gain	40	80	120	100	290	500		I_C = 10 μA V_{CE} = 5.0 V
h_{FE}	4	DC Current Gain				30	200			I_C = 1.0 μA V_{CE} = 5.0 V
h_{FE} (−55°C)	4	DC Current Gain	10			20				I_C = 10 μA V_{CE} = 5.0 V
V_{BE} (on)	4	Emitter-Base On Voltage	0.5	0.57	0.7	0.5	0.57	0.7	Volts	I_C = 100 μA V_{CE} = 5.0 V
* V_{CE} (sat)	1a	Collector Saturation Voltage		0.2	0.35		0.2	0.35	Volts	I_C = 1.0 mA I_B = 0.1 mA
h_{fe}	4	High Frequency Current Gain (f = 5.0 mc)	2.4	4.0		3.0	4.0			I_C = 50 μA V_{CE} = 5.0 V
h_{fe}	4	High Frequency Current Gain (f = 30 mc)	2.0	2.3		2.0	2.6			I_C = 500 μA V_{CE} = 5.0 V
* I_{CBO}	1b	Collector Cutoff Current		0.1	10		0.1	10	nA	I_E = 0 V_{CB} = 45 V
I_{CBO} (150°C)	4	Collector Cutoff Current		0.2	10		0.2	10	μA	I_E = 0 V_{CB} = 45 V
* I_{EBO}	1b	Emitter Cutoff Current		0.1	10		0.1	10	nA	I_C = 0 V_{EB} = 5.0 V
I_{CEO}	4	Collector-Emitter Cutoff Current		0.1	2.0		0.1	2.0	nA	I_B = 0 V_{CE} = 5.0 V
C_{ob}	4	Output Capacitance		3.5	6.0		3.5	6.0	pf	I_E = 0 V_{CB} = 5.0 V
C_{TE}	4	Emitter Transition Capacitance		3.5	6.0		3.5	6.0	pf	I_C = 0 V_{EB} = 0.5 V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	60			60			Volts	I_C = 10 μA I_E = 0
V_{CEO} (sust)	1a	Collector to Emitter Sustaining Voltage [Note 4 and 5]	60			60			Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	6.0			6.0			Volts	I_C = 0 I_E = 10 μA
NF	4	Wide Band Noise Figure [Note 6]		1.9	4.0		1.8	3.0	db	I_C = 10 μA V_{CE} = 5.0 V
NF	4	Narrow Band Noise Figure [Note 7]		1.9	4.0		1.8	3.0	db	I_C = 10 μA V_{CE} = 5.0 V
NF	4	Narrow Band Noise Figure [Note 8]		0.7	3.0		0.6	2.0	db	I_C = 10 μA V_{CE} = 5.0 V
NF	4	Narrow Band Noise Figure [Note 9]		4.0	15		4.0	10	db	I_C = 10 μA V_{CE} = 5.0 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

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 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/Watt (derating factor of 2.1 mW/°C).
(4) These ratings refer to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) R_S = 10 KΩ; Power Bandwidth of 15.7 Kc with 3 db points at 10 cycles and 10 Kc.
(7) f = 1 Kc; R_S = 10 KΩ; Power Bandwidth of 200 cps.
(8) f = 10 Kc; R_S = 10 KΩ; Power Bandwidth of 2 Kc.
(9) f = 100 cps; R_S = 10 KΩ; Power Bandwidth of 20 cps.

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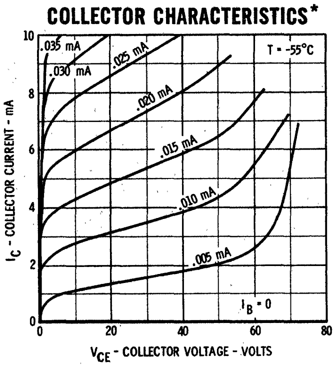
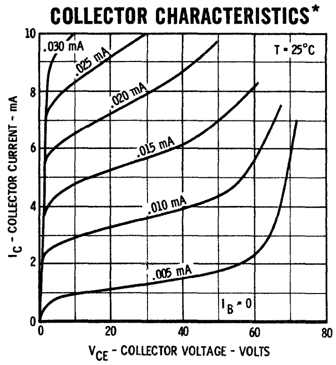
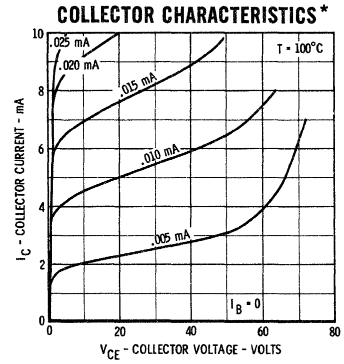
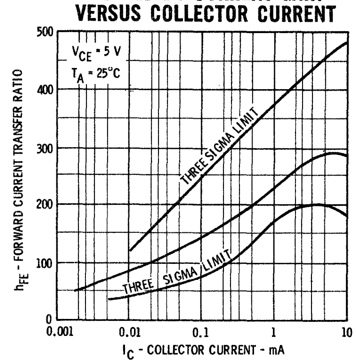
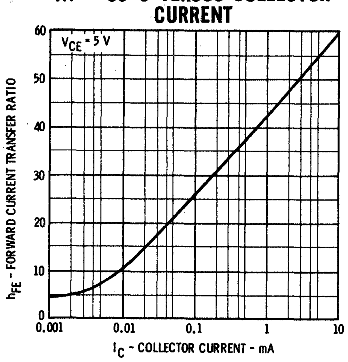
2N2483
TYPICAL ELECTRICAL CHARACTERISTICS

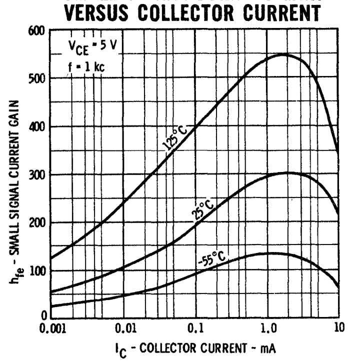
COLLECTOR CHARACTERISTICS*


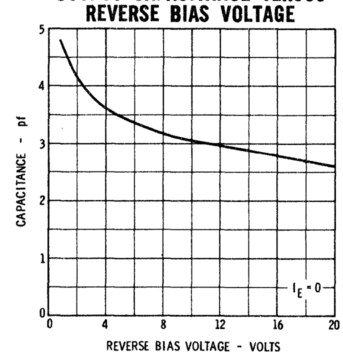
COLLECTOR CHARACTERISTICS*


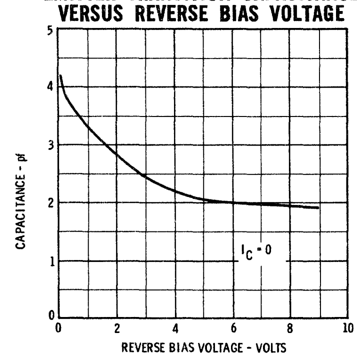
COLLECTOR CHARACTERISTICS*


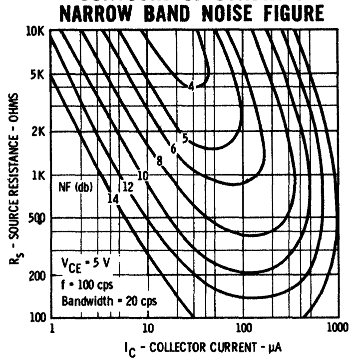
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT


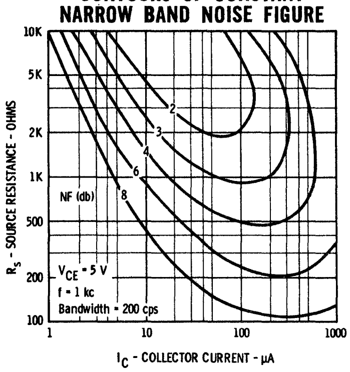
MINIMUM DC CURRENT GAIN AT −55°C VERSUS COLLECTOR CURRENT


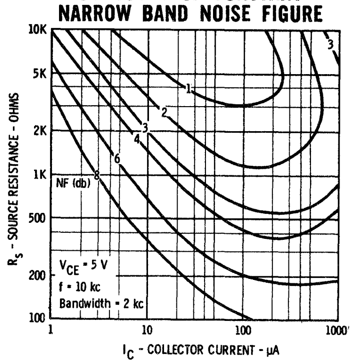
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT


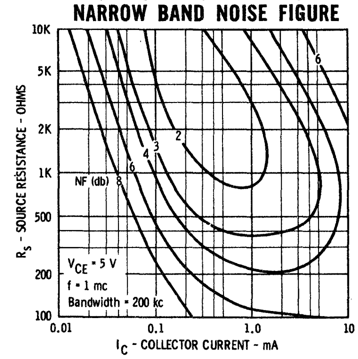
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE


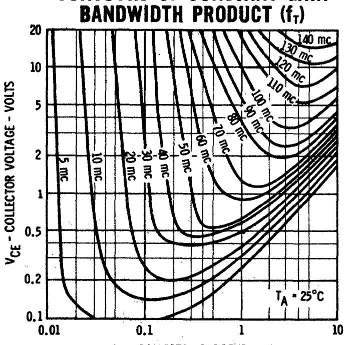
EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE


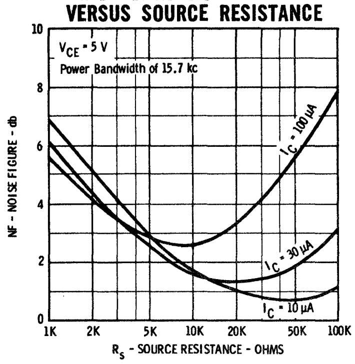
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


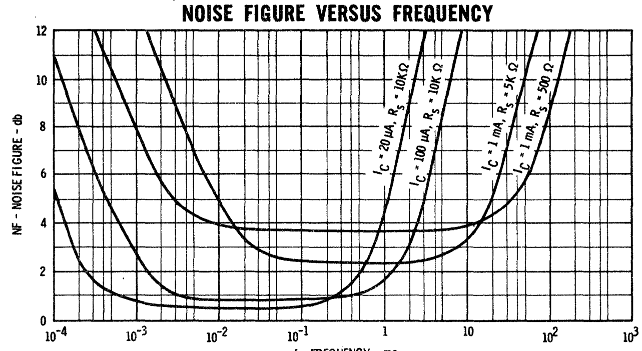
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


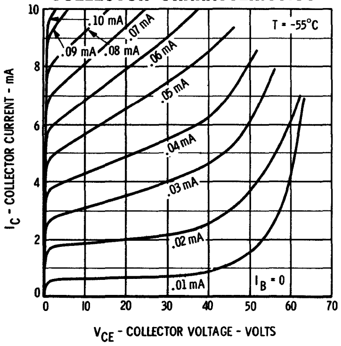
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)


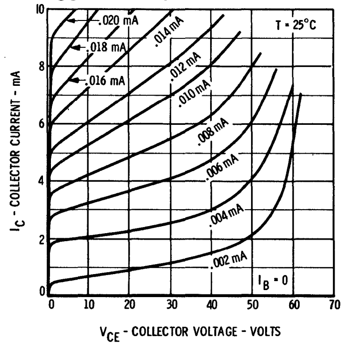
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE


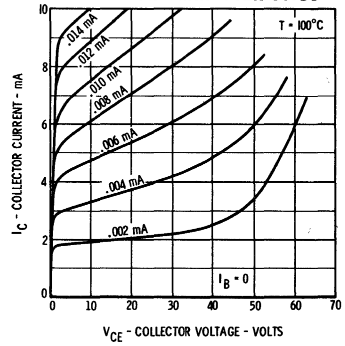
NOISE FIGURE VERSUS FREQUENCY


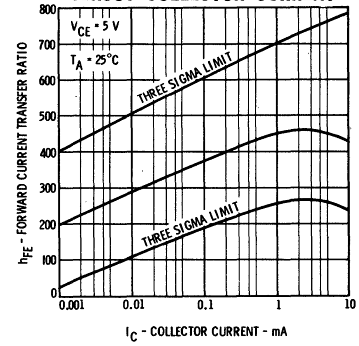
*** Single family characteristics on Transistor Curve Tracer.**

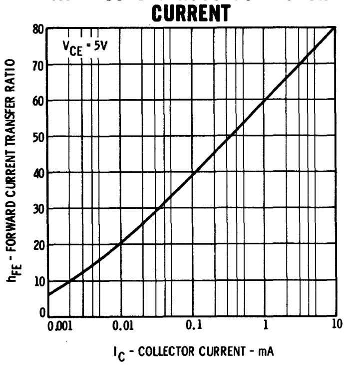
2N2484
TYPICAL ELECTRICAL CHARACTERISTICS

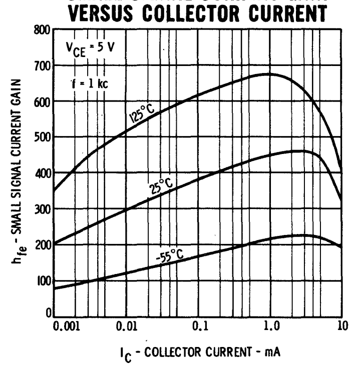
COLLECTOR CHARACTERISTICS*


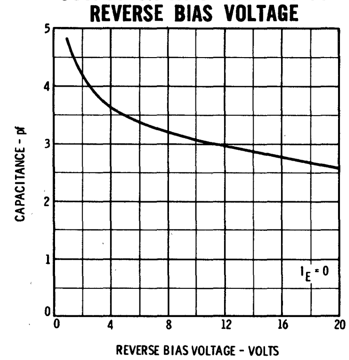
COLLECTOR CHARACTERISTICS*


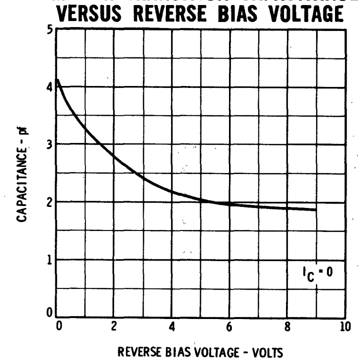
COLLECTOR CHARACTERISTICS*


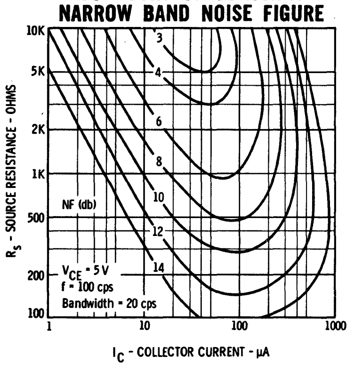
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT


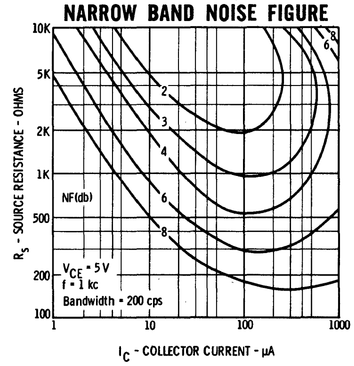
MINIMUM DC CURRENT GAIN AT −55°C VERSUS COLLECTOR CURRENT


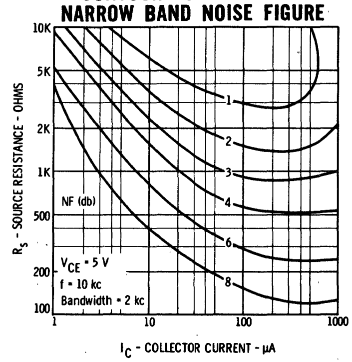
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT


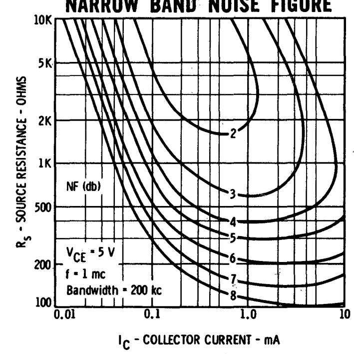
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE


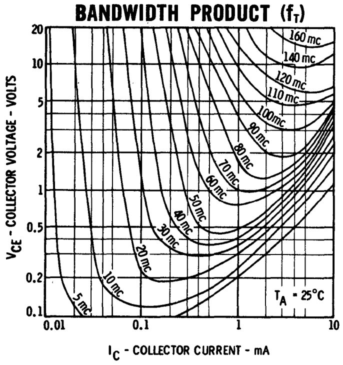
EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE


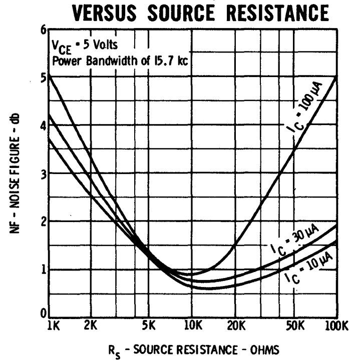
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


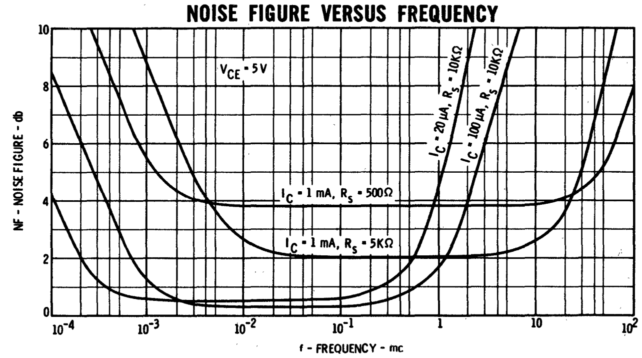
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE


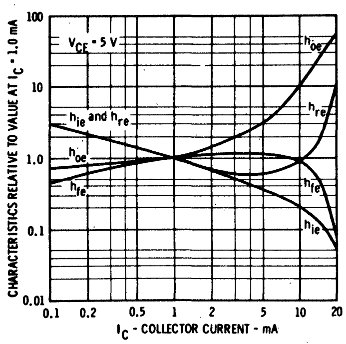
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)


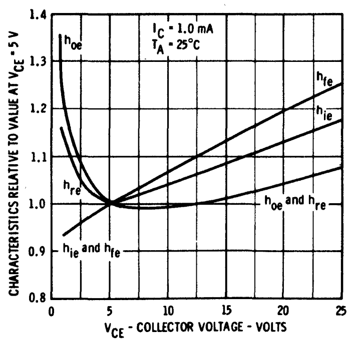
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE


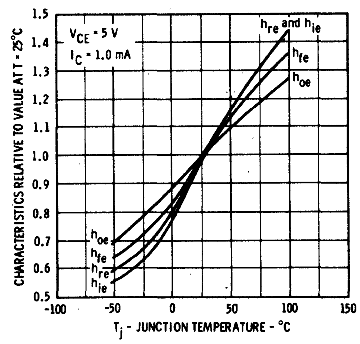
NOISE FIGURE VERSUS FREQUENCY


*** Single family characteristics on Transistor Curve Tracer.**

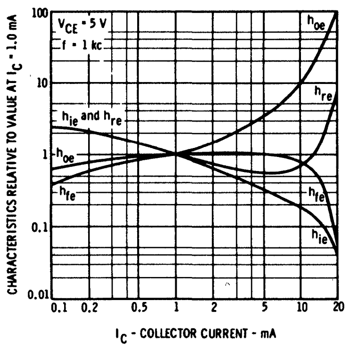
2N2483 — COMMON EMITTER CHARACTERISTICS

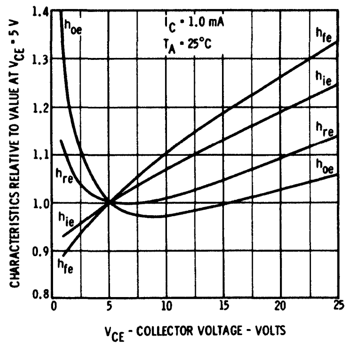


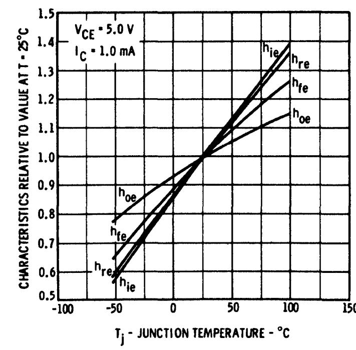




2N2484 — COMMON EMITTER CHARACTERISTICS







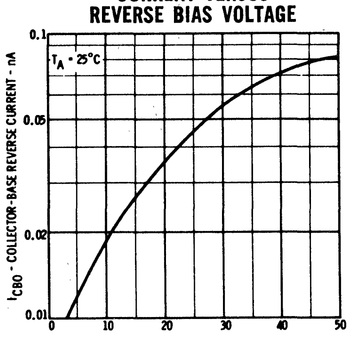
SMALL SIGNAL CHARACTERISTICS (f = 1KC)

SYMBOL	FACT † SUBGROUP	CHARACTERISTIC	2N2483 MIN.	2N2483 TYP.	2N2483 MAX.	2N2484 MIN.	2N2484 TYP.	2N2484 MAX.	UNITS	TEST CONDITIONS
h_{ie}	4	Input Resistance	1.5	7.5	13	3.5	15	24	Kohms	I_C = 1.0 mA V_{CE} = 5.0 V
h_{oe}	4	Output Conductance		11	30		15	40	μmho	I_C = 1.0 mA V_{CE} = 5.0 V
h_{re}	4	Voltage Feedback Ratio		300	800		425	800	$x10^{-6}$	I_C = 1.0 mA V_{CE} = 5.0 V
h_{fe}	4	Small Signal Current Gain	80	280	450	150	400	900		I_C = 1.0 mA V_{CE} = 5.0 V
h_{ib}	4	Input Resistance	25	27	32	25	27	32	ohms	I_C = 1.0 mA V_{CB} = 5.0 V

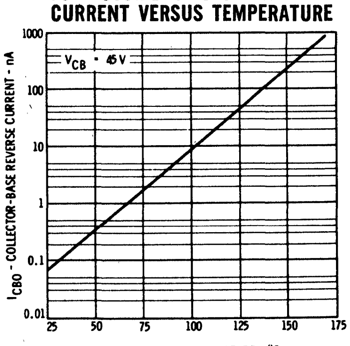
† NOTE: These Numerals Apply to the Fairchild FACT Program.

2N2483 — 2N2484

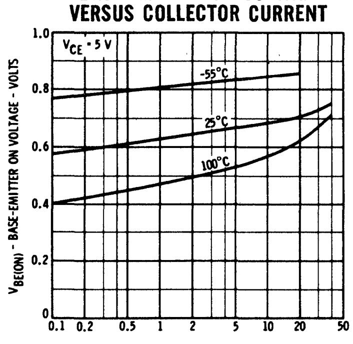
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



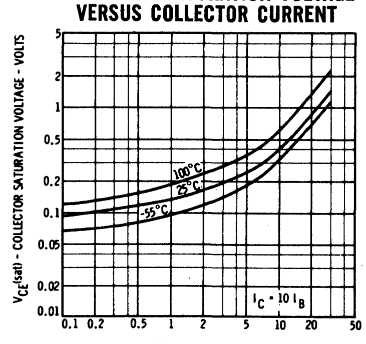
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

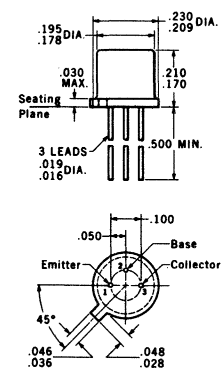
2N2509 • 2N2510 • 2N2511

NPN LOW-LEVEL, LOW-NOISE

DIFFUSED SILICON PLANAR* TRANSISTORS

- **HIGH GAIN . . . . . $h_{FE} = 40$ (MIN) (2N2509) AT 10 mA**
  . . . . . $h_{FE} = 150\text{-}500$ (2N2510) AT 10 mA
  . . . . . $h_{FE} = 240\text{-}750$ (2N2511) AT 10 mA
- **HIGH VOLTAGE . . . $LV_{CEO} = 80$ V (MIN) (2N2509)**
  . . . $LV_{CEO} = 65$ V (MIN) (2N2510)
  . . . $LV_{CEO} = 50$ V (MIN) (2N2511)
- **LOW NOISE . . . . . NF = 4.0 dB (MIN) (2N2510/11) AT 1.0 kHz**

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 +300°C
Operating Junction Temperature	+200°C

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

		2N2509	2N2510	2N2511
V_{CBO}	Collector to Base Voltage	125 Volts	100 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	80 Volts	65 Volts	50 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts	7.0 Volts

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

SYMBOL	CHARACTERISTICS	2N2509 MIN.	2N2509 MAX.	2N2510 MIN.	2N2510 MAX.	2N2511 MIN.	2N2511 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**	**40**		**150**	**500**	**240**	**750**		**$I_C = 10$ mA**	**$V_{CE} = 5.0$ V**
h_{FE}	DC Current Gain	25		75		120			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
$h_{FE}(-55°C)$	DC Current Gain	20		60		100			$I_C = 10$ mA	$V_{CE} = 5.0$ V
$h_{FE}(-55°C)$	DC Current Gain			25		40			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain					80			$I_C = 1.0\ \mu A$	$V_{CE} = 5.0$ V
$V_{CE(sat)}$	Collector Saturation Voltage		1.0		1.0		1.0	Volts	$I_C = 5.0$ mA	$I_B = 0.5$ mA
$V_{BE(sat)}$	Base-Emitter Voltage		0.9		0.9		0.9	Volts	$I_C = 5.0$ mA	$I_B = 0.5$ mA
h_{fe}	High-Frequency Current Gain (f = 30 MHz)	1.5		1.5		1.5			$I_C = 5.0$ mA	$V_{CE} = 10$ V
I_{CBO}	Collector Cutoff Current		5.0					nA	$I_E = 0$	$V_{CB} = 100$ V
I_{CBO}	Collector Cutoff Current				5.0			nA	$I_E = 0$	$V_{CB} = 80$ V
I_{CBO}	Collector Cutoff Current						5.0	nA	$I_E = 0$	$V_{CB} = 60$ V
$I_{CBO}(150°C)$	Collector Cutoff Current		10					μA	$I_E = 0$	$V_{CB} = 100$ V
$I_{CBO}(150°C)$	Collector Cutoff Current				10			μA	$I_E = 0$	$V_{CB} = 80$ V
$I_{CBO}(150°C)$	Collector Cutoff Current						10	μA	$I_E = 0$	$V_{CB} = 60$ V
I_{EBO}	Emitter Cutoff Current		2.0		2.0		2.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{obo}	Output Capacitance (f = 1.0 MHz)		6.0		6.0		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{ibo}	Input Capacitance (f = 1.0 MHz)		10		10		10	pF	$I_C = 0$	$V_{EB} = 0.5$ V
NF	**Noise Figure (f = 1.0 KHz)**		**7.0**		**4.0**		**4.0**	**dB**	**$I_C = 10\ \mu A$**	**$V_{CE} = 5.0$ V**
									BW = 200 Hz	**$R_{GT} = 10\ k\Omega$**
$r_b'C_c$	Collector-Base Time Constant (f = 4.0 MHz)		800		800		800	ps	$I_C = 10$ mA	$V_{CB} = 10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	125		100		80		Volts	$I_C = 10\ \mu A$	$I_E = 0$
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Note 4)	**80**		**65**		**50**		**Volts**	**$I_C = 10$ mA**	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0		7.0		7.0		Volts	$I_E = 0.1\ \mu A$	$I_C = 0$

See notes on back page

*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 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) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

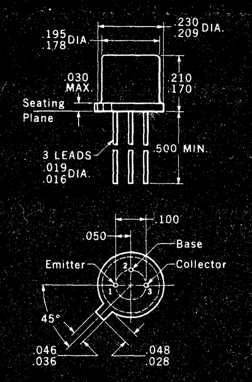
2N2586

NPN LOW-LEVEL, LOW-NOISE

DIFFUSED SILICON PLANAR*TRANSISTOR

GENERAL DESCRIPTION The Fairchild 2N2586 is an NPN PLANAR transistor designed for use in low-level, low-noise amplifier circuits from audio through high-frequency ranges.

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 +300°C
Operating Junction Temperature		175°C Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)		0.6 Watt
at 25°C Ambient Temperature (Notes 2 and 3)		0.3 Watt
Maximum Voltages and Current		
V_{CBO}	Collector to Base Voltage	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	45 Volts
V_{EBO}	Emitter to Base Voltage	6.0 Volts
I_C	Collector Current	30 mA

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 5)		600		I_C = 10 mA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	150			I_C = 500 μA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	120	360		I_C = 10 μA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	80			I_C = 1.0 μA	V_{CE} = 5.0 V
h_{FE}(-55°C)	DC Current Gain	40			I_C = 10 μA	V_{CE} = 5.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.5	Volts	I_C = 10 mA	I_B = 0.5 mA
V_{BE}	Base-Emitter Voltage	0.7	0.9	Volts	I_C = 10 mA	I_B = 0.5 mA
h_{fe}	High Frequency Current Gain (f = 30 MHz)	1.5			I_C = 500 μA	V_{CE} = 5.0 V
C_{obo}	Common Base Open Circuit Output Capacitance (f = 1.0 MHz)		7.0	pF	I_E = 0	V_{CB} = 5.0 V
I_{CBO}	Collector Cutoff Current		2.0	nA	I_E = 0	V_{CB} = 45 V
I_{CES}	Collector-Emitter Cutoff Current		2.0	nA	V_{CE} = 45 V	V_{BE} = 0
I_{CES}(170°C)	Collector-Emitter Cutoff Current		10	μA	V_{CE} = 45 V	V_{BE} = 0
I_{CEO}	Collector-Emitter Cutoff Current		2.0	nA	I_B = 0	V_{CE} = 5.0 V
I_{EBO}	Emitter Cutoff Current		2.0	nA	I_C = 0	V_{EB} = 5.0 V
NF	Spot Noise Figure (R_G = 1 MΩ; f = 10 kHz)		2.0	dB	I_C = 1.0 μA	V_{CE} = 5.0 V
NF	Spot Noise Figure (R_G = 10 kΩ; f = 10 kHz)		2.0	dB	I_C = 10 μA	V_{CE} = 5.0 V
NF	Spot Noise Figure (R_G = 10 kΩ; f = 1.0 kHz)		3.0	dB	I_C = 10 μA	V_{CE} = 5.0 V
NF	Spot Noise Figure (R_G = 1 MΩ; f = 1.0 kHz)		3.5	dB	I_C = 1.0 μA	V_{CE} = 5.0 V

Additional Electrical Characteristics on page 2

* Planar is a patented Fairchild process.

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ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance (f = 1.0 kHz)	4.5	18	Kohms	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{oe}	Output Admittance (f = 1.0 kHz)		100	μmhos	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	150	600		I_C = 1.0 mA	V_{CE} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	45		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		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 175°C and junction-to-case thermal resistance of 250°C/Watt (derating factor of 4.0 mW/°C); junction to ambient thermal resistance of 500°C/Watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length = 300 μsec; duty cycle $\leq$ 2%.

2N2605

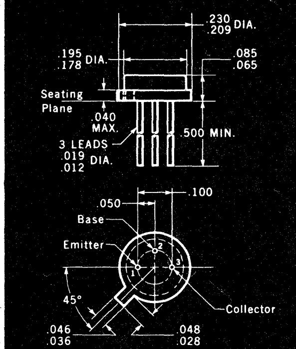
PNP LOW LEVEL, LOW NOISE TYPE

DIFFUSED SILICON PLANAR II TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD FT0019

GENERAL DESCRIPTION - The Fairchild 2N2605 is a PNP double-diffused silicon PLANAR II transistor designed for use in high-performance, low-level, low-noise amplifiers from audio to high frequency ranges.

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 (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +200°C
Lead Temperature (Soldering, 1/16" ±1/32", 10 sec time limit)		230°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)	0.4 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		-60 Volts
V_{CEO}	Collector to Emitter Voltage	(Notes 4 and 5)	-45 Volts
V_{EBO}	Emitter to Base Voltage		-6.0 Volts
I_C	Collector Current		30 mA

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

Symbol	Characteristics	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain (T_A = -55°C)	20			I_C = 10 μA	V_{CE} = -5.0 V
h_{FE}	DC Current Gain	100	300		I_C = 10 μA	V_{CE} = -5.0 V
h_{FE}	DC Current Gain	150			I_C = 500 μA	V_{CE} = -5.0 V
h_{FE}	DC Current Gain (Notes 4 & 5)		600		I_C = 10 mA	V_{CE} = -5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	-60		Volts	I_C = 10 μA	I_E = 0
LV_{CEO}	Collector to Emitter Limiting Voltage (Notes 4 & 5)	-45		Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-6.0		Volts	I_C = 0	I_E = 10 μA
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0	V_{CB} = -45 V
I_{CES}	Collector Reverse Current		10	nA	V_{CE} = -45 V	V_{EB} = 0
I_{CES}	Collector Reverse Current (T_A = 170°C)		10	μA	V_{CE} = -45 V	V_{EB} = 0
I_{EBO}	Emitter Cutoff Current		2.0	nA	I_C = 0	V_{EB} = -5.0 V

(See notes on back page)

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

Symbol	Characteristics	Min.	Max.	Units	Test Conditions
$V_{BE}(sat)$	Base Saturation Voltage (Notes 4 & 5)	-0.7	-0.9	Volts	I_C = 10 mA I_B = 0.5 mA
$V_{CE}(sat)$	Collector Saturation Voltage (Notes 4 & 5)		-0.5	Volts	I_C = 10 mA I_B = 0.5 mA
h_{fe}	High Frequency Current Gain (f = 30 Mc)	1.0			I_C = 0.5 mA V_{CE} = -5.0 V
C_{obo}	Common-base, Open-circuit Output Capacitance (f = 1.0 Mc)		6.0	pf	I_E = 0 V_{CB} = 5.0 V
NF	Wide Band Noise Figure (f = 10 Kc) (Note 6)		3.0	db	I_C = 10 μA V_{CE} = -5.0 V
$R_e(h_{ie})$	Real Part, Input Impedance (f = 100 Mc)		200	Ohms	I_C = 1.0 mA V_{CE} = 5.0 V

SMALL SIGNAL CHARACTERISTICS (f = 1 Kc)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{ib}	Input Resistance	25	35	Ohms	I_E = 1.0 mA V_{CB} = -5.0 V
h_{ob}	Output Conductance		1.0	μmho	I_E = 1.0 mA V_{CB} = -5.0 V
h_{fe}	Small Signal Current Gain	150	600		I_E = 1.0 mA V_{CE} = -5.0 V
h_{rb}	Voltage Feedback Ratio		10	$x10^{-4}$	I_E = 1.0 mA V_{CB} = -5.0 V

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 6.9 mW/°C; junction-to-ambient thermal resistance of 438°C/Watt (derating factor of 2.28 mW/°C).

(4) These ratings refer to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

(6) R_g = 10 KOhms, Power Bandwidth = 15.7 Kc.

2N2616 • 2N2729

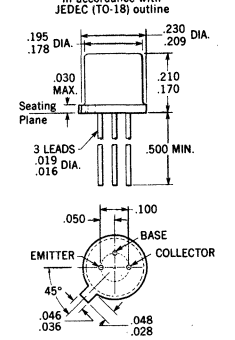
NPN ULTRA-HIGH FREQUENCY OSCILLATOR AND AMPLIFIER TYPE

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N2616 and 2N2729 are NPN Double-Diffused Silicon Planar Epitaxial Transistors. They are designed for low-noise, high-frequency amplifiers; 1 GHz local oscillators; non-neutralized IF amplifiers and non-saturating circuits with rise and fall times of less than 2.5 nanoseconds.

PHYSICAL DIMENSIONS

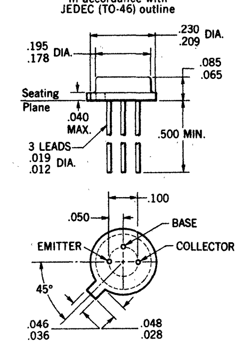
in accordance with JEDEC (TO-18) outline



NOTES: All dimensions in inches
Leads are gold-plated Kovar*
Lead No. 3 internally connected to case
Package weight is 0.44 gram

PHYSICAL DIMENSIONS

in accordance with JEDEC (TO-46) outline



NOTES: All dimensions in inches
Leads are gold-plated Kovar
Lead No. 3 internally connected to case
Package weight is 0.34 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, No Time Limit)	+300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.8 Watt
at 25°C Ambient Temperature	(Notes 2 and 3)	0.3 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	30 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	15 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts
I_C	Collector Current	50 mA

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	20	50			I_C = 3.0 mA	V_{CE} = 1.0 V
V_{BE}(sat)	Pulsed Base-Emitter Saturation Voltage (Note 6)			1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Pulsed Collector-Emitter Saturation Voltage (Note 6)			0.4	Volts	I_C = 10 mA	I_B = 1.0 mA
C_{obo}	Output Capacitance		2.4	2.8	pF	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance			2.0	pF	I_C = 0	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current			10	nA	I_E = 0	V_{CB} = 15 V
I_{CBO}(150°C)	Collector Cutoff Current			1.0	μA	I_E = 0	V_{CB} = 15 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	6.0	9.0			I_C = 4.0 mA	V_{CE} = 10 V
A_p	Available Power Gain (neutralized) (f = 200 MHz)	15	18		dB	I_C = 6.0 mA	V_{CE} = 12 V
P_o	Power Output (f = 500 MHz)	30	45		mW	I_C = 8.0 mA	V_{CE} = 15 V
	Collector Efficiency (f = 500 MHz)	25			%	I_C = 8.0 mA	V_{CE} = 15 V
NF	Noise Figure (Note 5)			6.0	dB	I_C = 1.0 mA	V_{CE} = 6.0 V
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4)	15			Volts	I_C = 3.0 mA	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	30			Volts	I_C = 1.0 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0			Volts	I_C = 0	I_E = 10 μA

* 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 219°C/Watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

(5) f = 60 MHz, R_G = 400Ω.

(6) Pulse Conditions: length = 300μs; duty cycle ≤ 1%

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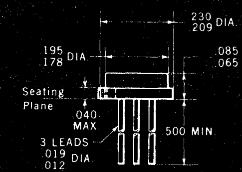
2N2695 • 2N2696 • 2N2927

PNP VHF AMPLIFIERS, HIGH CURRENT SWITCHES

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

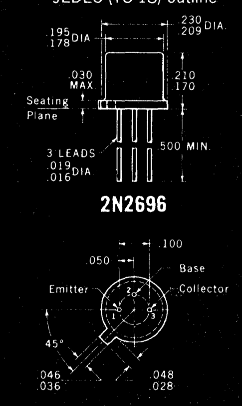
The 2N2695, 2N2696, and 2N2927 are PNP silicon PLANAR epitaxial transistors designed for digital and analog applications at current levels to 500 milliamperes. The high gain-bandwidth product, f_T, at high currents, makes them excellent units for line driving and memory applications.

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



2N2695

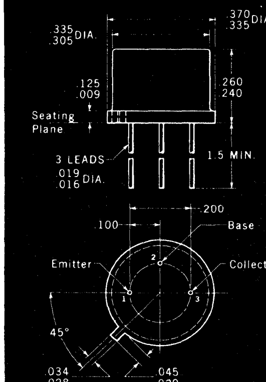
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



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

2N2695 2N2696

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.10 grams

2N2927

ABSOLUTE MAXIMUM RATINGS [Note 1]

		2N2695	2N2696	2N2927
Maximum Temperatures				
	Storage Temperature	−65°C to +200°C	−65°C to +200°C	−65°C to +200°C
	Operating Junction Temperature	200°C Maximum	200°C Maximum	200°C Maximum
	Lead Temperature (Soldering, 60 sec Time Limit)	300°C Maximum	300°C Maximum	300°C Maximum
Maximum Power Dissipation				
	Total Dissipation at 25°C Case Temperature [Note 2 and 3]	2.0 Watts	1.2 Watts	3.0 Watts
	at 100°C Case Temperature [Note 2 and 3]	1.0 Watt	0.68 Watt	1.7 Watts
	at 25°C Ambient Temperature [Note 2 & 3]	0.36 Watt	0.36 Watt	0.8 Watt
Maximum Voltages				
V_{CBO}	Collector to Base Voltage	−25 Volts	−25 Volts	−25 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	−25 Volts	−25 Volts	−25 Volts
V_{EBO}	Emitter to Base Voltage	−4.0 Volts	−4.0 Volts	−4.0 Volts
I_C	Collector Current [Note 2]	500 mA	500 mA	500 mA

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

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	30	130		$I_C = 50$ mA	$V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	20			$I_C = 300$ mA	$V_{CE} = -2.0$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	12			$I_C = 50$ mA	$V_{CE} = -1.0$ V
V_{BE} (sat)	Base Saturation Voltage		−1.1	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{BE} (sat)	Base Saturation Voltage		−2.0	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{CE} (sat)	Collector Saturation Voltage		−0.25	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{CE} (sat)	Collector Saturation Voltage		−1.0	Volts	$I_C = 300$ mA	$I_B = 30$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	1.0			$I_C = 50$ mA	$V_{CE} = -3.0$ V
C_{ob}	Output Capacitance		20	pf	$I_E = 0$	$V_{CB} = -10$ V
I_{CBO}	Collector Cutoff Current		25	nA	$I_E = 0$	$V_{CB} = -10$ V
I_{CBO} (150°C)	Collector Cutoff Current		5.0	μA	$I_E = 0$	$V_{CB} = -10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	−25		Volts	$I_C = 100\ \mu$A	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 4 & 5]	−25		Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.0		Volts	$I_C = 0$	$I_E = 100\ \mu$A
T_{on}	Turn On Time [Note 6]		75	nsec	$I_C \approx 300$ mA	$I_{B1} \approx 30$ mA
T_{off}	Turn Off Time [Note 6]		170	nsec	$I_C \approx 300$ mA $I_{B1} \approx 30$ mA	$I_{B2} \approx -30$ mA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor 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 87.5°C/watt (derating factor of 11.4 mW/°C) for the 2N2695; for the 2N2696 146°C/watt (derating factor of 6.9 mW/°C); for the 2N2927 58.3°C/watt (derating factor of 17.2 mW/°C). Junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.1 mW/°C) for the 2N2695 and 2N2696; for the 2N2927 219°C/watt (derating factor of 4.56 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Pub. APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

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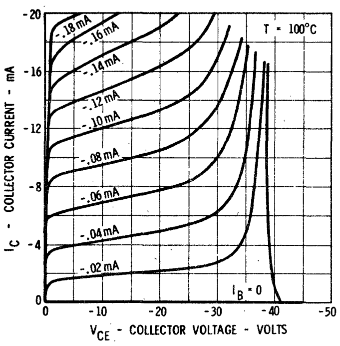
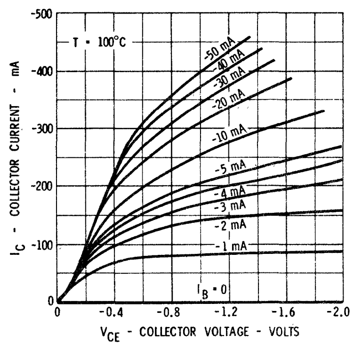
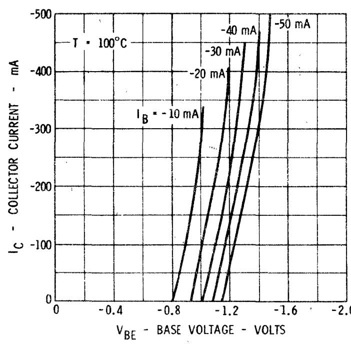
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

ACTIVE REGION

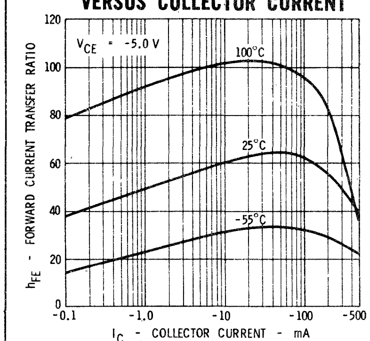


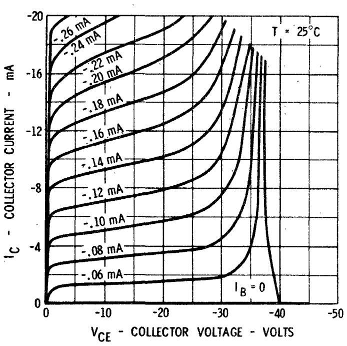
SATURATION REGION

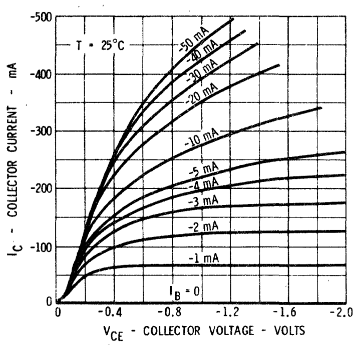


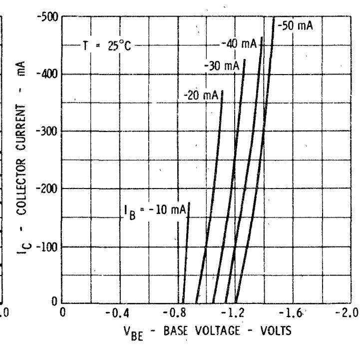


PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

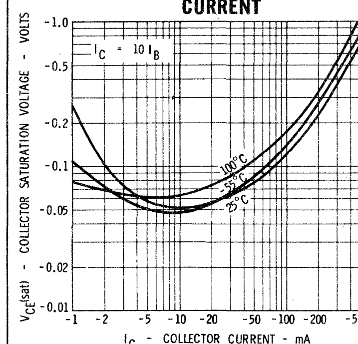


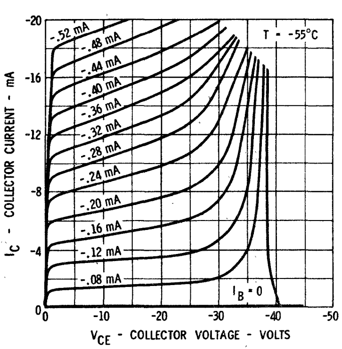


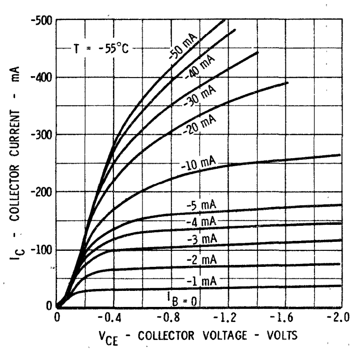


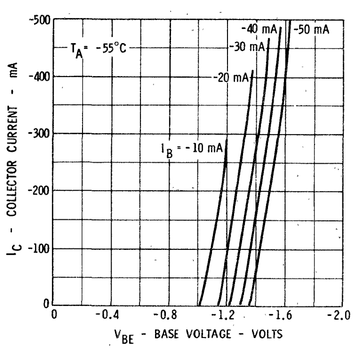


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

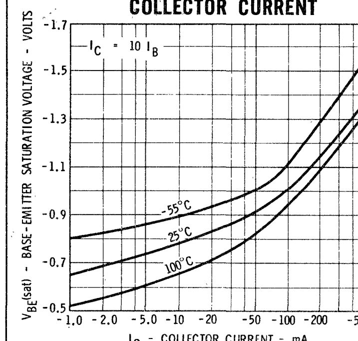






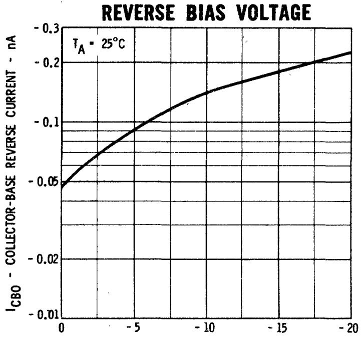


BASE-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

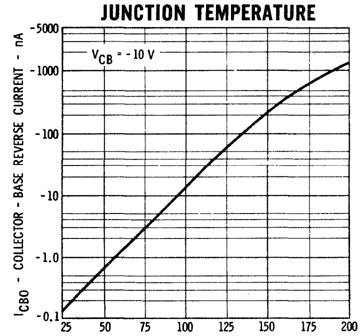


* Single family characteristics on Transistor Curve Tracer

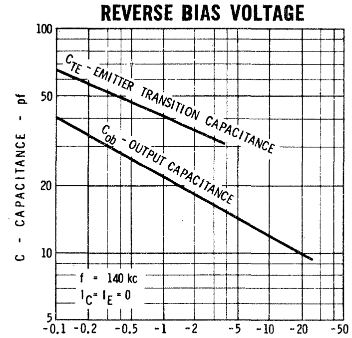
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



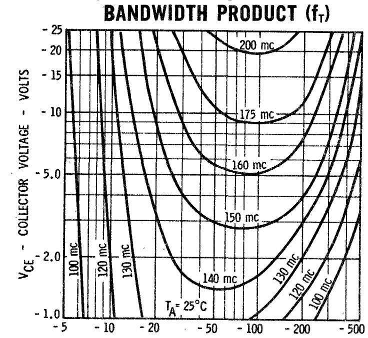
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS JUNCTION TEMPERATURE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

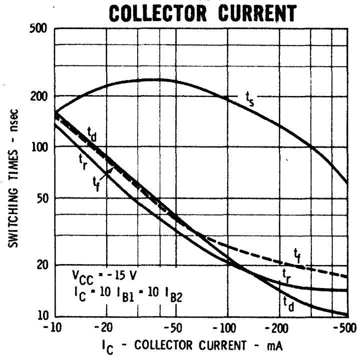


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

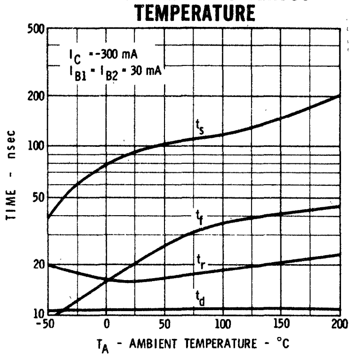


TYPICAL ELECTRICAL CHARACTERISTICS

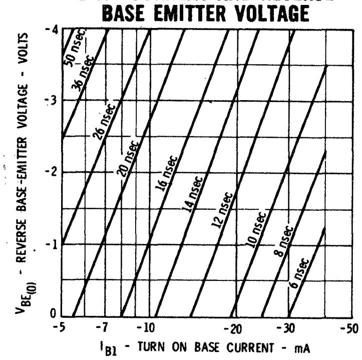
SWITCHING TIMES VERSUS COLLECTOR CURRENT



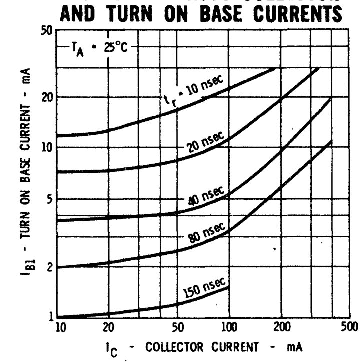
SWITCHING TIMES VERSUS TEMPERATURE



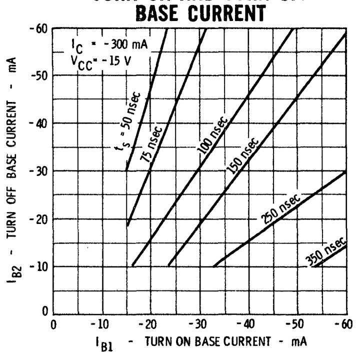
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



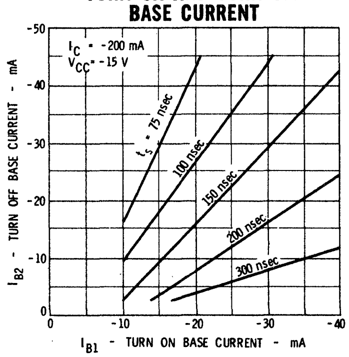
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



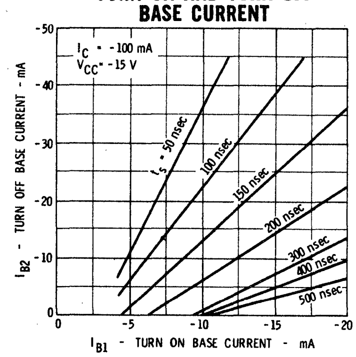
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



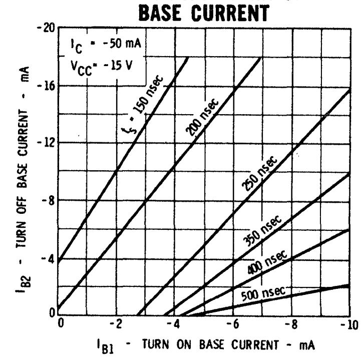
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



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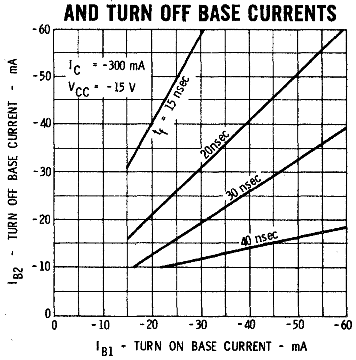
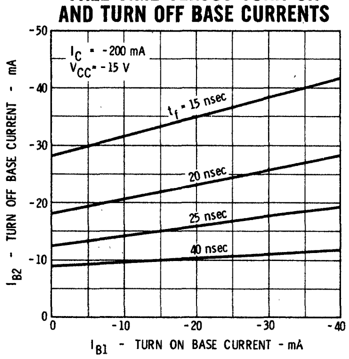
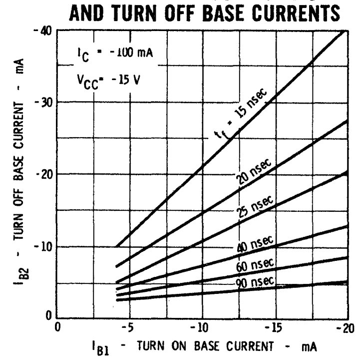


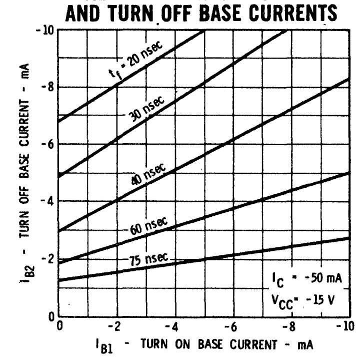
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



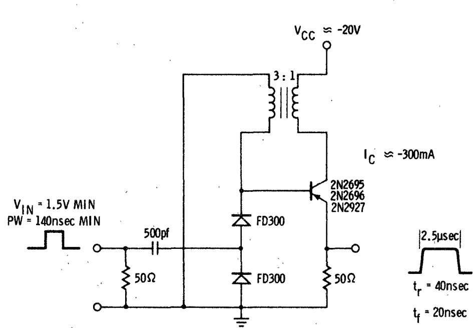
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



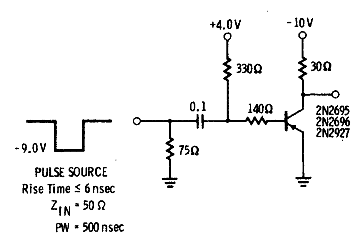
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



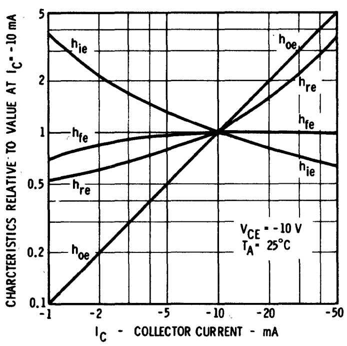
MONOSTABLE BLOCKING OSCILLATOR

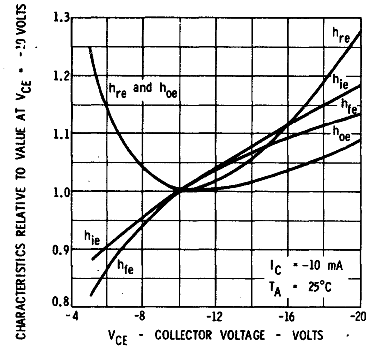


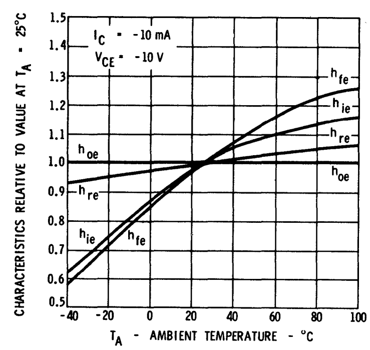
T_{on} and T_{off} TEST CIRCUIT



SMALL SIGNAL CHARACTERISTICS



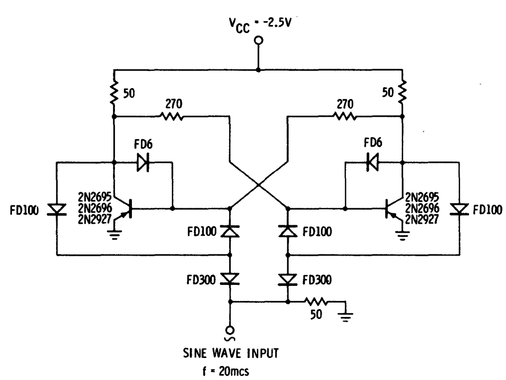




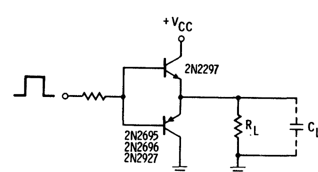
h PARAMETERS (f = 1kc)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{ie}	Input Resistance		480	1500	ohms	$I_C = 10$ mA $V_{CE} = -10$ V
h_{oe}	Output Conductance		80	1200	μmhos	$I_C = 10$ mA $V_{CE} = -10$ V
h_{re}	Voltage Feedback Ratio		162	2600	x10^{-6}	$I_C = 10$ mA $V_{CE} = -10$ V
h_{fe}	Small Signal Current Gain	25	74	180		$I_C = 10$ mA $V_{CE} = -10$ V

20mc BINARY COUNTER



LINE DRIVER



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FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

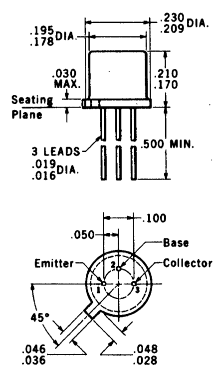
2N2845 • 2N2846 • 2N2847 • 2N2848

NPN HIGH-SPEED SATURATED SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION — The 2N2845, 2N2846, 2N2847, and 2N2848 are NPN double-diffused silicon PLANAR epitaxial transistors designed primarily for high-speed, 20–60 volt switching applications at collector currents up to 500 milliamperes. They are excellent drivers, featuring 20 nanosecond transition times for rod and magnetic memory, clock drivers for magnetic logic circuits, and general purpose circuitry. These devices are also useful as high frequency DC to DC converters.

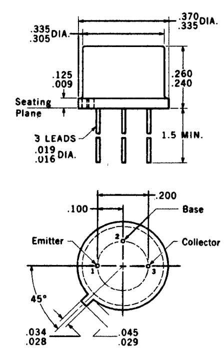
PHYSICAL DIMENSIONS in accordance with JEDEC (TO-18) outline



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

2N2845 • 2N2847

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

2N2846 • 2N2848

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

Maximum Power Dissipation	2N2845 2N2847	2N2846 2N2848
Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	1.2 Watts	3.0 Watts
at 100°C Case Temperature [Notes 2 and 3]	0.68 Watt	1.7 Watts
at 25°C Ambient Temperature [Notes 2 and 3]	0.36 Watt	0.8 Watt

Maximum Voltages		2N2845 2N2846	2N2847 2N2848
V_{CBO}	Collector to Base Voltage	60 Volts	60 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	30 Volts	20 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts	5.0 Volts

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

SYMBOL	CHARACTERISTIC	2N2845 2N2846 Min.	Typ.	Max.	2N2847 2N2848 Min.	Typ.	Max.	Units	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain [Note 5]	30	60	120	40	60	140		$I_C = 150$ mA $V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain [Note 5]	20	50		30	50			$I_C = 500$ mA $V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain [Note 5]	10			10				$I_C = 500$ mA $V_{CE} = 1.0$ V
V_{CE} (sat)	Collector Saturation Voltage [pulsed, Note 5]		0.22	0.4		0.18	0.4	Volts	$I_C = 150$ mA $I_B = 15$ mA
V_{BE} (sat)	Base Saturation Voltage [pulsed, Note 5]		0.85	1.2		0.85	1.2	Volts	$I_C = 150$ mA $I_B = 15$ mA
V_{CE} (sat)	Collector Saturation Voltage [pulsed, Note 5]		0.48	1.0		0.4	0.75	Volts	$I_C = 500$ mA $I_B = 50$ mA
V_{BE} (sat)	Base Saturation Voltage [pulsed, Note 5]		1.1	1.6		1.1	1.6	Volts	$I_C = 500$ mA $I_B = 50$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5	3.5		2.5	3.5			$I_C = 50$ mA $V_{CE} = 10$ V
I_{CES}	Collector Reverse Current		0.04	0.2		0.04	0.2	μA	$V_{EB} = 0$ $V_{CE} = 30$ V
I_{CBO} (150°C)	Collector Cutoff Current		20	200		20	200	μA	$I_E = 0$ $V_{CB} = 30$ V
C_{obo}	Output Capacitance		6.0	8.0		6.0	8.0	pF	$I_C = 0$ $V_{CB} = 10$ V
T_{on}	Turn On Time [Note 6]		18	40		14	25	ns	$I_C \approx 150$ mA $I_{B1} \approx 15$ mA
T_{off}	Turn Off Time [Note 6]		25	40		20	40	ns	$I_C \approx 150$ mA, $I_{B1} \approx 15$ mA, $I_{B2} \approx -15$ mA
BV_{CBO}	Collector to Base Breakdown Voltage	60			60			Volts	$I_C = 0.1$ mA $I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	30			20			Volts	$I_C = 30$ mA $I_B = 0$ (pulsed)
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			5.0			Volts	$I_E = 0.1$ mA $I_C = 0$

* 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 for the 2N2845 and 2N2847 (derating factor of 6.9 mW/°C); for the 2N2846 and 2N2848, 58.3°C/watt (derating factor of 17.2 mW/°C). Junction-to-ambient thermal resistance of 486°C/watt (derating factor of 2.1 mW/°C) for the 2N2845 and 2N2847; for the 2N2846 and 2N2848, 219°C/watt (derating factor of 4.6 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs ; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

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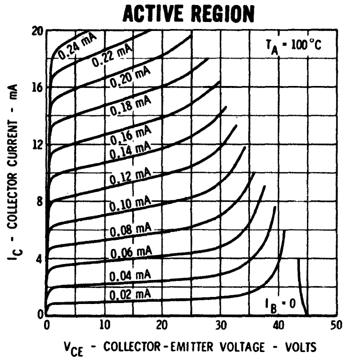
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

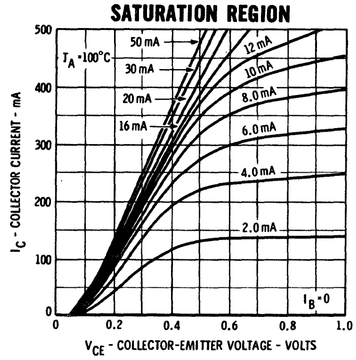
TYPICAL ELECTRICAL CHARACTERISTICS

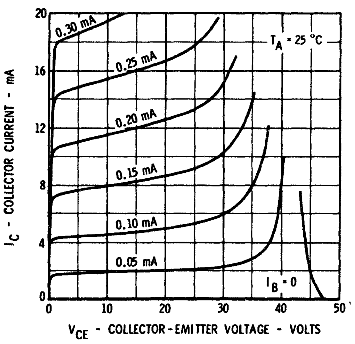
COLLECTOR CHARACTERISTICS*

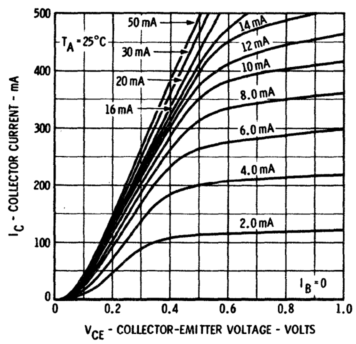
ACTIVE REGION

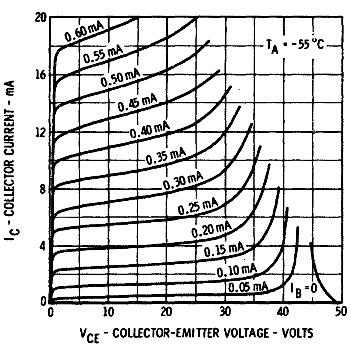


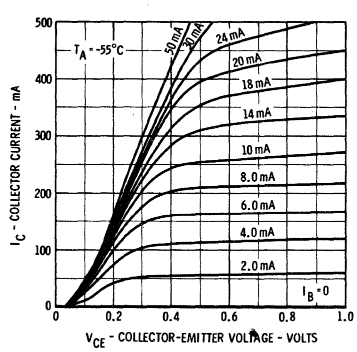
SATURATION REGION





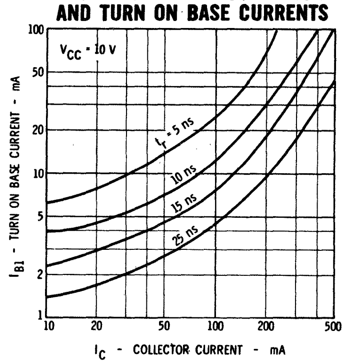




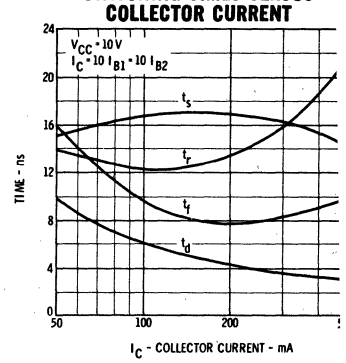


* Single family characteristics on Transistor Curve Tracer

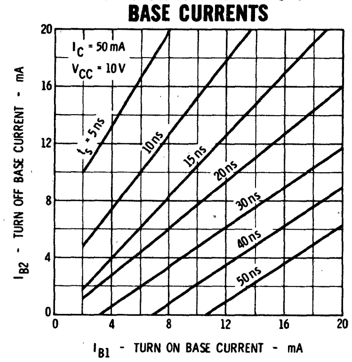
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



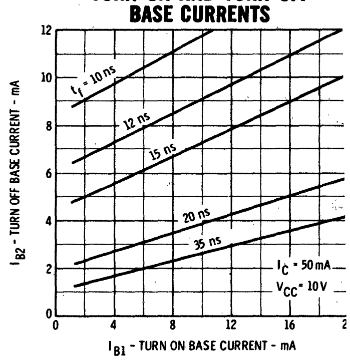
SWITCHING TIMES VERSUS COLLECTOR CURRENT



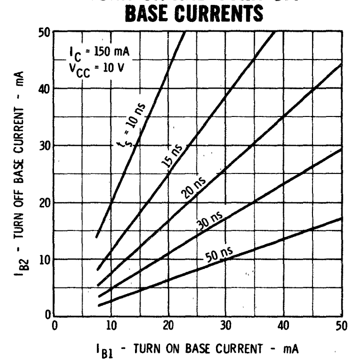
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



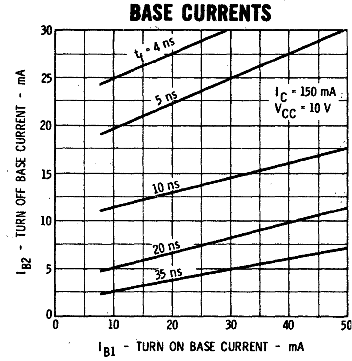
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



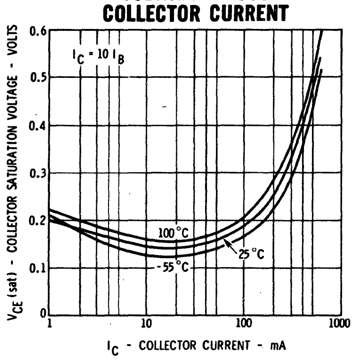
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



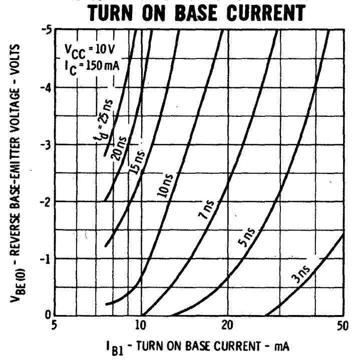
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



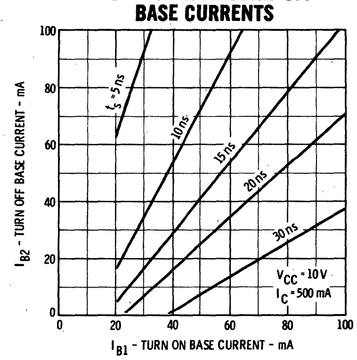
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



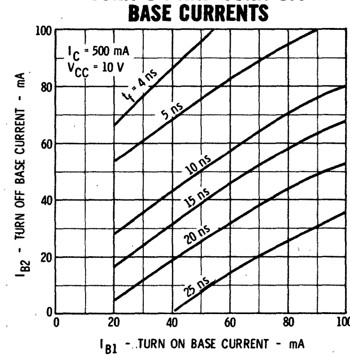
CONTOURS OF CONSTANT DELAY TIME VERSUS REVERSE BASE-EMITTER VOLTAGE AND TURN ON BASE CURRENT



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



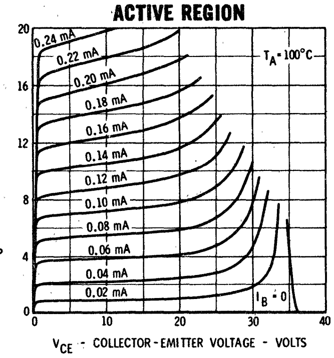
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



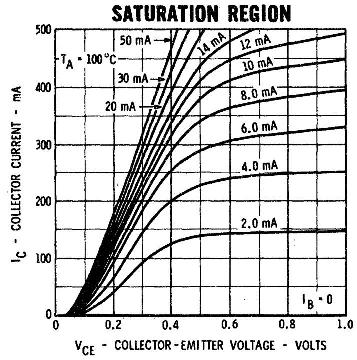
TYPICAL ELECTRICAL CHACTERISTICS

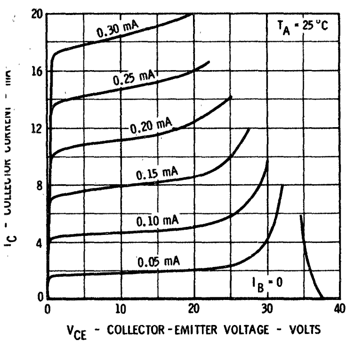
COLLECTOR CHARACTERISTICS*

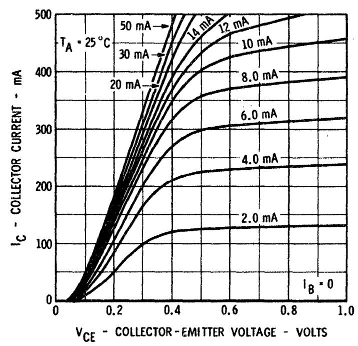
ACTIVE REGION

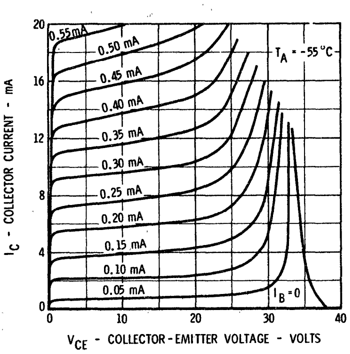


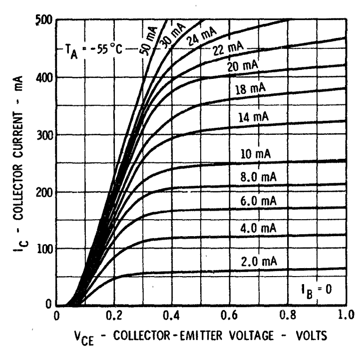
SATURATION REGION





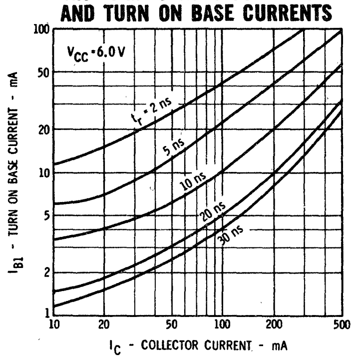




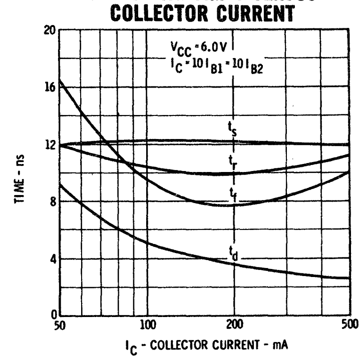


* Single family characteristics on Transistor Curve Tracer

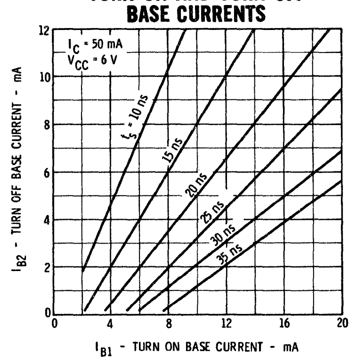
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



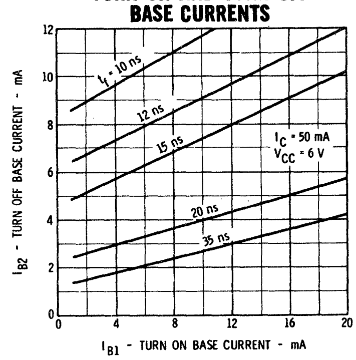
SWITCHING TIMES VERSUS COLLECTOR CURRENT



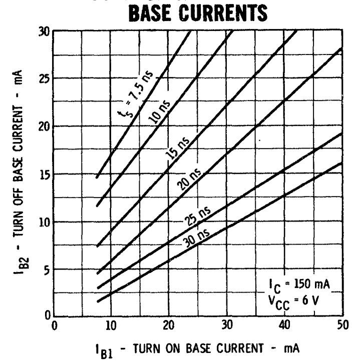
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



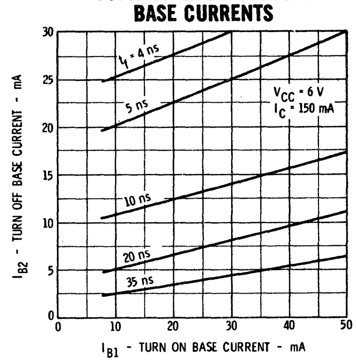
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



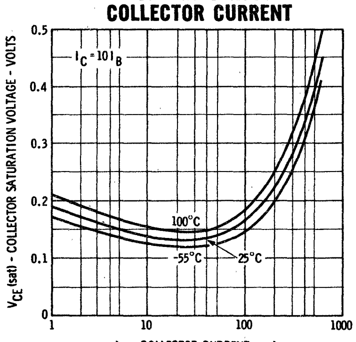
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



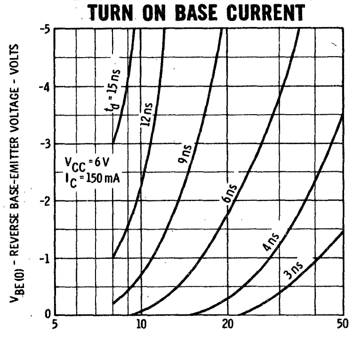
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



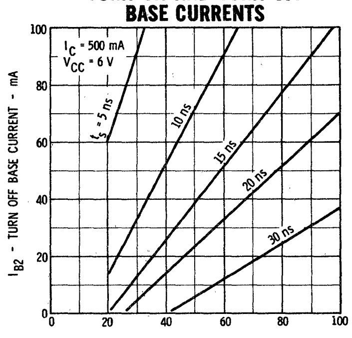
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



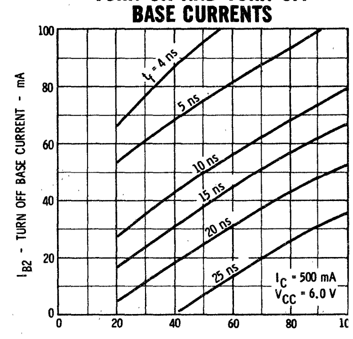
CONTOURS OF CONSTANT DELAY TIME VERSUS REVERSE BASE-EMITTER VOLTAGE AND TURN ON BASE CURRENT



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

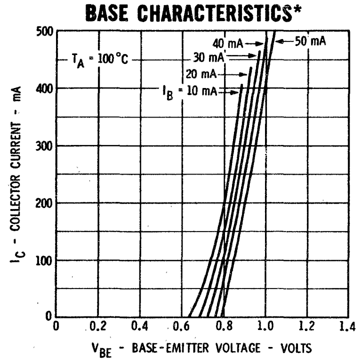


FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

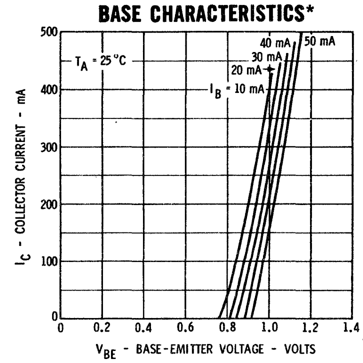


TYPICAL ELECTRICAL CHARACTERISTICS

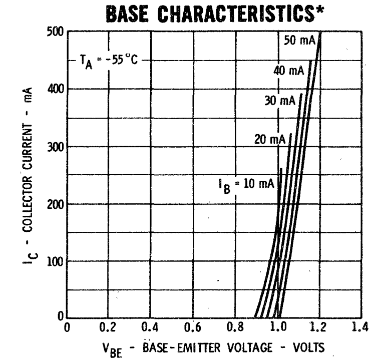
BASE CHARACTERISTICS*



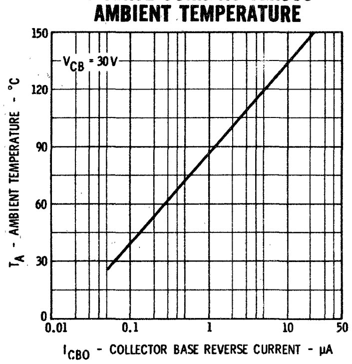
BASE CHARACTERISTICS*



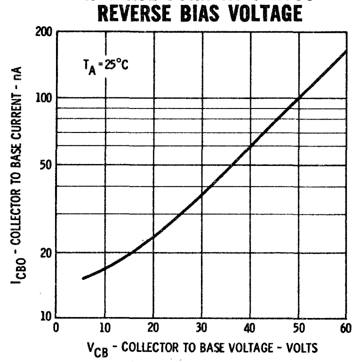
BASE CHARACTERISTICS*



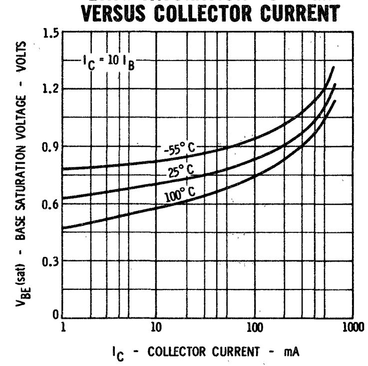
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



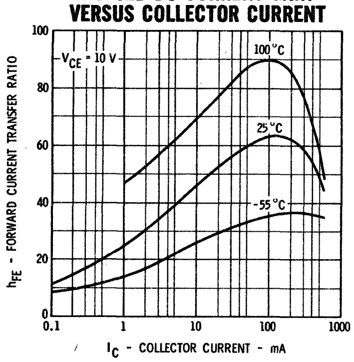
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



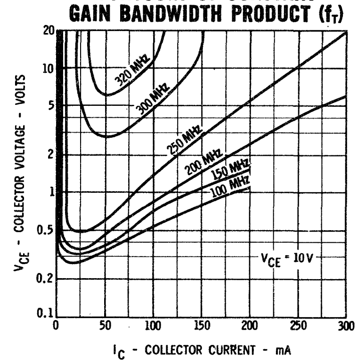
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



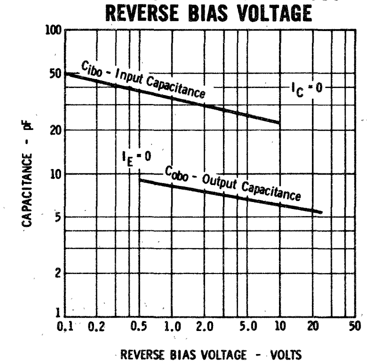
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

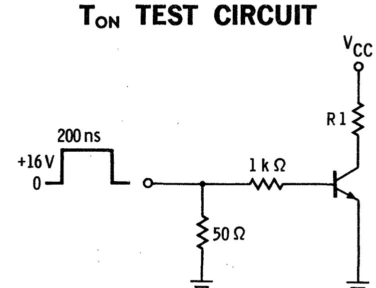


INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



* Single family characteristics on Transistor Curve Tracer

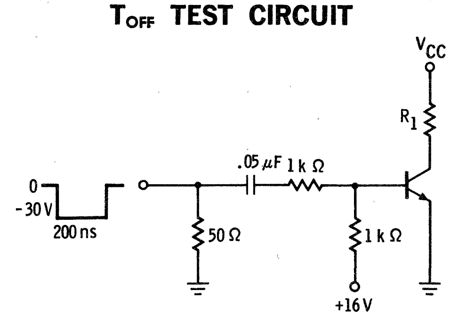
T_{ON} TEST CIRCUIT



Rise time of input pulse < 2.0 ns

2N2845 2N2846	2N2847 2N2848
$V_{CC} = +10V$ $R_l = 62\Omega$	$V_{CC} = +6.0V$ $R_l = 39\Omega$

T_{OFF} TEST CIRCUIT



Rise time of input pulse < 2.0 ns

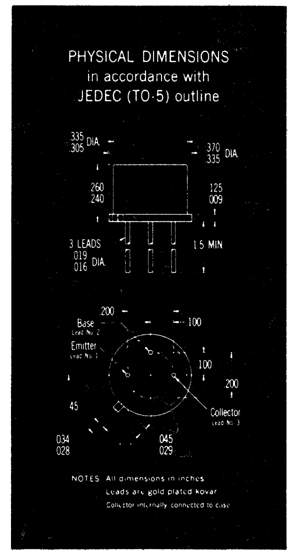
2N2845 2N2846	2N2847 2N2848
$V_{CC} = +10V$ $R_l = 62\Omega$	$V_{CC} = +6.0V$ $R_l = 39\Omega$

2N2868

NPN HIGH-SPEED, HIGH-CURRENT SWITCH

SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3108, 2N3110



GENERAL DESCRIPTION - The Fairchild 2N2868 is an NPN silicon PLANAR epitaxial transistor designed for use in high-speed, high current switching applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures			
Storage Temperature			-65°C to +300°C
Operating Junction Temperature			200°C Maximum
Lead Temperature (Soldering, no time limit)			250°C Maximum
Maximum Power Dissipation			
Total Dissipation at 25°C Case Temperature		(Notes 2 and 3)	2.8 Watts
at 100°C Case Temperature		(Notes 2 and 3)	1.6 Watts
at 25°C Ambient Temperature		(Notes 2 and 3)	0.8 Watt
Maximum Voltages and Current			
V_{CBO}	Collector to Base Voltage		60 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	40 Volts
V_{EBO}	Emitter to Base Voltage		7.0 Volts
I_C	Collector Current		1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic		Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 5)	40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	30			I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	DC Current Gain		30			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	20			I_C = 500 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Current Gain		20			I_C = 10 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage			0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage			1.3	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 mc)		2.5			I_C = 50 mA	V_{CE} = 10 V
I_{CBO}	Collector Cutoff Current			10	nA	V_{CB} = 30 V	I_E = 0
I_{CBO}(150°C)	Collector Cutoff Current			15	μA	V_{CB} = 30 V	I_E = 0
I_{EBO}	Emitter Cutoff Current			50	nA	V_{EB} = 5.0 V	I_C = 0
I_{CEX}	Collector Cutoff Current			100	nA	V_{CE} = 30 V	V_{EB} = 3.0 V
I_{EBX}	Emitter Cutoff Current			100	nA	V_{CE} = 30 V	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage		60		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage	(Notes 4 and 5)	40		Volts	I_C = 25 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		7.0		Volts	I_E = 100 μA	I_C = 0
C_{ob}	Output Capacitance (f = 1.0 mc)			20	pf	V_{CB} = 10 V	I_E = 0
τ_b	Base Stored Charge			2.0	μsec	See Figure I	

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 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 62.5°C/Watt (derating factor of 16 mW/°C); junction-to-ambient thermal resistance of 218°C/Watt (derating factor of 4.6 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

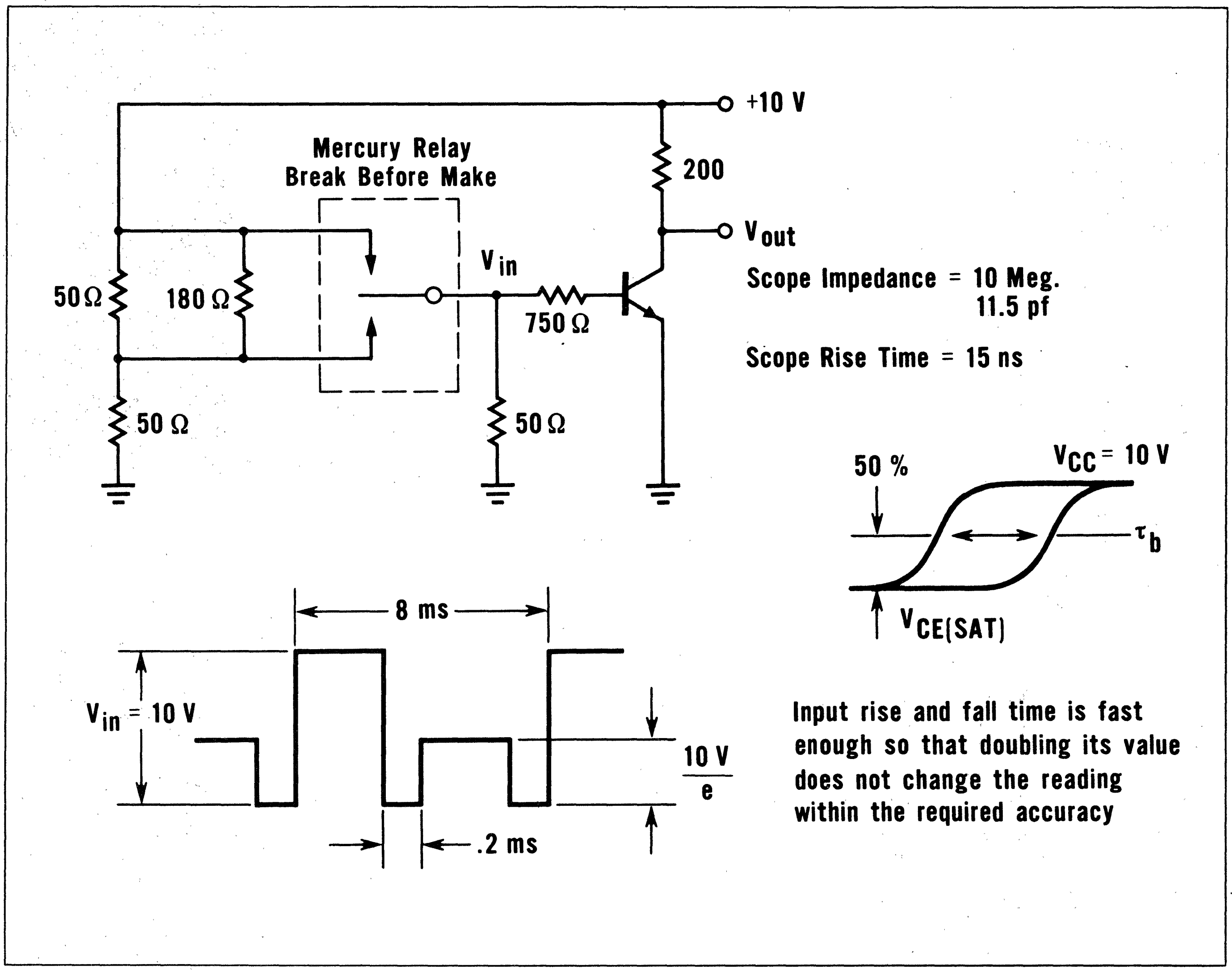


FIGURE 1

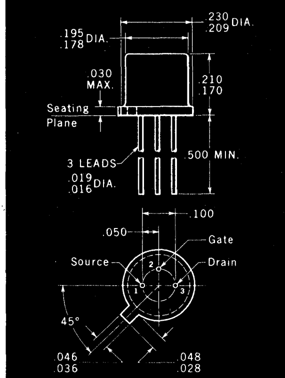
2N2894

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

The **2N2894** is a 600 MHz PNP silicon PLANAR* epitaxial transistor designed for saturated and non-saturated switching circuits requiring up to 200 milliamperes of collector current. It is suitable for 20 MHz RF amplifiers, 10.7 MHz IF amplifiers, and 100 MHz oscillator converter circuits.

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 Junction 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]	0.72 Watt
at 25°C Ambient Temperature [Notes 2 and 3]	0.36 Watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	−12 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	−12 Volts
V_{EBO} Emitter to Base Voltage	−4.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain [Note 5]	40	75	150		$I_C = 30$ mA $V_{CE} = -0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	30	55			$I_C = 10$ mA $V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	25				$I_C = 100$ mA $V_{CE} = -1.0$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	17	43			$I_C = 30$ mA $V_{CE} = -0.5$
V_{CE} (sat)	Collector-Emitter Saturation Voltage		−0.07	−0.15	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
V_{CE} (sat)	Collector-Emitter Saturation Voltage		−0.1	−0.2	Volts	$I_C = 30$ mA $I_B = 3.0$ mA
V_{CE} (sat)	Collector-Emitter Saturation Voltage		−0.25	−0.5	Volts	$I_C = 100$ mA $I_B = 10$ mA
V_{BE} (sat)	Base-Emitter Saturation Voltage	−0.78	−0.92	−0.98	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
V_{BE} (sat)	Base-Emitter Saturation Voltage	−0.85	−1.1	−1.2	Volts	$I_C = 30$ mA $I_B = 3.0$ mA
V_{BE} (sat)	Base-Emitter Saturation Voltage		−1.4	−1.7	Volts	$I_C = 100$ mA $I_B = 10$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	4.0	5.5			$I_C = 30$ mA $V_{CE} = -10$ V
C_{ob}	Output Capacitance		3.3	6.0	pf	$V_{CB} = -5.0$ V $I_E = 0$
C_{TE}	Emitter Transition Capacitance		3.8	6.0	pf	$V_{EB} = -0.5$ V $I_C = 0$
I_{CES}	Collector Reverse Current		0.05	80	nA	$V_{CE} = -6.0$ V $V_{EB} = 0$
I_{CBO} (125°C)	Collector Cutoff Current		0.025	10	μA	$V_{CB} = -6.0$ V $I_E = 0$
V_{CEO} (sust)	Collector-Emitter Sustaining Voltage [Notes 4 and 5]	−12			Volts	$I_C = 10$ mA $I_B = 0$ (pulsed)
BV_{CBO}	Collector-Base Breakdown Voltage	−12			Volts	$I_C = 10$ μA $I_E = 0$
BV_{EBO}	Emitter-Base Breakdown Voltage	−4.0			Volts	$I_E = 100$ μA $I_C = 0$
T_{ON}	Turn On Time [Note 6]		23	60	nsec	$I_C \approx 30$ mA $I_{B1} \approx 1.5$ mA
T_{OFF}	Turn Off Time [Note 6]		34	90	nsec	$I_C \approx 30$ mA, $I_{B1} \approx 1.5$ mA, $I_{B2} \approx -1.5$ 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 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. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

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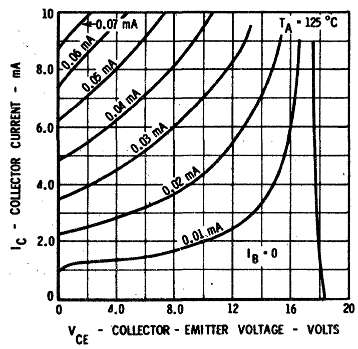
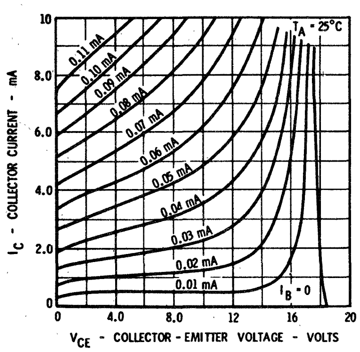
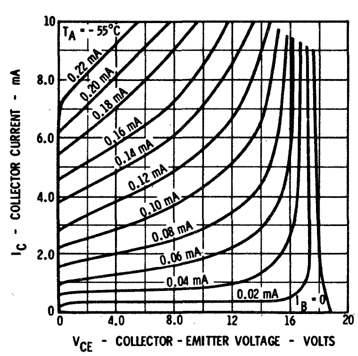
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

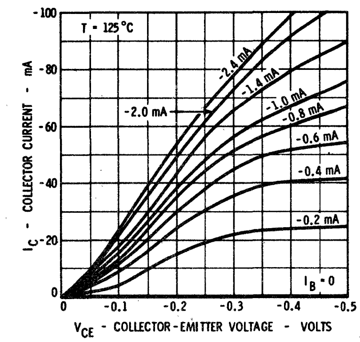
ACTIVE REGION

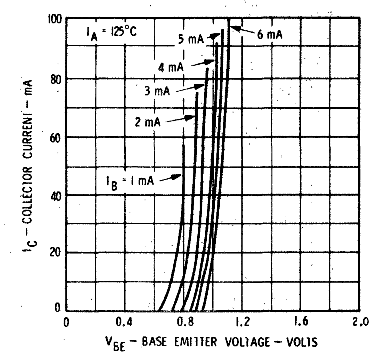


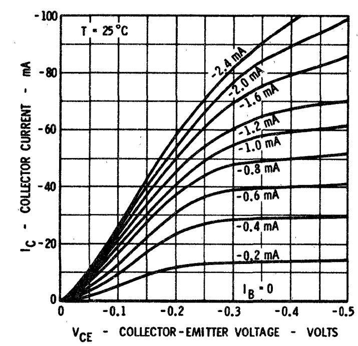


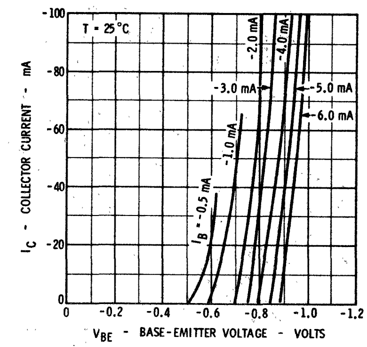


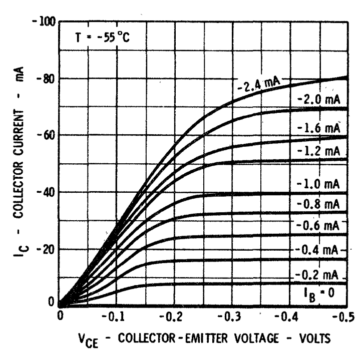
SATURATION REGION

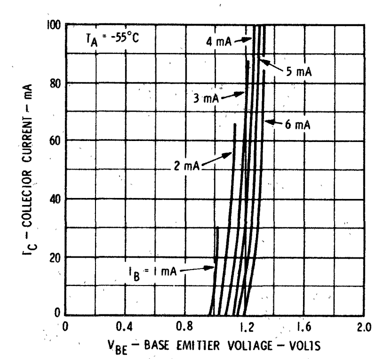








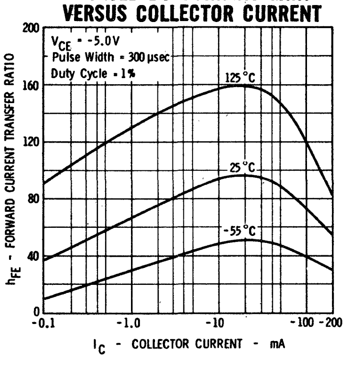




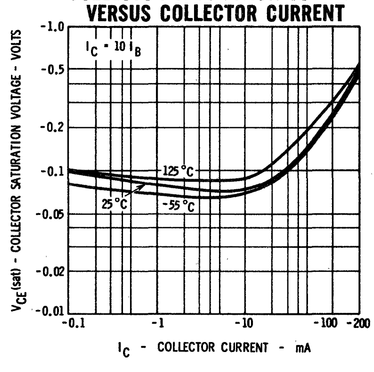
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

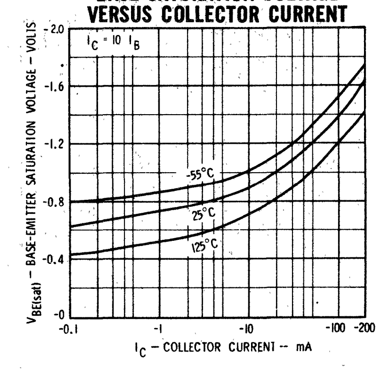
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

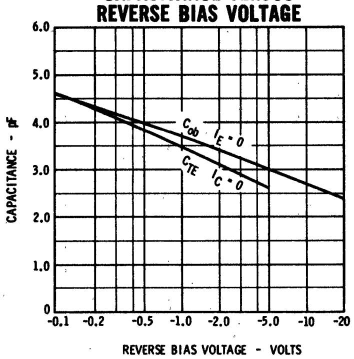


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

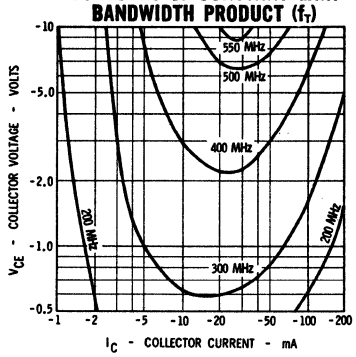


TYPICAL ELECTRICAL CHARACTERISTICS

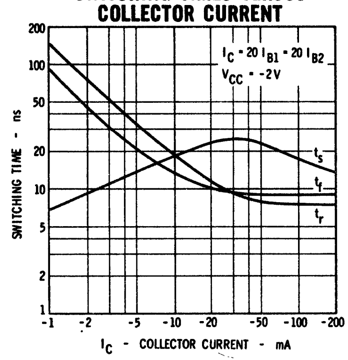
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



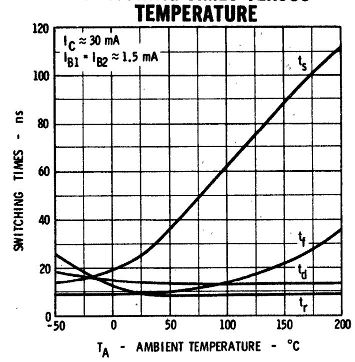
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



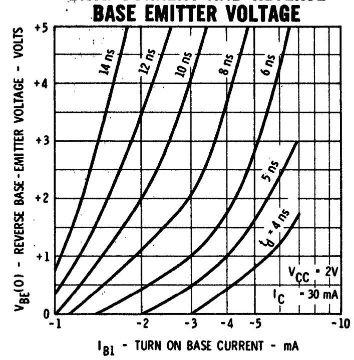
SWITCHING TIMES VERSUS COLLECTOR CURRENT



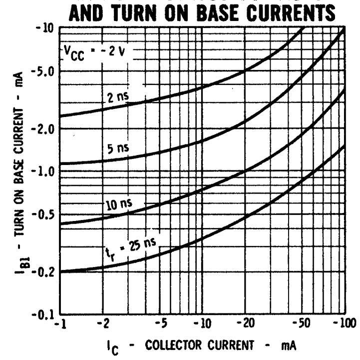
SWITCHING TIMES VERSUS TEMPERATURE



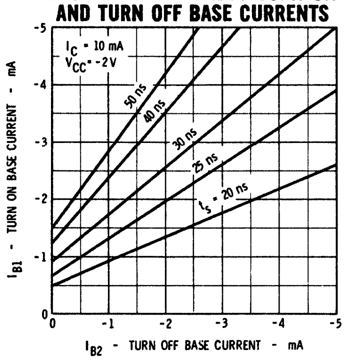
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



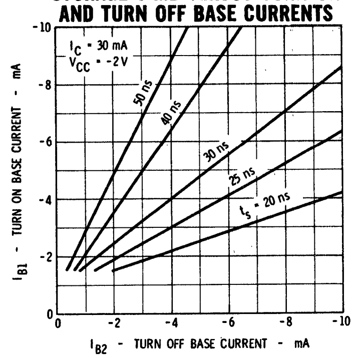
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



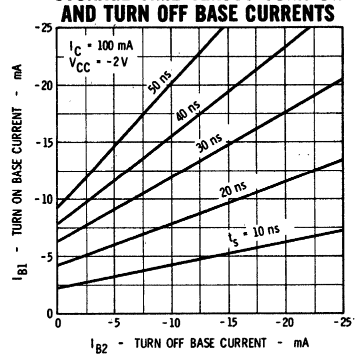
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



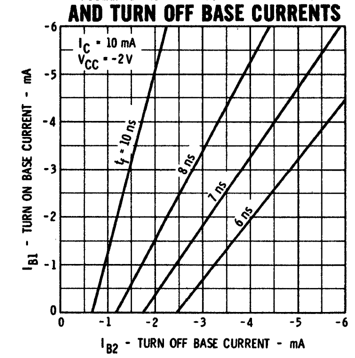
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



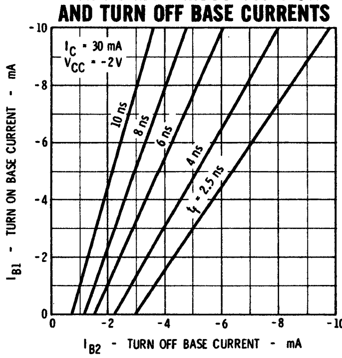
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



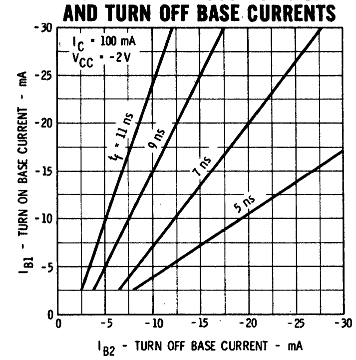
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



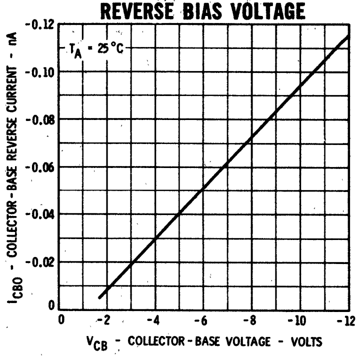
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



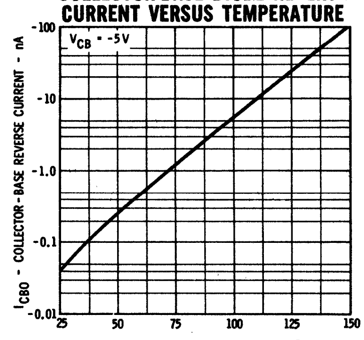
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



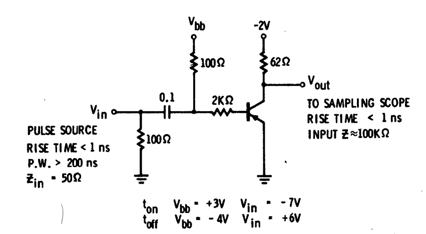
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE

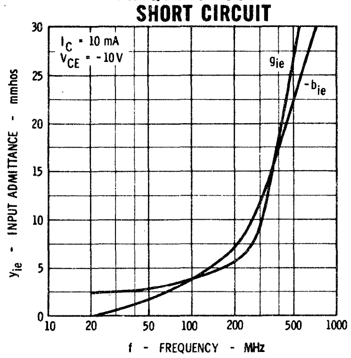


SWITCHING TIME TEST CIRCUIT

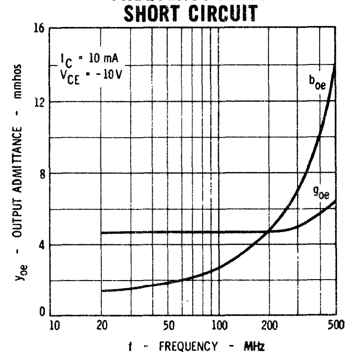


TYPICAL COMMON EMITTER "Y" PARAMETERS

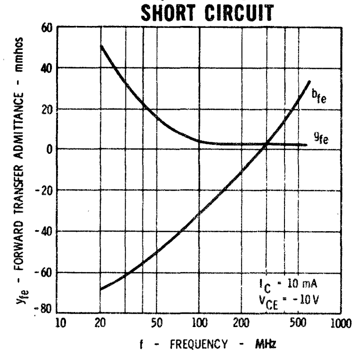
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



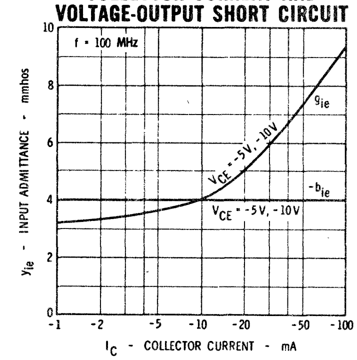
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



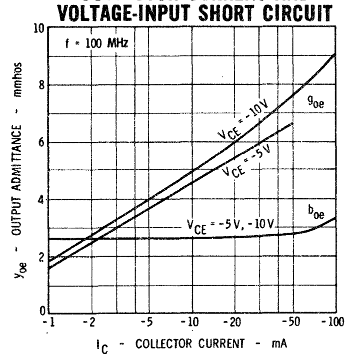
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



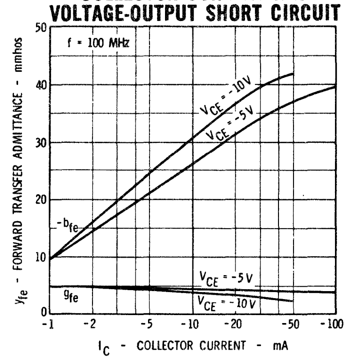
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



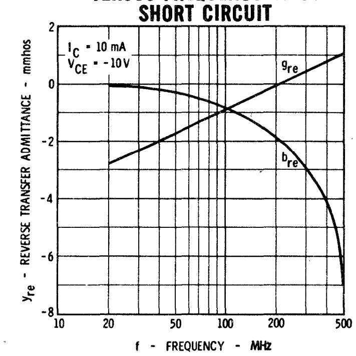
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



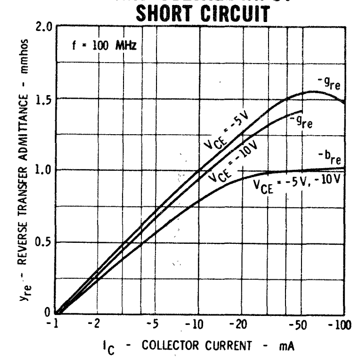
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



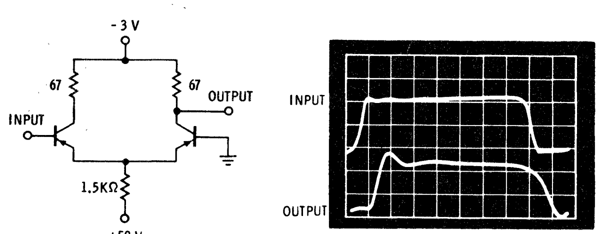
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT

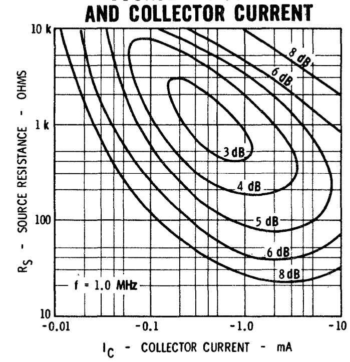


NON SATURATED SWITCHING PERFORMANCE

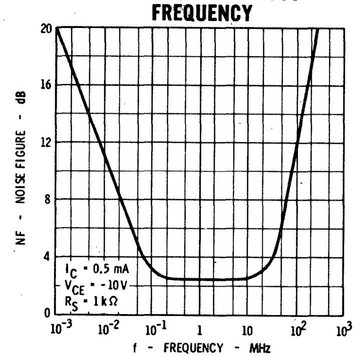


SCALE = 2 ns/cm

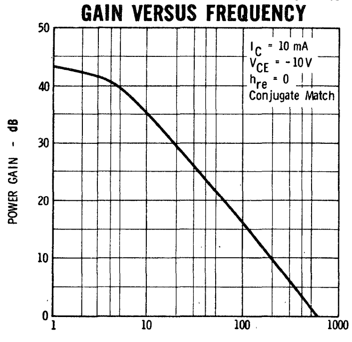
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



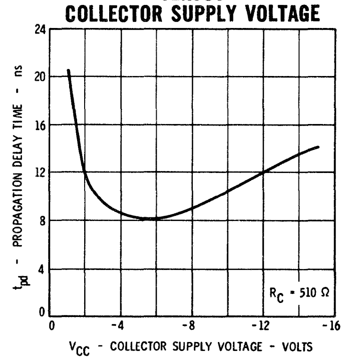
NOISE FIGURE VERSUS FREQUENCY



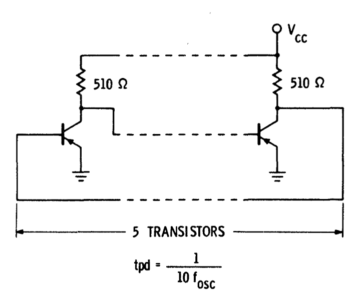
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



$$tpd = \frac{1}{10 f_{osc}}$$

Fairchild cannot assume responsibility for use of any circuitry described. No circuit patent licenses are implied.

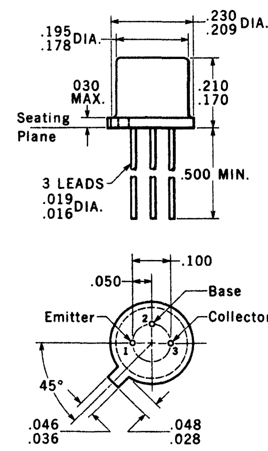
2N2894A

PNP HIGH SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTOR

- **FAST SWITCHING** -- t_{on} = 20 ns **(MAX)**
  -- t_{off} = 25 ns **(MAX)**
  -- τ_s = 20 ns **(MAX)**
- **HIGH FREQUENCY** -- f_T = 800 **MHz (MIN)**
- **LOW CAPACITANCE** -- C_{obo} = 4.5 **pF (MAX)**
- **LOW SATURATION VOLTAGE** -- $V_{CE(SAT)}$ = 0.13 **V (MAX) @** I_C = 10 **mA**

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 0.44 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 second 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]	0.72 Watt
at 25°C Ambient Temperature [Notes 2 and 3]	0.36 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	−12 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	−12 Volts
V_{EBO}	Emitter to Base Voltage	−4.5 Volts

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
t_{on}	**Turn On Time** [Note 6, Figure 1]		**10**	**20**	**ns**	**$I_C \approx$ 30 mA**	**$I_{B1} \approx$ 3.0 mA**
t_{off}	**Turn Off Time** [Note 6, Figure 1]		**15**	**25**	**ns**	**$I_C \approx$ 30 mA**	**$I_{B1} \approx I_{B2} \approx$ 3.0 mA**
t_{on}	Turn On Time [Note 6, Figure 2]		23	60	ns	$I_C \approx$ 30 mA	$I_{B1} \approx$ 1.5 mA
t_{off}	Turn Off Time [Note 6, Figure 2]		13	35	ns	$I_C \approx$ 30 mA	$I_{B1} \approx I_{B2} \approx$ 1.5 mA
τ_s	**Charge Storage Time Constant** [Note 6, Figure 3]		**15**	**20**	**ns**	**$I_C \approx I_{B1} \approx I_{B2} \approx$ 10 mA**	
V_{CE} (sat)	**Pulsed Collector-Emitter Saturation Voltage** [Note 5]		**−0.08**	**−0.13**	**Volts**	**I_C = 10 mA**	**I_B = 1.0 mA**
V_{CE} (sat)	Pulsed Collector-Emitter Saturation Voltage [Note 5]		−0.12	−0.19	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Pulsed Collector-Emitter Saturation Voltage [Note 5]		−0.28	−0.45	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE} (sat)	Pulsed Base-Emitter Saturation Voltage [Note 5]	−0.78	−0.82	−0.92	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Pulsed Base-Emitter Saturation Voltage [Note 5]	−0.85	−0.93	−1.15	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE} (sat)	Pulsed Base-Emitter Saturation Voltage [Note 5]	−1.0	−1.14	−1.5	Volts	I_C = 100 mA	I_B = 10 mA
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**8.0**	**12**			**I_C = 30 mA**	**V_{CE} = −10 V**
C_{obo}	**Output Capacitance**		**3.3**	**4.5**	**pF**	**I_E = 0**	**V_{CB} = −5.0 V**
C_{ibo}	Input Capacitance		4.7	6.0	pF	I_C = 0	V_{EB} = −0.5 V
I_{CES}	Collector Reverse Current		0.29	50	nA	V_{BE} = 0	V_{CE} = −10 V

Additional Electrical Characteristics on page 2

* 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) 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.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

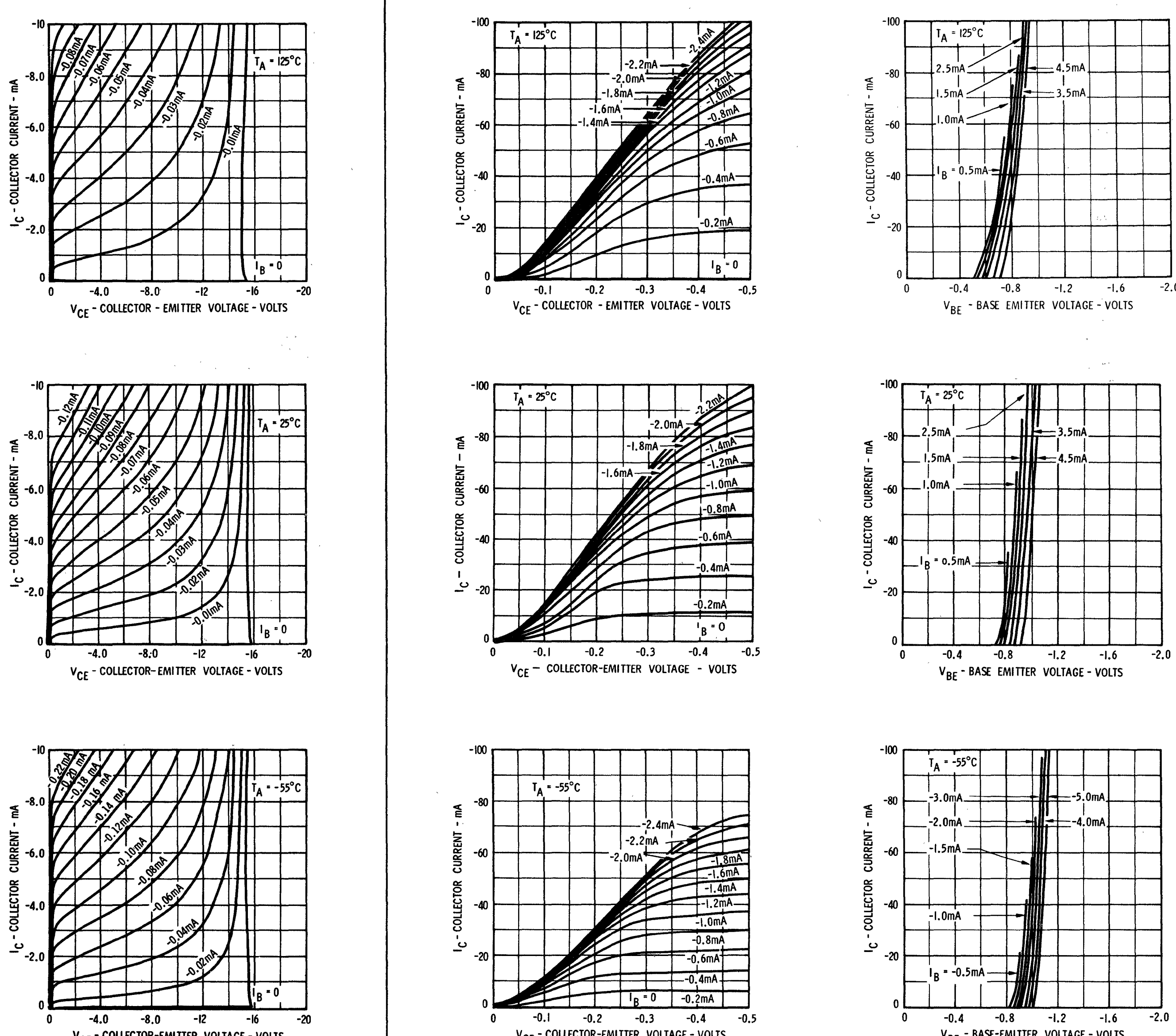
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
I_{CBO} (125°C)	Collector Cutoff Current		0.05	10	μA	$I_E = 0$	$V_{CB} = -10$ V
V_{CEO} (sust)	**Collector-Emitter Sustaining Voltage** [Notes 4 and 5]	**−12**			**Volts**	**$I_C = 10$ mA** (pulsed)	**$I_B = 0$**
BV_{CBO}	Collector-Base Breakdown Voltage	−12			Volts	$I_C = 10\ \mu$A	$I_E = 0$
BV_{CES}	Collector-Emitter Breakdown Voltage	−12			Volts	$I_C = 10\ \mu$A	$V_{BE} = 0$
BV_{EBO}	Emitter-Base Breakdown Voltage	−4.5			Volts	$I_C = 0$	$I_E = 100\ \mu$A
h_{FE}	DC Pulse Current Gain [Note 5]	20	44			$I_C = 1.0$ mA	$V_{CE} = -0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	30	53			$I_C = 10$ mA	$V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	40	63	120		$I_C = 30$ mA	$V_{CE} = -0.5$ V
h_{FE}	**DC Pulse Current Gain [Note 5]**	**30**	**55**			**$I_C = 100$ mA**	**$V_{CE} = -1.0$ V**
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	20	38			$I_C = 30$ mA	$V_{CE} = -0.5$ V

TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

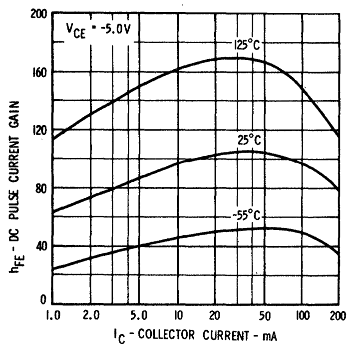
ACTIVE REGION | **SATURATION REGION**



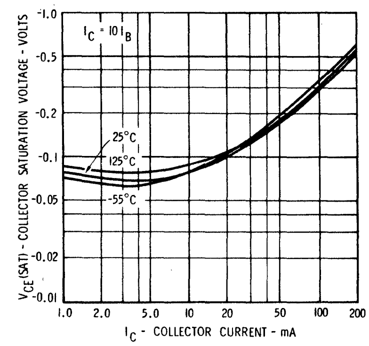
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

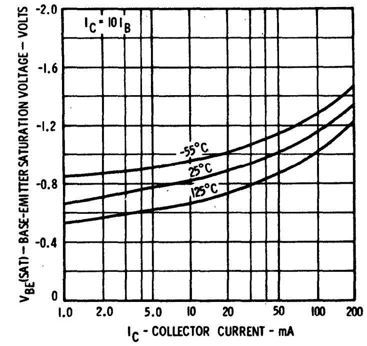
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



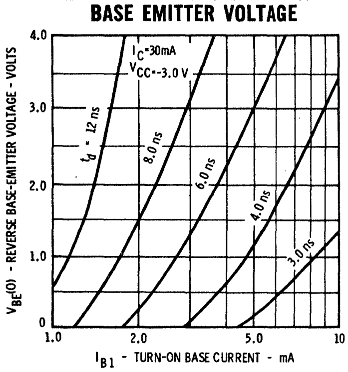
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



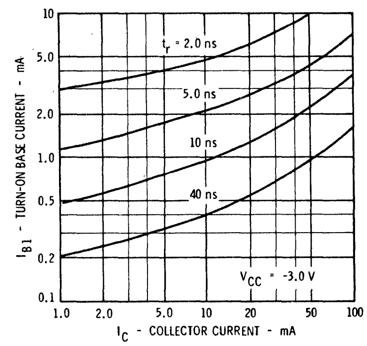
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



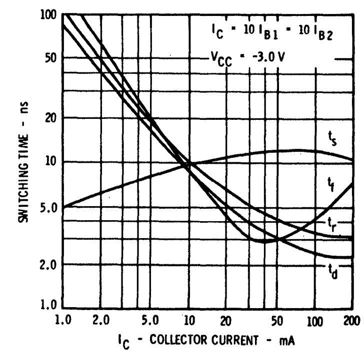
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



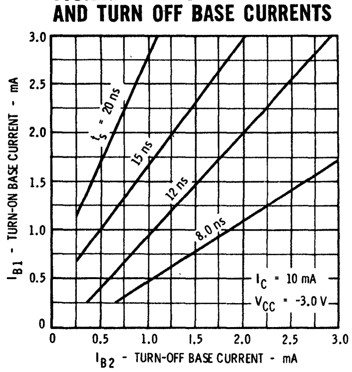
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



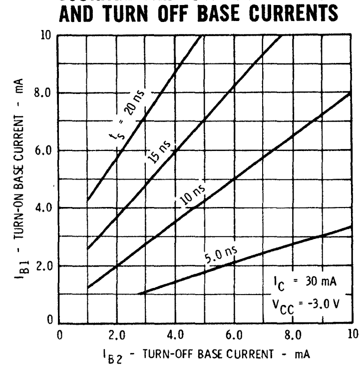
SWITCHING TIMES VERSUS COLLECTOR CURRENT



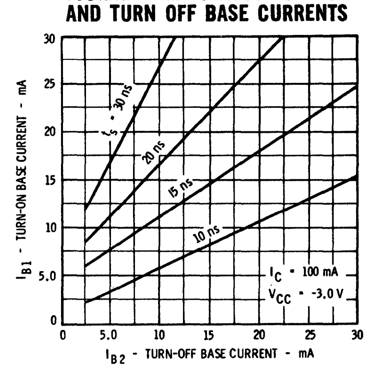
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



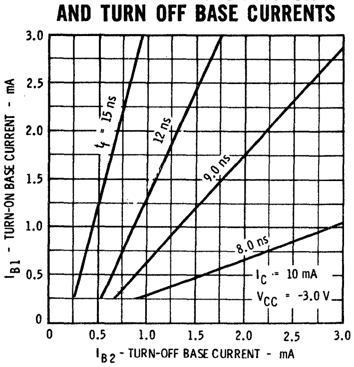
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



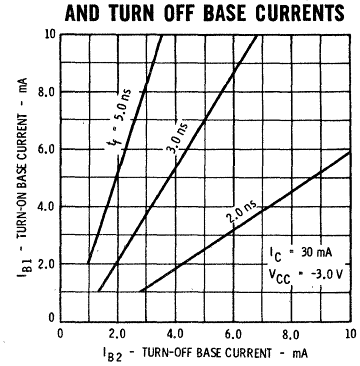
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



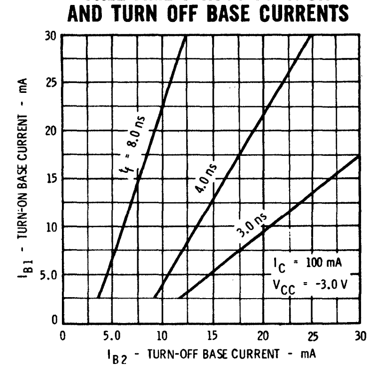
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

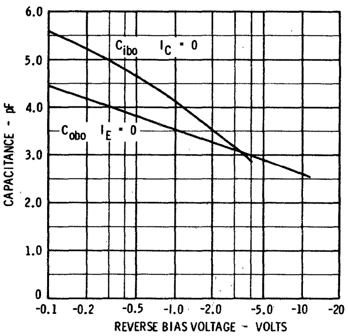


FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

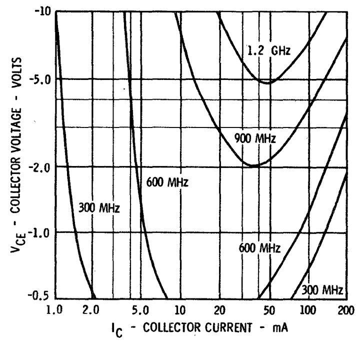


TYPICAL ELECTRICAL CHARACTERISTICS

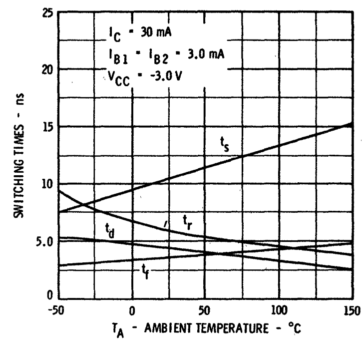
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



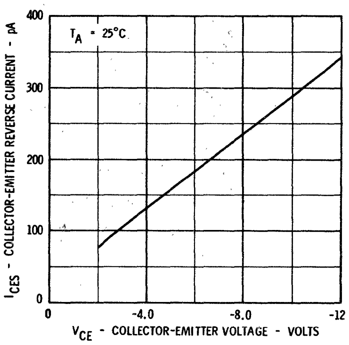
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



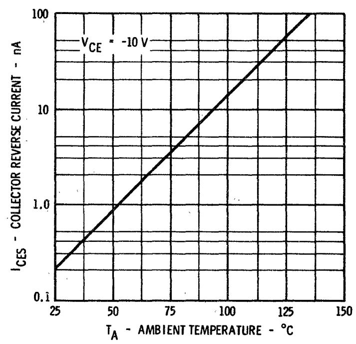
SWITCHING TIMES VERSUS TEMPERATURE



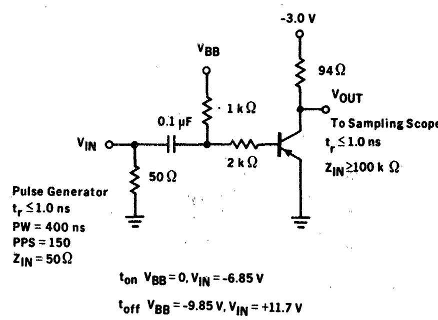
COLLECTOR-EMITTER REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



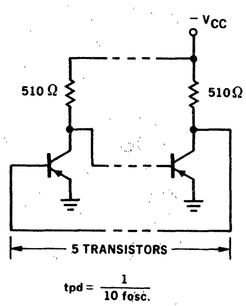
COLLECTOR REVERSE CURRENT VERSUS TEMPERATURE



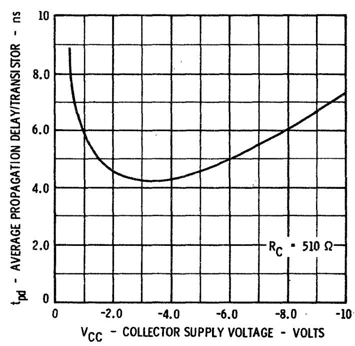
SWITCHING TIME TEST CIRCUIT FIGURE 1



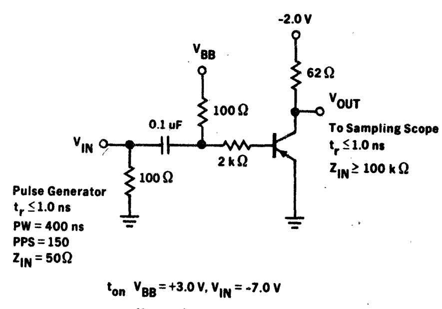
FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



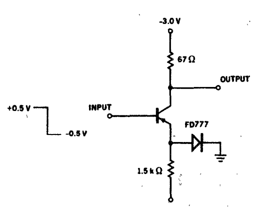
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



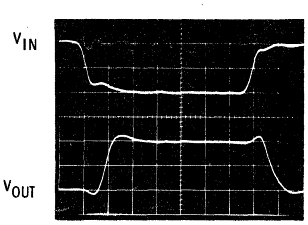
SWITCHING TIME TEST CIRCUIT FIGURE 2



NON SATURATED SWITCHING PERFORMANCE

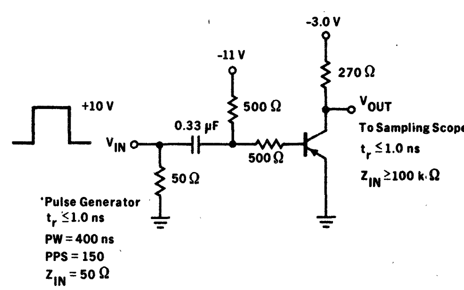


$t_{on} = 2$ ns (typ.)
$t_{off} = 2$ ns (typ.)



2ns/DIV.

STORAGE TIME TEST CIRCUIT FIGURE 3

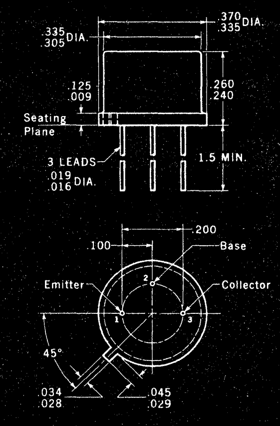


2N2904 • 2N2905 • 2N2906 • 2N2907
2N2904A • 2N2905A • 2N2906A • 2N2907A
PNP HIGH-SPEED SWITCHES AND CORE DRIVERS
SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - These PNP silicon PLANAR epitaxial transistors are designed primarily for high-speed saturated switching and core driver applications.

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3502 THROUGH 2N3505

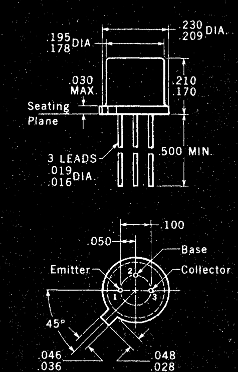
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-5) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.10 grams

2N2904 • 2N2904A
2N2905 • 2N2905A

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

2N2906 • 2N2906A
2N2907 • 2N2907A

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	200°C Maximum

Maximum Power Dissipation	2N2904 2N2904A 2N2905 2N2905A	2N2906 2N2906A 2N2907 2N2907A
Total Dissipation @ 25°C Case Temperature (Notes 2 and 3)	3.0 Watts	1.8 Watts
@25°C Free Air Temperature (Notes 2 and 3)	0.6 Watt	0.4 Watt

Maximum Voltages and Current		2N2904 2N2906 2N2905 2N2907	2N2904A 2N2906A 2N2905A 2N2907A
V_{CBO}	Collector to Base Voltage	-60 Volts	-60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	-40 Volts	-60 Volts
V_{EBO}	Emitter to Base Voltage	-5.0 Volts	-5.0 Volts
I_C	Collector Current (Note 2)	600 mA	600 mA

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

Symbol	Characteristic	2N2904 2N2906 Min.	Max.	2N2904A 2N2906A Min.	Max.	2N2905 2N2907 Min.	Max.	2N2905A 2N2907A Min.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	40	120	100	300	100	300		I_C = 150 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	35		40		75		100			I_C = 10 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	25		40		50		100			I_C = 1.0 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	20		40		35		75			I_C = 0.1 mA	V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20		40		30		50			I_C = 500 mA	V_{CE} = -10 V
$V_{CE}(sat)$	Collector Saturation Voltage (pulsed, see note 5)		-0.4		-0.4		-0.4		-0.4	Volts	I_C = 150 mA	I_B = 15 mA
$V_{CE}(sat)$	Collector Saturation Voltage (pulsed, see note 5)		-1.6		-1.6		-1.6		-1.6	Volts	I_C = 500 mA	I_B = 50 mA
$V_{BE}(sat)$	Base Saturation Voltage (pulsed, see note 1)		-1.3		-1.3		-1.3		-1.3	Volts	I_C = 150 mA	I_B = 15 mA
$V_{BE}(sat)$	Base Saturation Voltage (pulsed, see note 1)		-2.6		-2.6		-2.6		-2.6	Volts	I_C = 500 mA	I_B = 50 mA
t_d	Turn-On Delay Time (see Figure 1)		10		10		10		10	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_r	Rise Time (see Figure 1)		40		40		40		40	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_s	Storage Time (see Figure 2)		80		80		80		80	nsec	I_{CS} = 150 mA, I_{B1} = I_{B2}	= 15 mA
t_f	Fall Time (see Figure 2)		30		30		30		30	nsec	I_{CS} = 150 mA, I_{B1} = I_{B2}	= 15 mA
t_{on}	Turn On Time (see Figure 1)				45				45	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_{off}	Turn Off Time (see Figure 2)				100				100	nsec	I_{CS} = 150 mA, I_{B1} = I_{B2}	= 15 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 Free Air Temperature unless otherwise noted)

Symbol	Characterisitc	2N2904 2N2906 Min.	Max.	2N2904A 2N2906A Min.	Max.	2N2905 2N2907 Min.	Max.	2N2905A 2N2907A Min.	Max.	Units	Test Conditions	
h_{fe}	High Frequency Current Gain (f = 100 mc)	2.0		2.0		2.0		2.0			I_C = 50 mA	V_{CE} = -20 V
I_{CBO}	Collector Cutoff Current		20		10		20		10	nA	I_E = 0	V_{CB} = -50 V
I_{CBO}(150°C)	Collector Cutoff Current		20		10		20		10	μA	I_E = 0	V_{CB} = -50 V
I_{CEX}	Collector Reverse Current		50		50		50		50	nA	V_{CE} = -30 V	V_{BE} = +0.5 V
I_B	Base Current		50		50		50		50	nA	V_{CE} = -30 V	V_{BE} = +0.5 V
C_{ob}	Output Capacitance (f = 100 kc)		8.0		8.0		8.0		8.0	pf	I_E = 0	V_{CB} = -10 V
C_{TE}	Emitter Transition Capacitance (f = 100 kc)		30		30		30		30	pf	I_C = 0	V_{EB} = -0.5 V
BV_{CBO}	Collector to Base Breakdown Voltage	-60		-60		-60		-60		Volts	I_C = 10 μA	I_B = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-40		-60		-40		-60		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		-5.0		-5.0		-5.0		Volts	I_E = 10 μA	I_C = 0

FIG. 1 TEST CIRCUIT FOR DETERMINING DELAY TIME AND RISE TIME

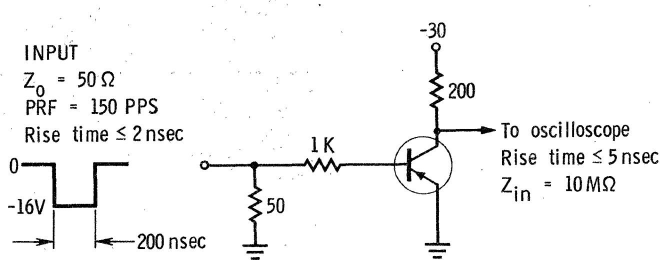
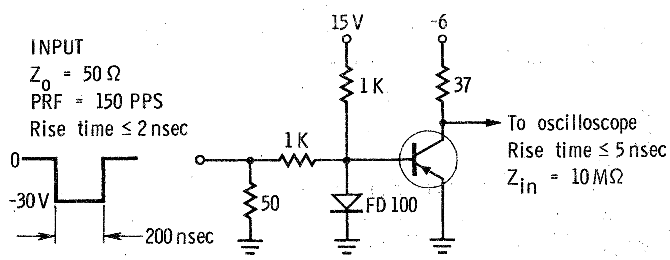


FIG. 2 TEST CIRCUIT FOR DETERMINING STORAGE TIME AND FALL TIME



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 58.3°C/Watt (derating factor of 17.2 mW/°C); junction-to-ambient thermal resistance of 292°C/Watt (derating factor of 3.42 mW/°C) for the 2N2904, 2N2904A, 2N2905, and 2N2905A. Junction-to-case thermal resistance of 97.3°C/Watt (derating factor of 10.3 mW/°C); junction-to-ambient thermal resistance of 437°C/Watt (derating factor of 2.28 mW/°C) for the 2N2906, 2N2906A, 2N2907, and 2N2907A.

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

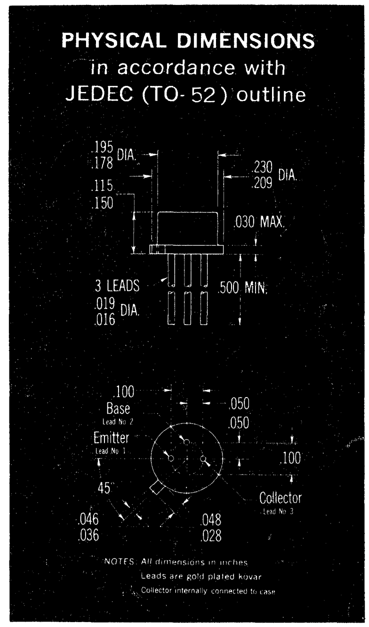
(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

2N3009

FAIRCHILD NPN DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

HIGH SPEED SATURATED SWITCH

The 2N3009 is an NPN silicon PLANAR epitaxial transistor designed for memory applications to 500 milliamperes. It features the unique combination of 350 mc f_T minimum with a guaranteed 300 milliampere collector saturation voltage of 0.5 volt.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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	
V_{CBO} Collector to Base Voltage	40 Volts
V_{CES} Collector to Emitter Voltage	40 Volts
V_{CEO} Collector to Emitter Voltage	15 Volts
V_{EBO} Emitter to Base Voltage	4.0 Volts

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]	30	60	120		I_C = 30 mA	V_{CE} = 0.4 V
h_{FE}	DC Pulse Current Gain [Note 5]	25	55			I_C = 100 mA	V_{CE} = 0.5 V
h_{FE}	DC Pulse Current Gain [Note 5]	15				I_C = 300 mA	V_{CE} = 1.0 V
V_{CE} (sat)	Collector Saturation Voltage		0.16	0.18	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Collector Saturation Voltage		0.18	0.28	Volts	I_C = 100 mA	I_B = 10 mA
V_{CE} (sat)	Collector Saturation Voltage (+85°C)		0.18	0.3	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Collector Saturation Voltage		0.39	0.5	Volts	I_C = 300 mA	I_B = 30 mA
V_{BE} (sat)	Base Saturation Voltage	0.75	0.82	0.95	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE} (sat)	Base Saturation Voltage		0.97	1.2	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE} (sat)	Base Saturation Voltage		1.3	1.7	Volts	I_C = 300 mA	I_B = 30 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	3.5	5.5			I_C = 30 mA	V_{CE} = 10 V
C_{ob}	Output Capacitance		3.3	5.0	pf	I_E = 0	V_{CB} = 5.0 V
C_{TE}	Emitter Transition Capacitance		6.5	8.0	pf	I_C = 0	V_{EB} = 0.5 V
I_{CES}	Collector Reverse Current		0.04	0.5	μA	V_{CE} = 20 V	V_{BE} = 0
I_{CES} (85°C)	Collector Reverse Current		0.5	15	μA	V_{CE} = 20 V	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	I_C = 100 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	40			Volts	I_C = 100 μA	V_{EB} = 0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	15			Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0			Volts	I_E = 100 μA	I_C = 0
τ_s	Charge Storage Time Constant [Note 6]		8.0	18	nsec	$I_C = I_{B1} \approx$ 10 mA, $I_{B2} \approx$ −10 mA	
t_{on}	Turn On Time [Note 6]		9.0	15	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA	
t_{off}	Turn Off Time [Note 6]		15	25	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx$ −30 mA	

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).

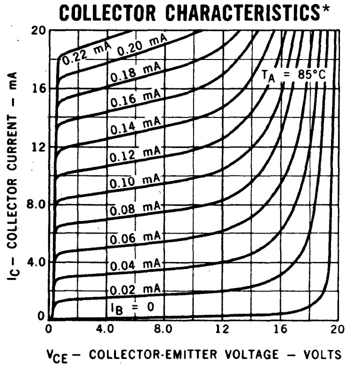
(NOTES CONTINUED ON PAGE 4)

FAIRCHILD SEMICONDUCTOR

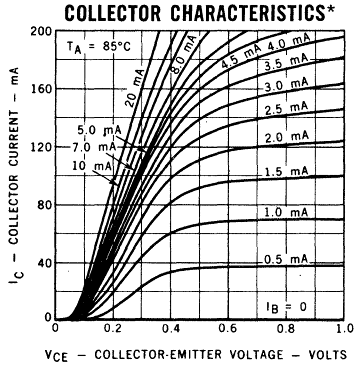
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPICAL ELECTRICAL CHARACTERISTICS

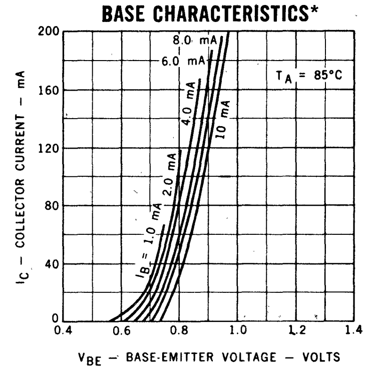
COLLECTOR CHARACTERISTICS*



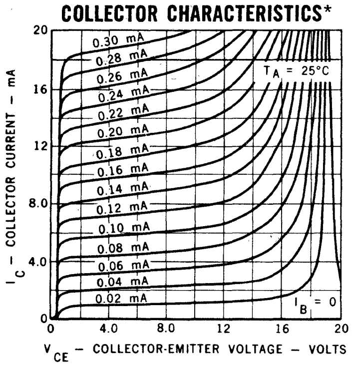
COLLECTOR CHARACTERISTICS*



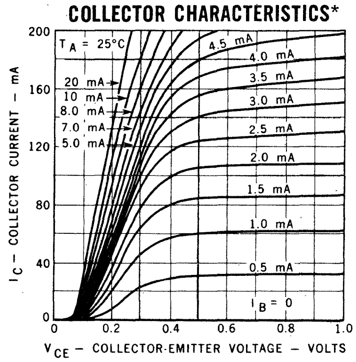
BASE CHARACTERISTICS*



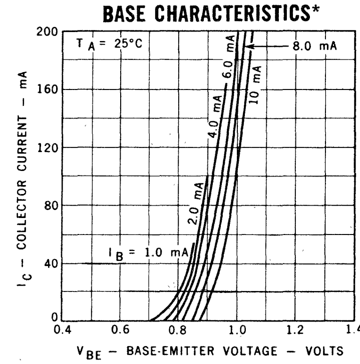
COLLECTOR CHARACTERISTICS*



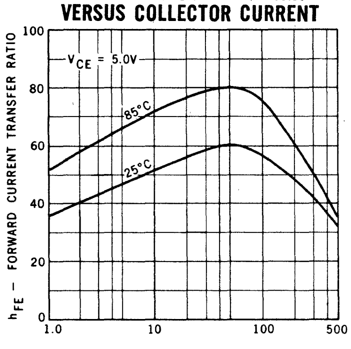
COLLECTOR CHARACTERISTICS*



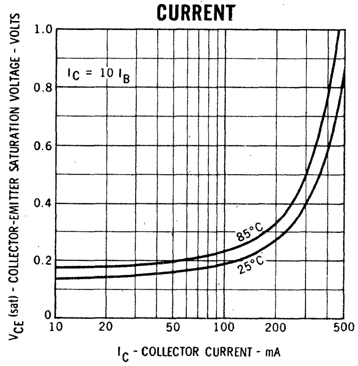
BASE CHARACTERISTICS*



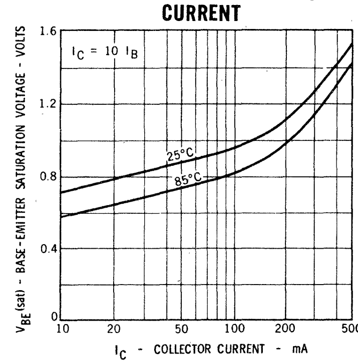
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



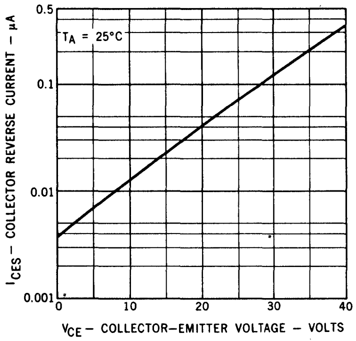
BASE-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



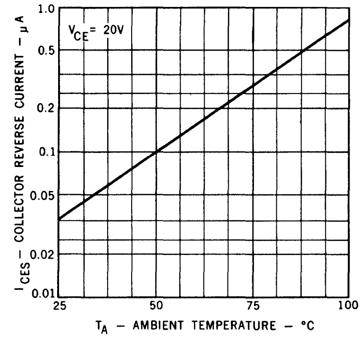
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

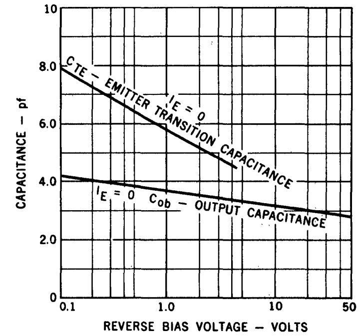
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



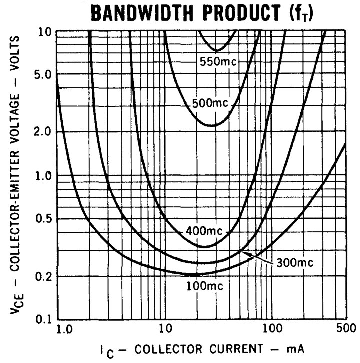
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



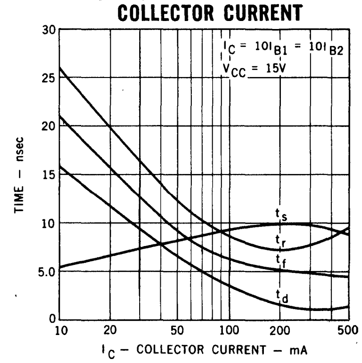
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



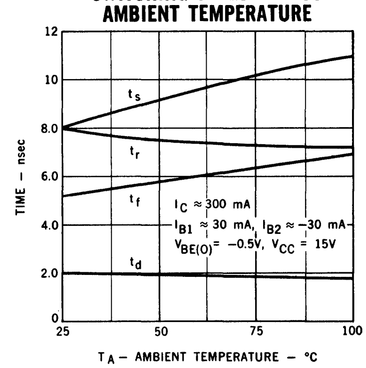
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



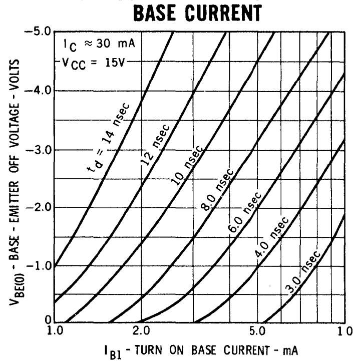
SWITCHING TIMES VERSUS COLLECTOR CURRENT



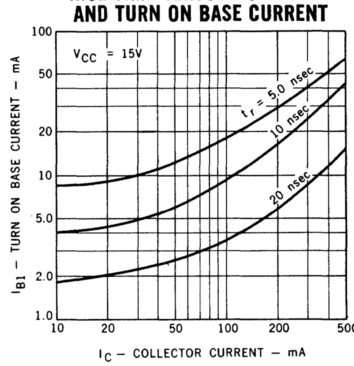
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



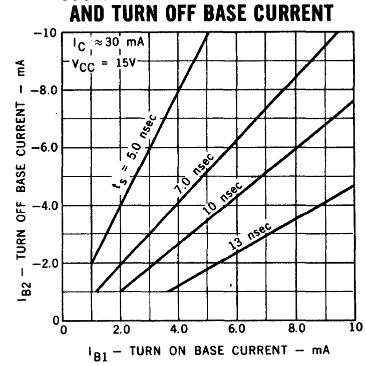
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



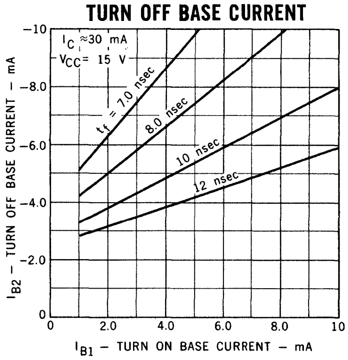
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



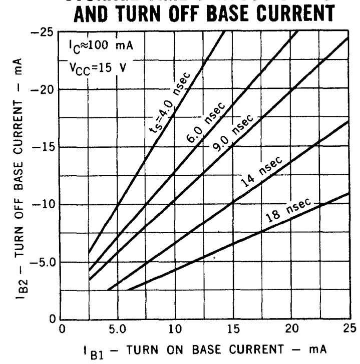
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



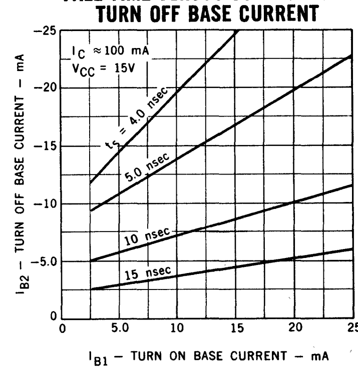
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



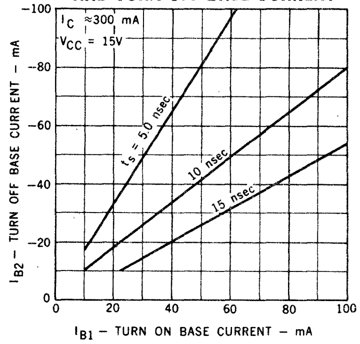
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



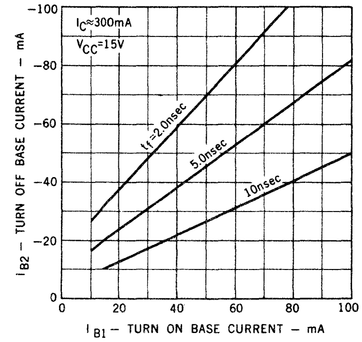
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



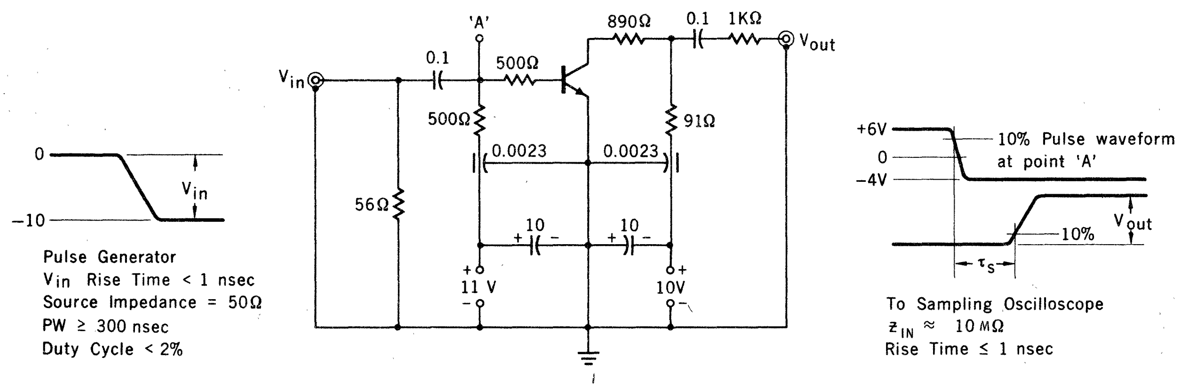
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



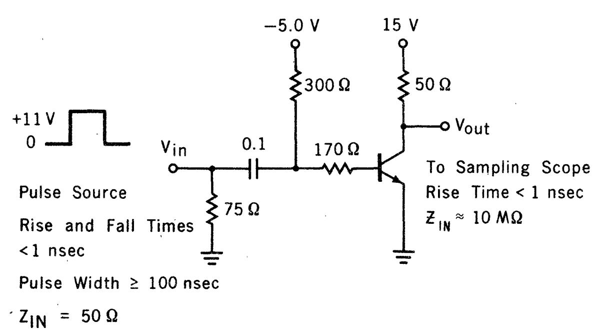
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



CHARGE STORAGE TIME MEASUREMENT CIRCUIT



t_{on}-t_{off} MEASUREMENT CIRCUIT



FAIRCHILD SEMICONDUCTOR
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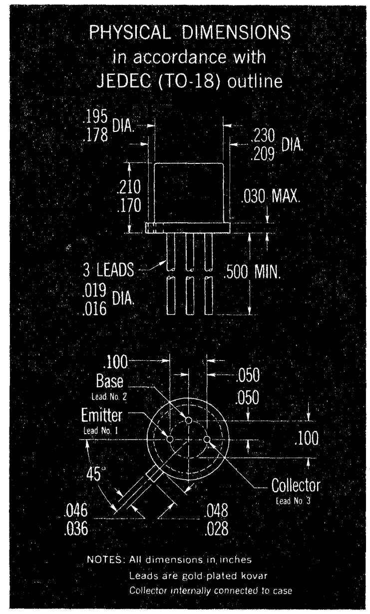
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

2N3010

FAIRCHILD NPN DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

HIGH SPEED SATURATED SWITCH

The 2N3010 is an NPN silicon PLANAR epitaxial designed specifically for high-speed saturated switching applications in the 50-100 mc range at power levels from 100 microwatts to 300 milliwatts. This device is suitable for most small-signal, RF, and digital type circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec time limit)	300°C Maximum
Maximum Power Dissipation	
Total Dissipation at 25°C Ambient Temperature [Notes 2 and 3]	0.3 Watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	15 Volts
V_{CES} Collector to Emitter Voltage	11 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	6.0 Volts
V_{EBO} Emitter to Base Voltage	4.0 Volts

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]	25	70	125		I_C = 10 mA	V_{CE} = 0.4 V
h_{FE}	DC Pulse Current Gain [Note 5]	15	60			I_C = 30 mA	V_{CE} = 0.4 V
h_{FE}	DC Current Gain	15				I_C = 1.0 mA	V_{CE} = 0.4 V
V_{CE} (sat)	Collector Saturation Voltage		0.18	0.25	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{CE} (sat)	Collector Saturation Voltage		0.19	0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE} (sat)	Collector Saturation Voltage		0.23	0.38	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Collector Saturation Voltage (+85°C)		0.2	0.4	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage	0.68	0.74	0.85	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{BE} (sat)	Base Saturation Voltage	0.75	0.84	0.95	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage		0.93	1.3	Volts	I_C = 30 mA	I_B = 3.0 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	6.0	8.0			I_C = 10 mA	V_{CE} = 4.0 V
C_{ob}	Output Capacitance		2.3	3.0	pf	I_E = 0	V_{CB} = 5.0 V
C_{TE}	Emitter Transition Capacitance		1.7	2.0	pf	I_C = 0	V_{EB} = 0.5 V
I_{CES}	Collector Reverse Current		4.0	100	nA	V_{CE} = 5.0 V	V_{EB} = 0
I_{CES}	Collector Reverse Current		0.013	10	μA	V_{CE} = 11 V	V_{BE} = 0
I_{CES} (85°C)	Collector Reverse Current		0.2	5.0	μA	V_{CE} = 5.0 V	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	15			Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	11			Volts	I_C = 10 μA	V_{EB} = 0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	6.0			Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0			Volts	I_E = 10 μA	I_C = 0
τ_S	Charge Storage Time Constant [Note 6]			6.0	nsec	$I_C = I_{B1} \approx$ 5.0 mA,	$I_{B2} \approx$ −5.0 mA
t_{on}	Turn On Time [Note 6]			12	nsec	$I_C \approx$ 10 mA	$I_{B1} \approx$ 2.0 mA
t_{off}	Turn Off Time [Note 6]			12	nsec	$I_C \approx$ 10 mA, $I_{B1} \approx$ 1.0 mA,	$I_{B2} \approx$ −1.0 mA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) This is a steady state limit. The factory should be consulted on applications involving pulsed or low duty cycle operations
(3) This rating gives a maximum junction temperature of 200°C and junction-to-ambient thermal resistance of 583°C/watt (derating factor of 1.71 mW/°C).

(NOTES CONTINUED ON PAGE 4)

FAIRCHILD SEMICONDUCTOR
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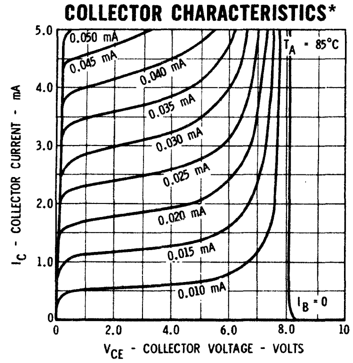
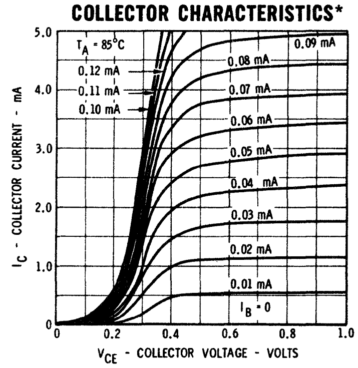
TYPICAL ELECTRICAL CHARACTERISTICS

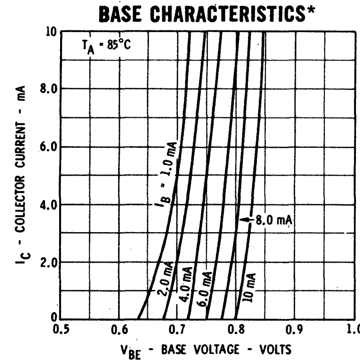
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



BASE CHARACTERISTICS*



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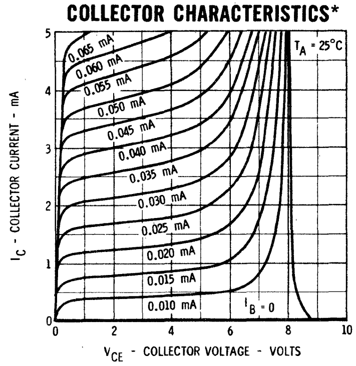

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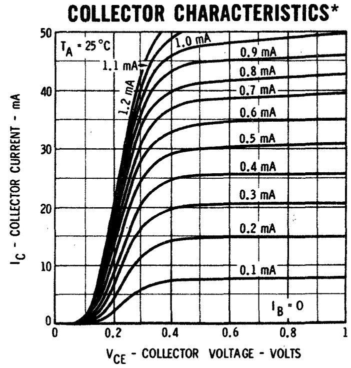
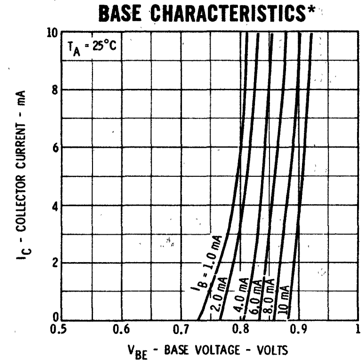
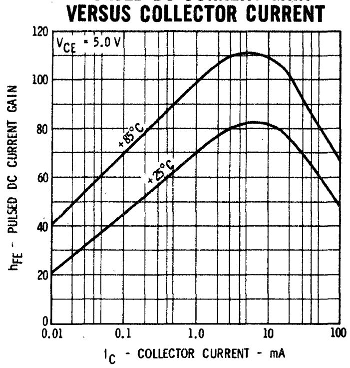


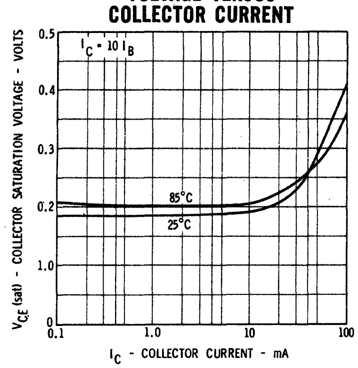
BASE CHARACTERISTICS*



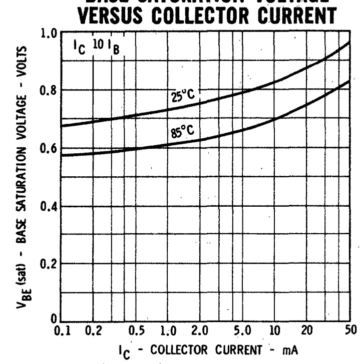
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



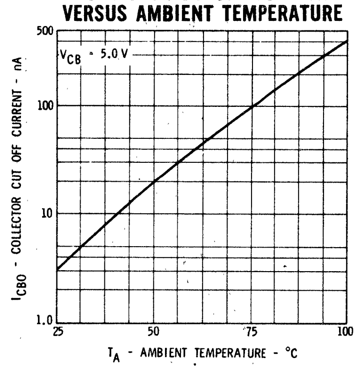
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



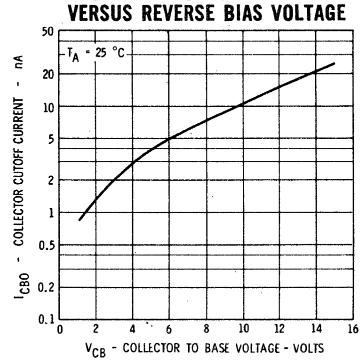
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

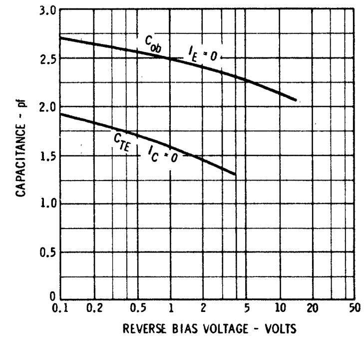
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



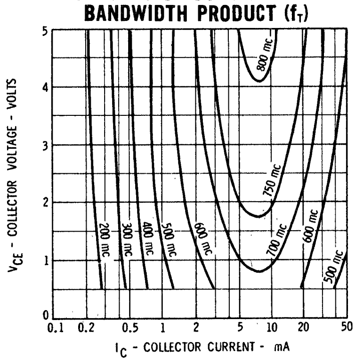
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



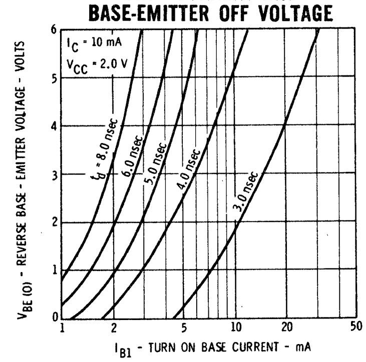
EMITTER TRANSISTION AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



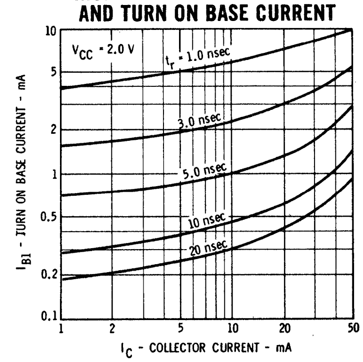
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



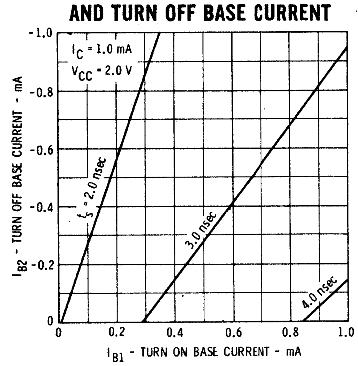
DELAY TIME VERSUS TURN ON BASE CURRENT AND BASE-EMITTER OFF VOLTAGE



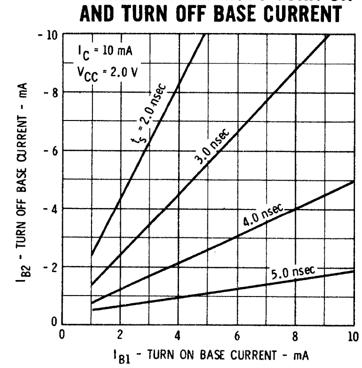
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



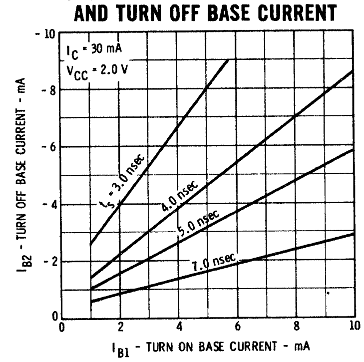
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



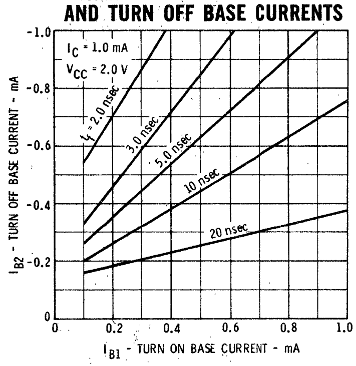
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



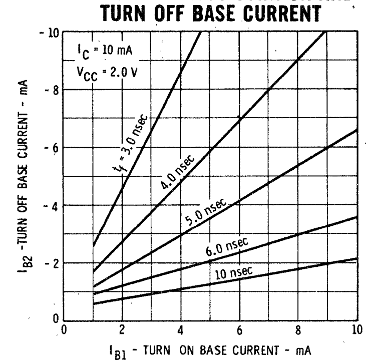
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



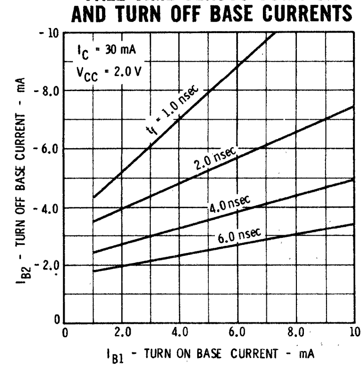
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



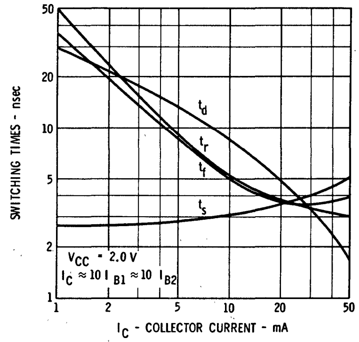
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



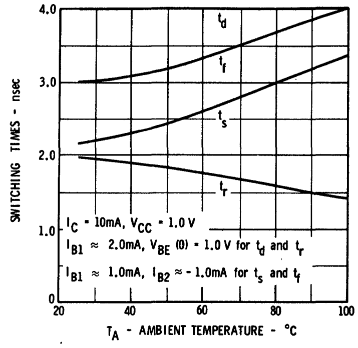
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



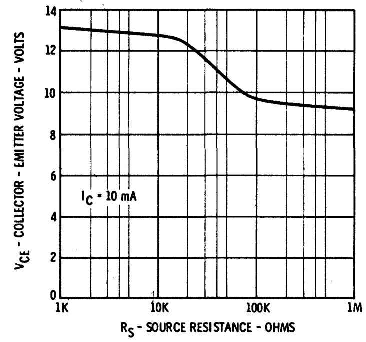
SWITCHING TIMES VERSUS COLLECTOR CURRENT



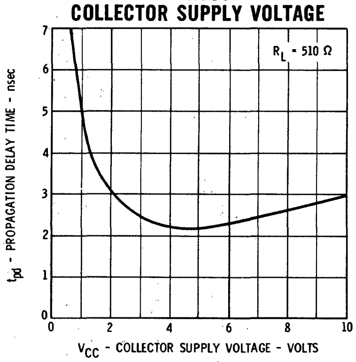
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



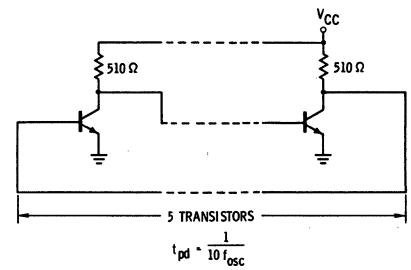
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



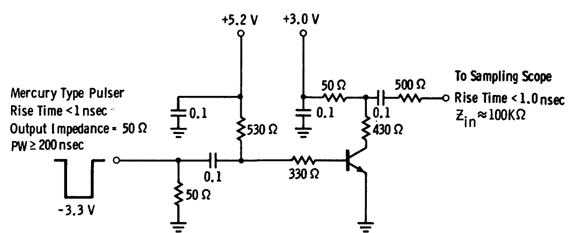
PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



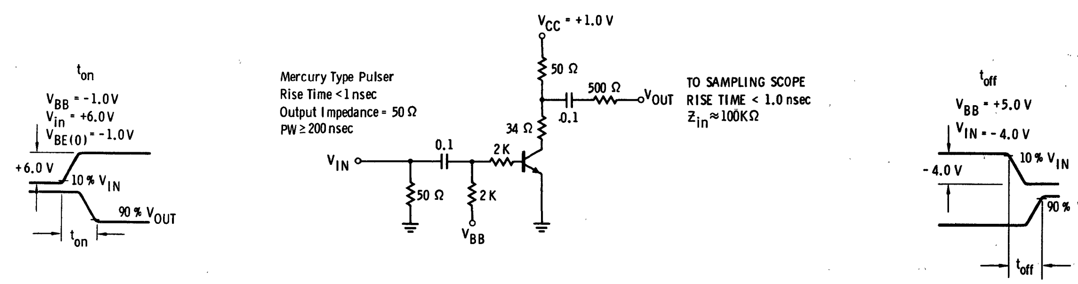
FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



CHARGE STORAGE TIME — CONSTANT TEST CIRCUIT



t_{ON} AND t_{OFF} TEST CIRCUIT



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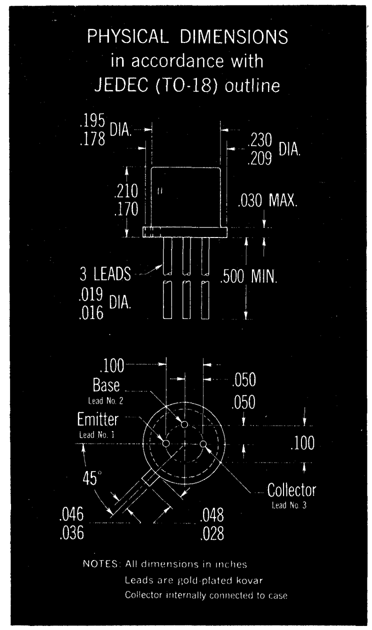
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

2N3011

FAIRCHILD NPN DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

HIGH SPEED SATURATED SWITCH

The 2N3011 is an NPN silicon PLANAR epitaxial transistor designed specifically for high-speed saturated switching applications in the 50-100 mc range at current levels from 100 microamperes to 100 milliamperes. It is suitable for most small-signal, RF, and digital type circuits.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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	
V_{CBO} Collector to Base Voltage	30 Volts
V_{CES} Collector to Emitter Voltage	30 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	12 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 Pulse Current Gain [Note 5]	30	70	120		$I_C = 10$ mA	$V_{CE} = 0.35$ V
h_{FE}	DC Pulse Current Gain [Note 5]	25	75			$I_C = 30$ mA	$V_{CE} = 0.4$ V
h_{FE}	DC Pulse Current Gain [Note 5]	12	50			$I_C = 100$ mA	$V_{CE} = 1.0$ V
V_{CE} (sat)	Collector Saturation Voltage		0.17	0.2	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.18	0.25	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{CE} (sat)	Collector Saturation Voltage (+85°C)		0.15	0.3	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.3	0.5	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE} (sat)	Base Saturation Voltage	0.72	0.8	0.87	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE} (sat)	Base Saturation Voltage		0.9	1.15	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{BE} (sat)	Base Saturation Voltage		1.1	1.6	Volts	$I_C = 100$ mA	$I_B = 10$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	4.0	6.5			$I_C = 20$ mA	$V_{CE} = 10$ V
C_{ob}	Output Capacitance		2.3	4.0	pf	$I_E = 0$	$V_{CB} = 5.0$ V
I_{CES}	Collector Reverse Current		0.05	0.4	μA	$V_{CE} = 20$ V	$V_{BE} = 0$
I_{CES} (85°C)	Collector Reverse Current		1.0	10	μA	$V_{CE} = 20$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	30			Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	30			Volts	$I_C = 10$ μA	$V_{EB} = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage	12			Volts	$I_C = 10$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			Volts	$I_E = 100$ μA	$I_C = 0$
τ_S	Charge Storage Time Constant [Note 6]			13	nsec	$I_C = I_{B1} \approx 10$ mA,	$I_{B2} \approx -10$ mA
t_{on}	Turn On Time [Note 6]			15	nsec	$I_C \approx 30$ mA	$I_{B1} \approx 3.0$ mA
t_{off}	Turn Off Time [Note 6]			20	nsec	$I_C \approx 30$ mA, $I_{B1} \approx 3.0$ mA,	$I_{B2} \approx -3.0$ mA

NOTES:

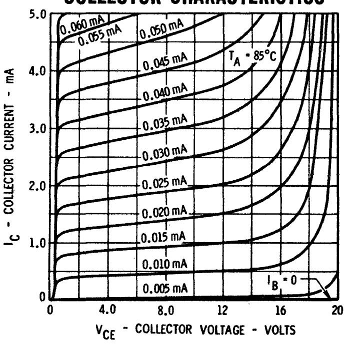
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature 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).

(NOTES CONTINUED ON PAGE 4)

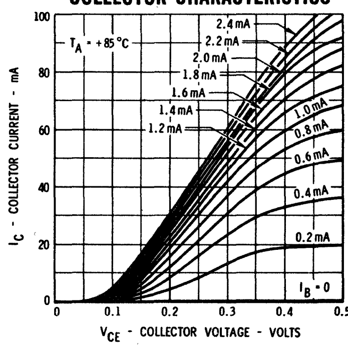
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPICAL ELECTRICAL CHARACTERISTICS

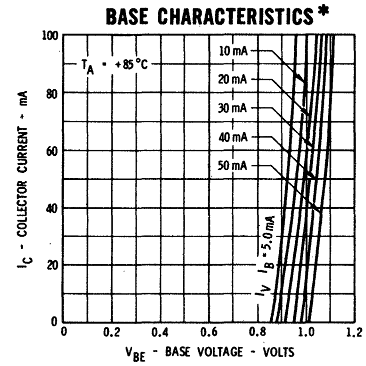
COLLECTOR CHARACTERISTICS*



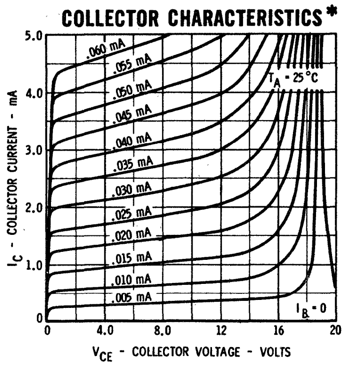
COLLECTOR CHARACTERISTICS*



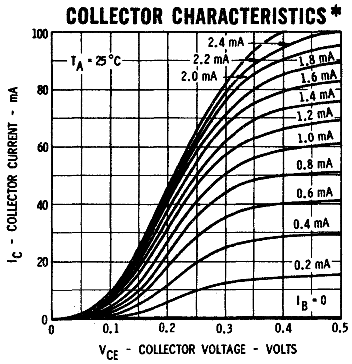
BASE CHARACTERISTICS*



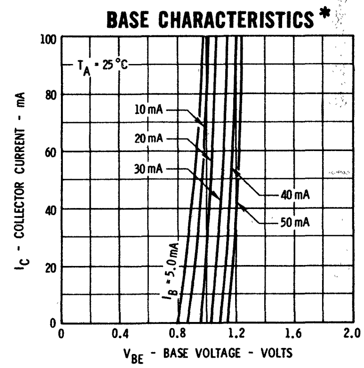
COLLECTOR CHARACTERISTICS*



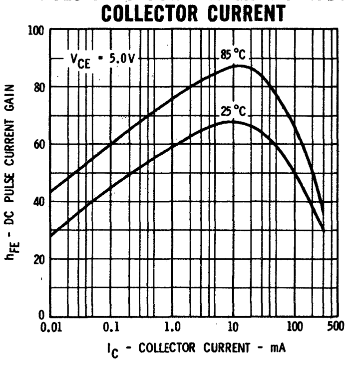
COLLECTOR CHARACTERISTICS*



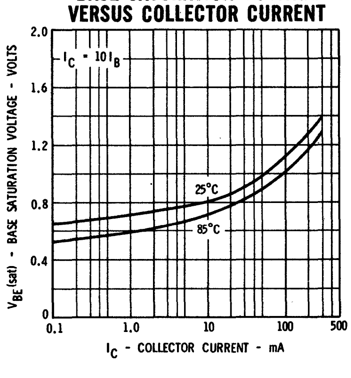
BASE CHARACTERISTICS*



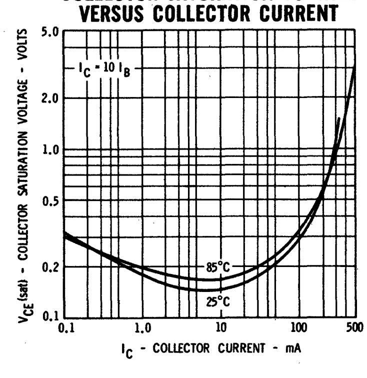
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



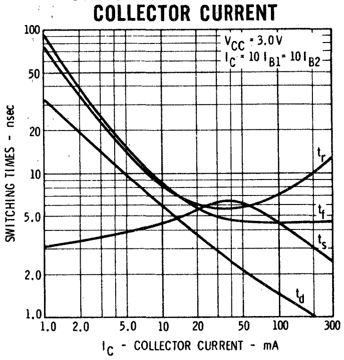
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



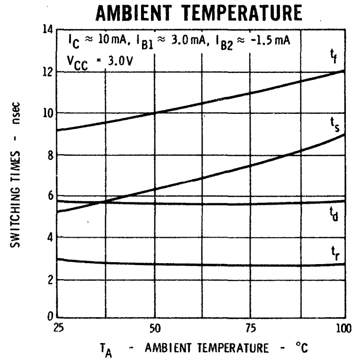
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

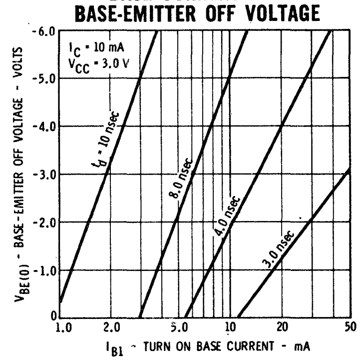
SWITCHING TIMES VERSUS COLLECTOR CURRENT



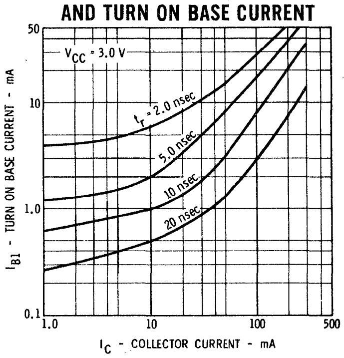
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



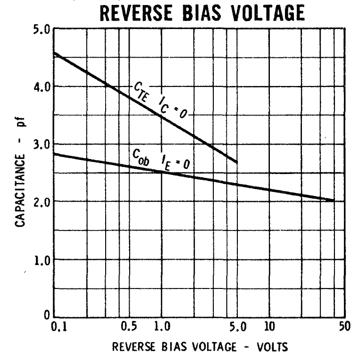
DELAY TIME VERSUS TURN ON BASE CURRENT AND BASE-EMITTER OFF VOLTAGE



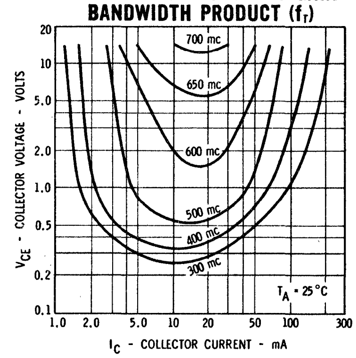
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



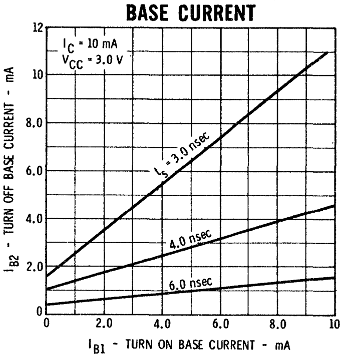
EMITTER TRANSITION AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



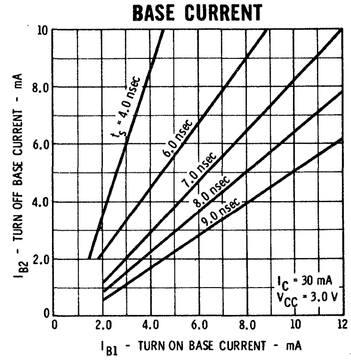
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



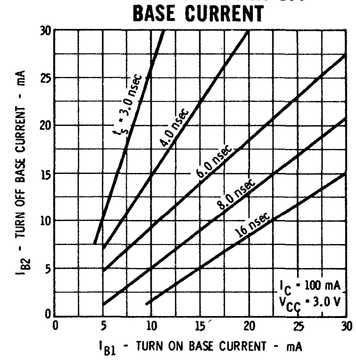
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



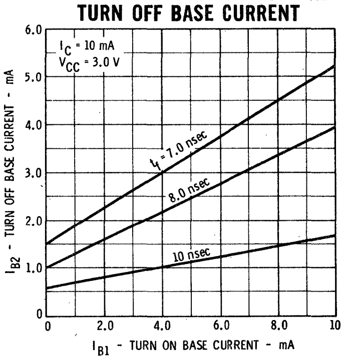
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



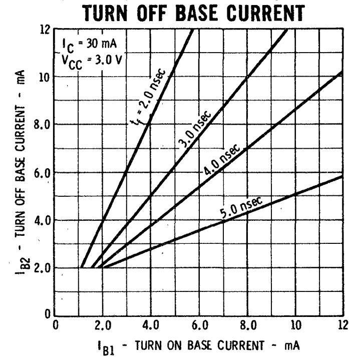
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



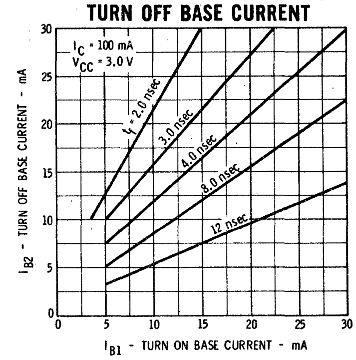
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



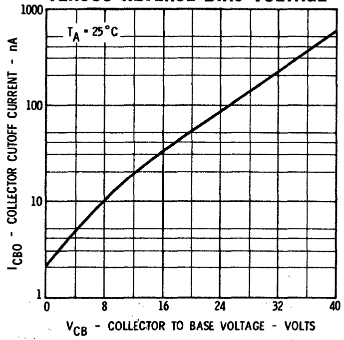
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



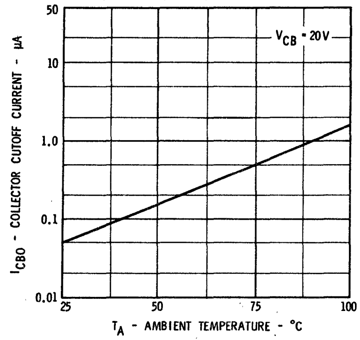
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



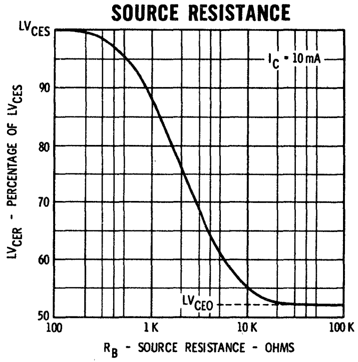
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



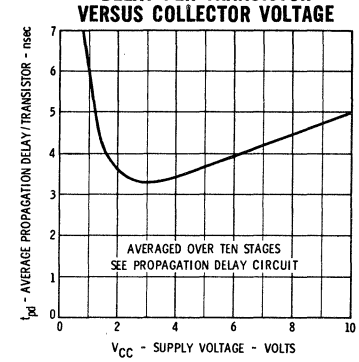
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



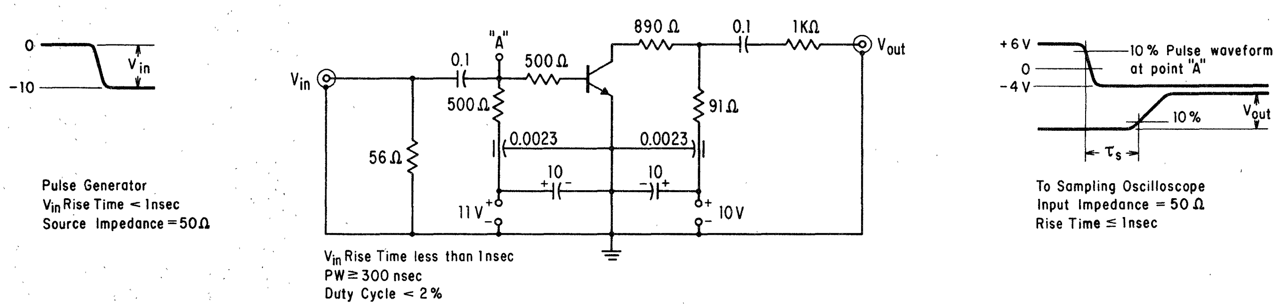
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



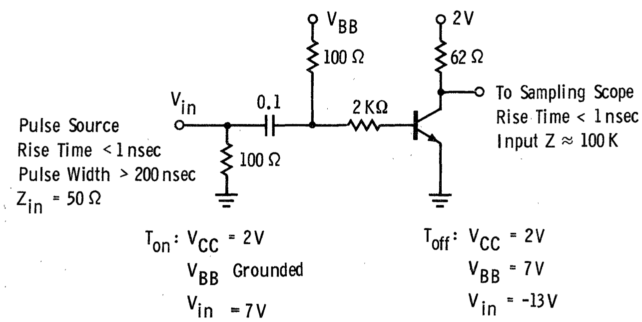
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



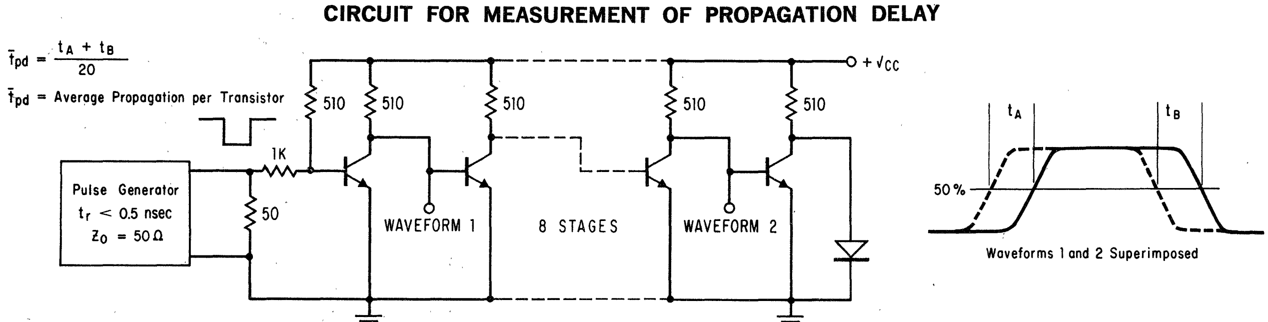
CHARGE STORAGE TIME — CONSTANT TEST CIRCUIT



t_{on}-t_{off} MEASUREMENT CIRCUIT



CIRCUIT FOR MEASUREMENT OF PROPAGATION DELAY



FAIRCHILD
SEMICONDUCTOR
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(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 µsec; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

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

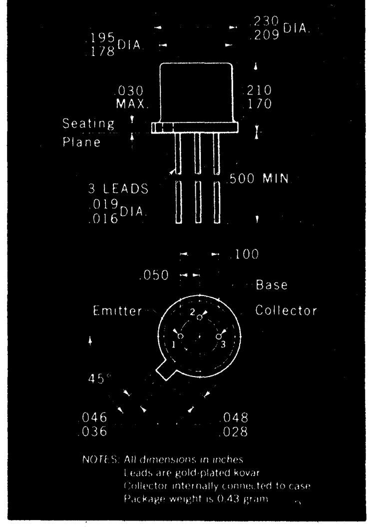
2N3012

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

The 2N3012 is a 600 mc PNP silicon PLANAR epitaxial transistor designed for saturated and non-saturated switching circuits requiring up to 200 milliamperes of collector current. It is suitable for 20 mc amplifiers, 10.7 mc IF amplifiers, and 100 mc oscillator converter circuits.

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



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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 25°C Ambient Temperature [Notes 2 and 3]	0.36 Watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	−12 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	−12 Volts
V_{CES} Collector to Emitter Voltage	−12 Volts
V_{EBO} Emitter to Base Voltage	−4.0 Volts

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]	30	70	120		I_C = 30 mA	V_{CE} = −0.5 V
h_{FE}	DC Pulse Current Gain [Note 5]	25	50			I_C = 10 mA	V_{CE} = −0.3 V
h_{FE}	DC Pulse Current Gain [Note 5]	20	40			I_C = 100 mA	V_{CE} = −1.0 V
V_{CE} (sat)	Collector Saturation Voltage		−0.07	−0.15	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE} (sat)	Collector Saturation Voltage		−0.1	−0.2	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Collector Saturation Voltage (+85°C)		−0.15	−0.4	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{CE} (sat)	Collector Saturation Voltage		−0.25	−0.5	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE} (sat)	Base Saturation Voltage	−0.78	−0.90	−0.98	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage	−0.85	−1.12	−1.2	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE} (sat)	Base Saturation Voltage		−1.4	−1.7	Volts	I_C = 100 mA	I_B = 10 mA
h_{fe}	High Frequency Current Gain (f = 100 mC)	4.0	5.5			I_C = 30 mA	V_{CE} = −10 V
C_{ob}	Output Capacitance		3.3	6.0	pf	I_E = 0	V_{CB} = −5.0 V
C_{TE}	Emitter Transition Capacitance		3.8	6.0	pf	I_C = 0	V_{EB} = −0.5 V
I_{CES}	Collector Reverse Current		0.05	80	nA	V_{CE} = −6.0 V	V_{BE} = 0
I_{CES} (85°C)	Collector Reverse Current		0.003	5.0	μA	V_{CE} = −6.0 V	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	−12			Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−12			Volts	I_C = 10 μA	I_E = 0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	−12			Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.0			Volts	I_E = 100 μA	I_C = 0
t_{on}	Turn On Time [Note 6]		25	60	nsec	I_C ≈ 30 mA	I_{B1} ≈ 1.5 mA
t_{off}	Turn Off Time [Note 6]		35	75	nsec	I_C ≈ 30 mA, I_{B1} ≈ 1.5 mA, I_{B2} ≈ −1.5 mA	

(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).

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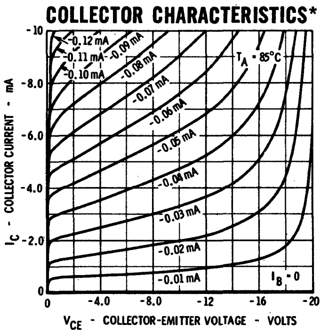
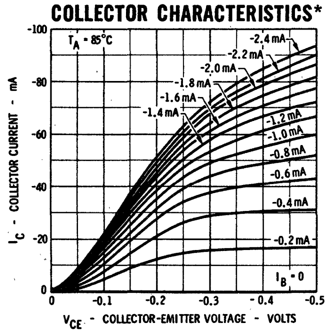
TYPICAL ELECTRICAL CHARACTERISTICS

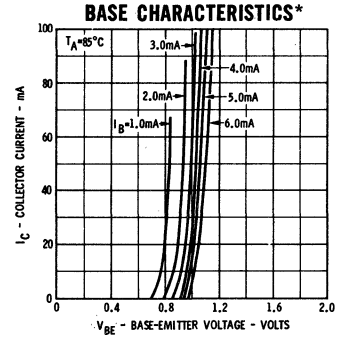
COLLECTOR CHARACTERISTICS*



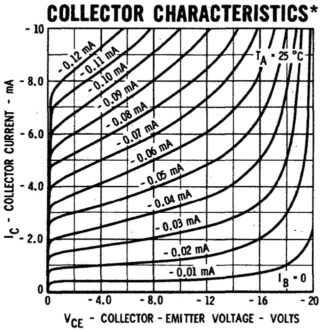
COLLECTOR CHARACTERISTICS*



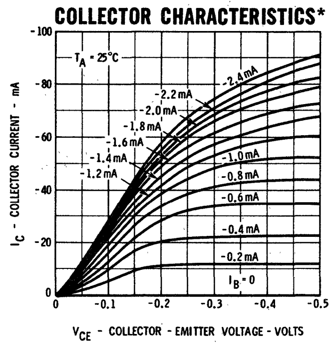
BASE CHARACTERISTICS*



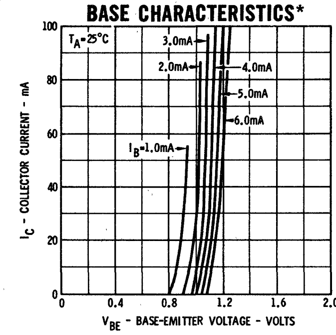
COLLECTOR CHARACTERISTICS*



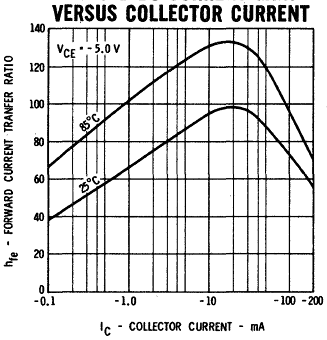
COLLECTOR CHARACTERISTICS*



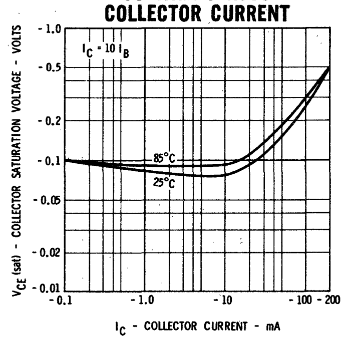
BASE CHARACTERISTICS*



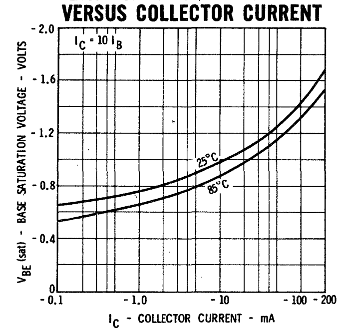
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



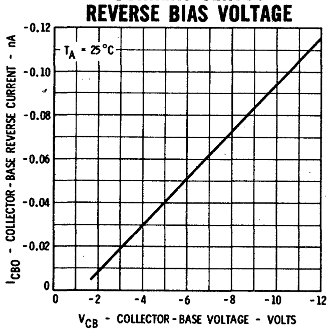
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



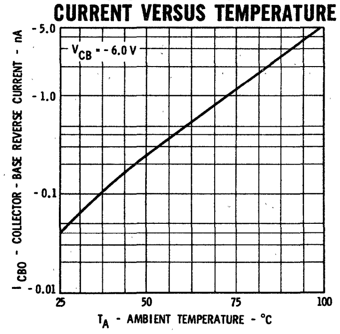
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



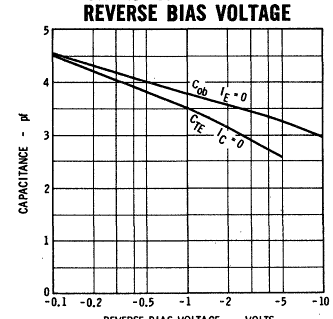
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



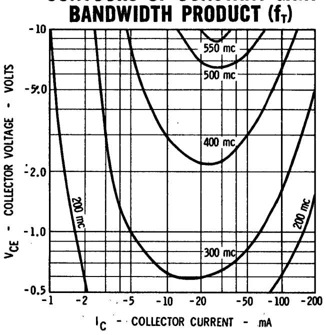
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



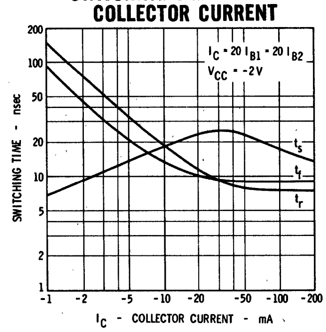
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

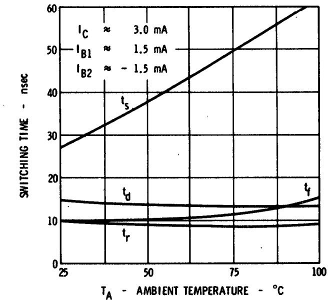
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



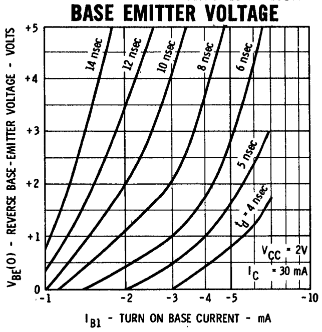
SWITCHING TIMES VERSUS COLLECTOR CURRENT



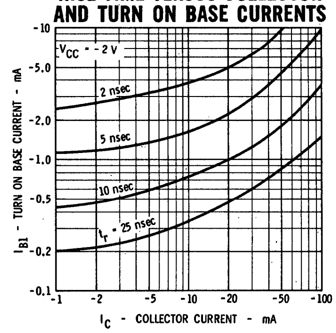
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



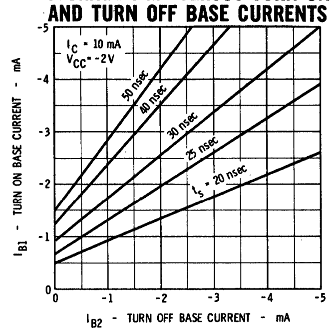
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



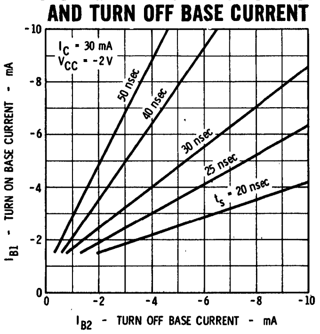
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



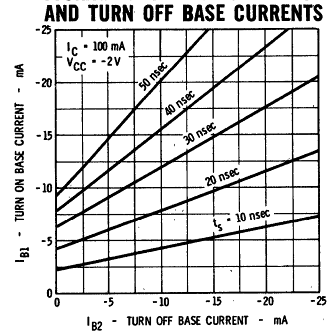
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



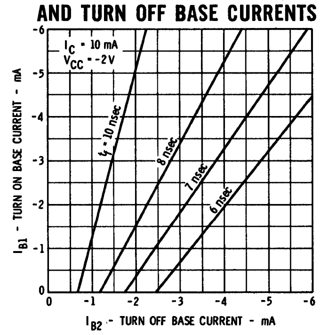
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



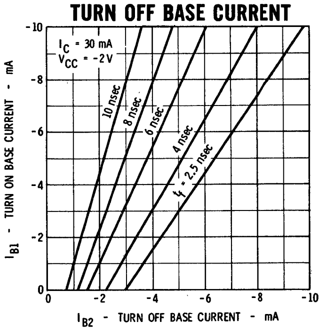
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



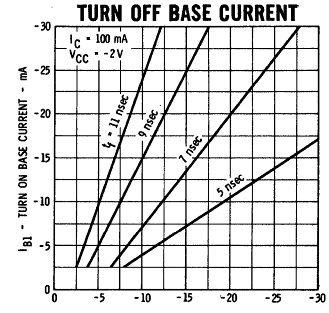
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



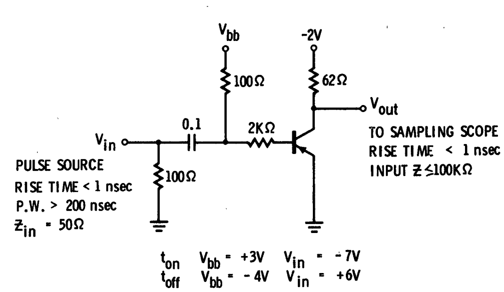
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT

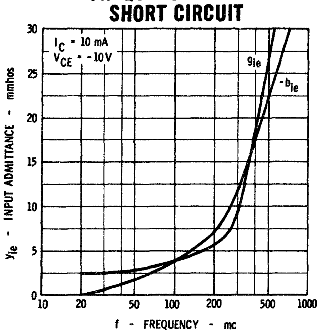


SWITCHING TIME TEST CIRCUIT

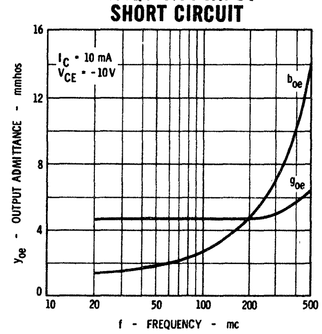


TYPICAL COMMON EMITTER "Y" PARAMETERS

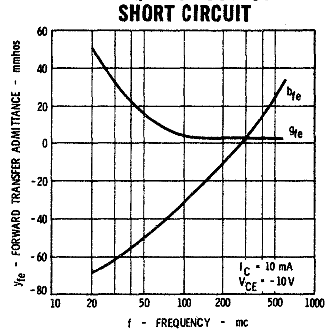
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



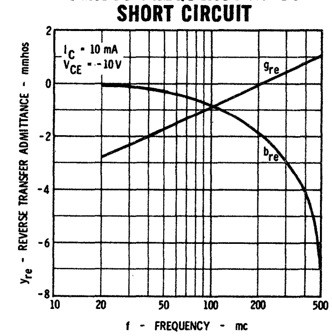
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



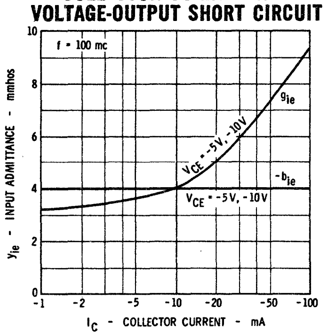
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



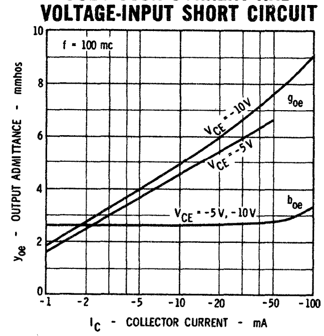
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



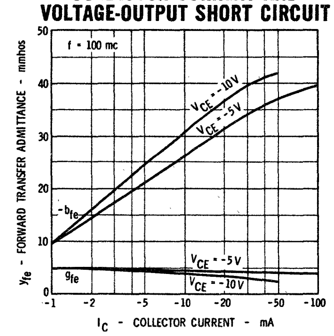
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



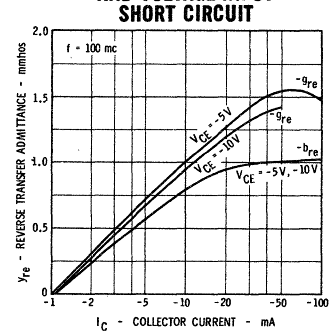
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



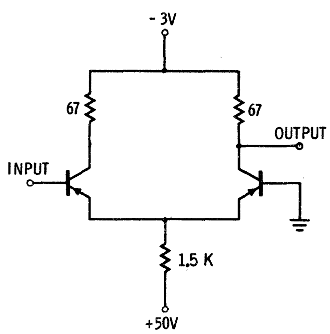
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT

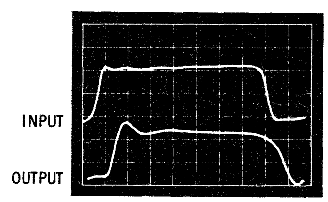


REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



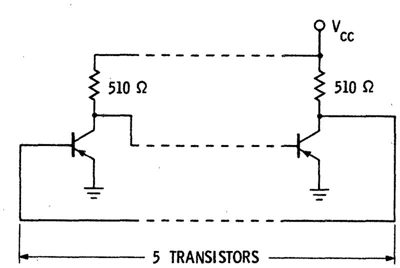
NON SATURATED SWITCHING PERFORMANCE





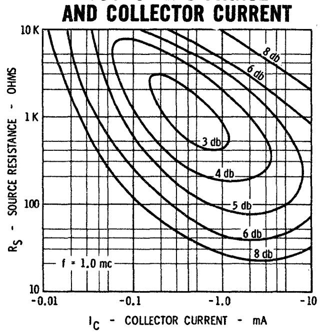
Scale = 2 nsec / cm.

FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY

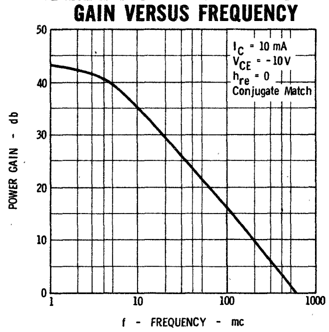


$$tpd = \frac{1}{10\, f_{osc}}$$

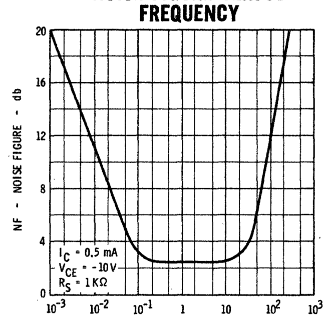
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



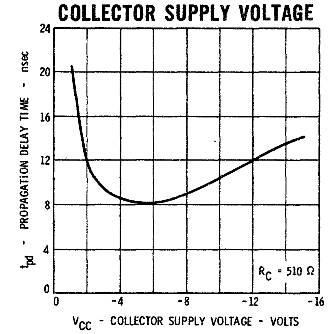
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



NOISE FIGURE VERSUS FREQUENCY



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



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(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

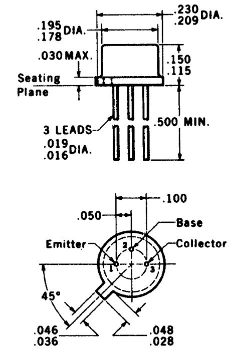
2N3013

NPN HIGH SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The 2N3013 is an NPN Silicon Planar Epitaxial Transistor designed for memory applications to 500 milliamperes. It features the unique combination of 350 MHz minimum f_T with a guaranteed 300 milliampere collector saturation voltage of 0.5 volt.

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-52) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 0.41 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec time limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C 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

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		5.0 Volts

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)	30	60	120		I_C = 30 mA V_{CE} = 0.4 V
h_{FE}	DC Pulse Current Gain (Note 5)	25	55			I_C = 100 mA V_{CE} = 0.5 V
h_{FE}	DC Pulse Current Gain (Note 5)	15	40			I_C = 300 mA V_{CE} = 1.0 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	12	30			I_C = 30 mA V_{CE} = 0.4 V
V_{CE}(sat)	Collector Saturation Voltage		0.16	0.18	Volts	I_C = 30 mA I_B = 3.0 mA
V_{CE}(sat)	Collector Saturation Voltage (+125°C)		0.19	0.25	Volts	I_C = 30 mA I_B = 3.0 mA
V_{CE}(sat)	Collector Saturation Voltage		0.18	0.28	Volts	I_C = 100 mA I_B = 10 mA
V_{CE}(sat)	Collector Saturation Voltage		0.39	0.5	Volts	I_C = 300 mA I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage	0.75	0.82	0.95	Volts	I_C = 30 mA I_B = 3.0 mA
V_{BE}(sat)	Base Saturation Voltage		0.97	1.2	Volts	I_C = 100 mA I_B = 10 mA
V_{BE}(sat)	Base Saturation Voltage		1.3	1.7	Volts	I_C = 300 mA I_B = 30 mA

Additional Electrical Characteristics on page 2

* 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) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 µs; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

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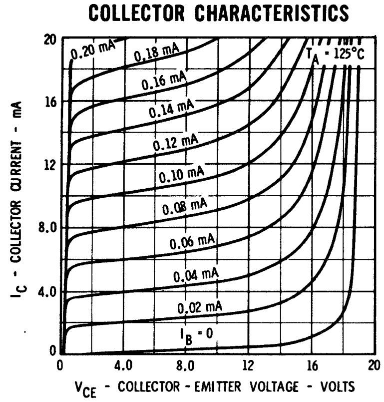
FAIRCHILD TRANSISTOR 2N3013

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

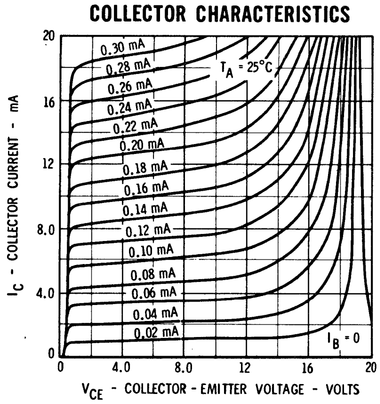
Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.5	5.5			I_C = 30 mA V_{CE} = 10 V
C_{obo}	Output Capacitance		3.3	5.0	pF	I_E = 0 V_{CB} = 5.0 V
C_{ibo}	Emitter Transition Capacitance		6.5	8.0	pF	I_C = 0 V_{EB} = 0.5 V
I_{CES}	Collector Reverse Current		0.04	0.3	μA	V_{CE} = 20 V V_{BE} = 0
I_{CES}(125°C)	Collector Reverse Current		2.0	40	μA	V_{CE} = 20 V V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	I_C = 100 μA I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	40			Volts	I_C = 100 μA I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	15			Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			Volts	I_E = 100 μA I_C = 0
τ_s	Charge Storage Time Constant (Note 6)		8.0	18	ns	$I_C = I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA
t_{on}	Turn On Time (Note 6)		9.0	15	ns	$I_C \approx$ 300 mA $I_{B1} \approx$ 30 mA
t_{off}	Turn Off Time (Note 6)		15	25	ns	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx$ -30 mA

TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

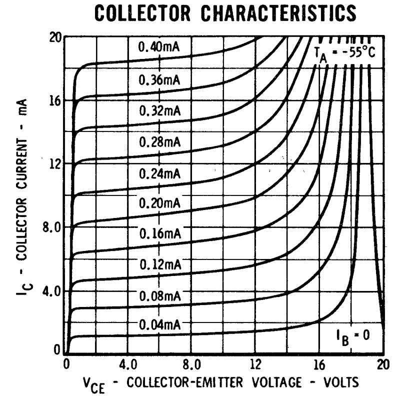
COLLECTOR CHARACTERISTICS



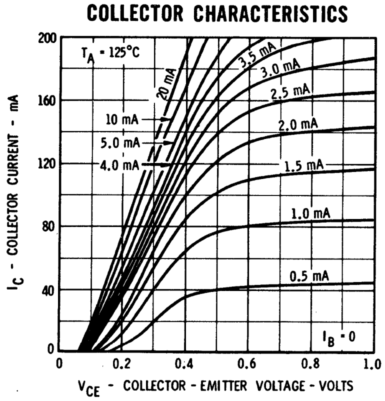
COLLECTOR CHARACTERISTICS



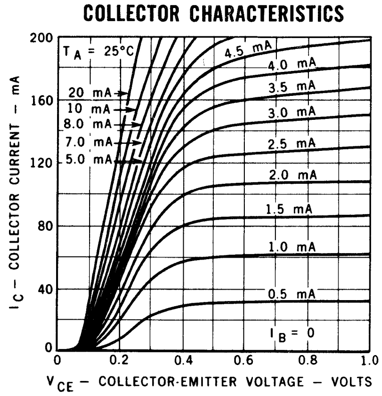
COLLECTOR CHARACTERISTICS



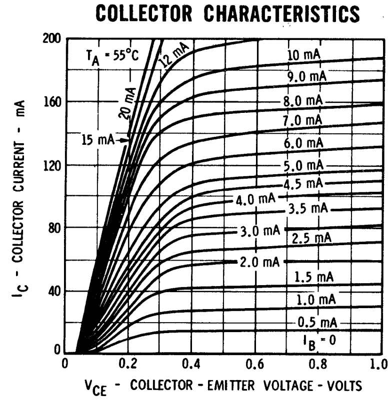
COLLECTOR CHARACTERISTICS



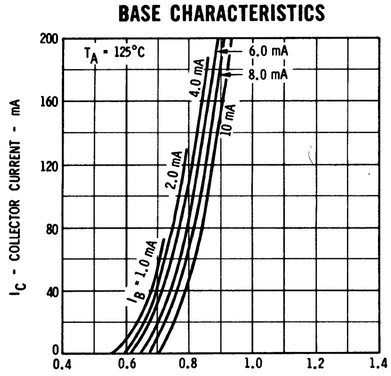
COLLECTOR CHARACTERISTICS



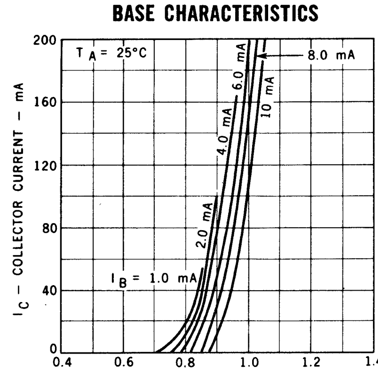
COLLECTOR CHARACTERISTICS



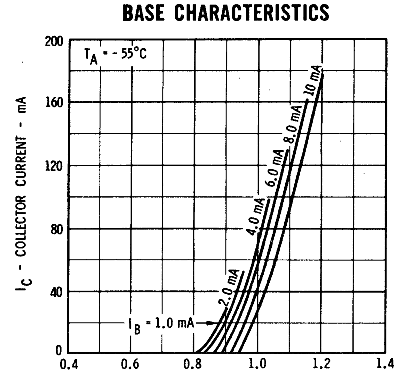
BASE CHARACTERISTICS



BASE CHARACTERISTICS



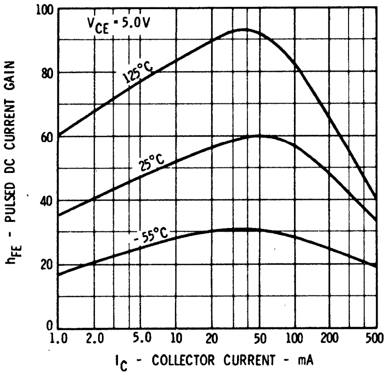
BASE CHARACTERISTICS



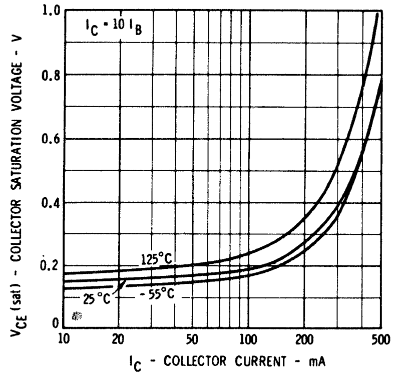
* **Single family characteristics on Transistor Curve Tracer.**

TYPICAL ELECTRICAL CHARACTERISTICS

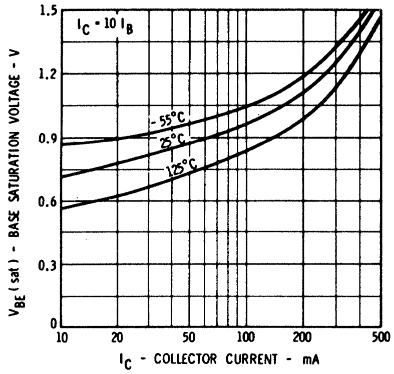
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



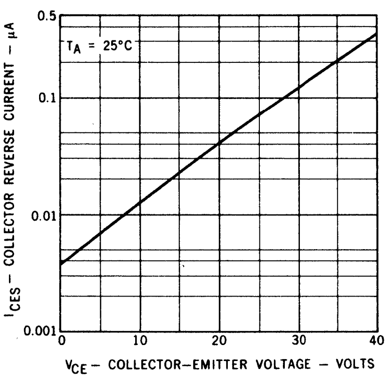
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



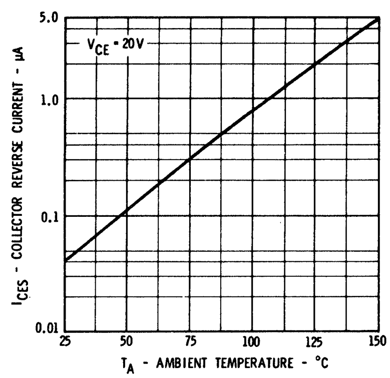
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



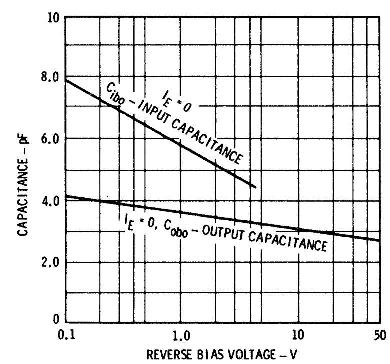
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



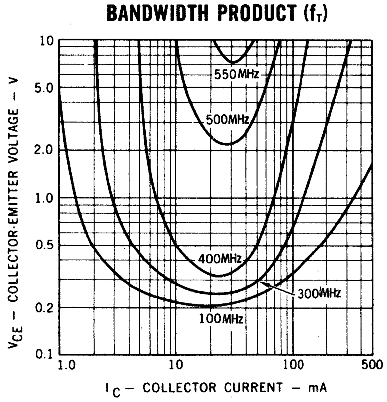
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



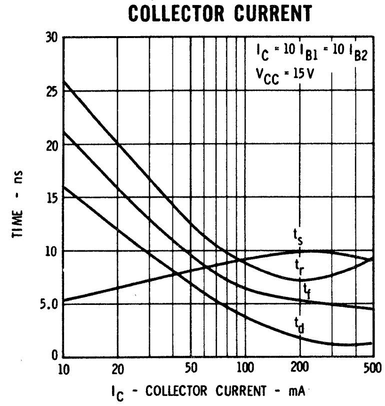
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



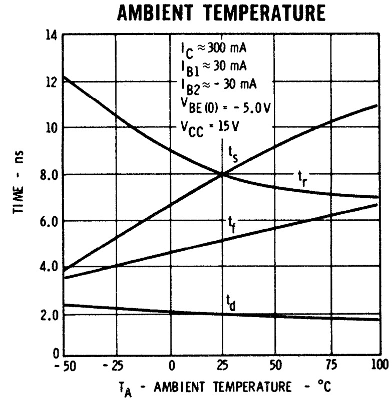
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



SWITCHING TIMES VERSUS COLLECTOR CURRENT

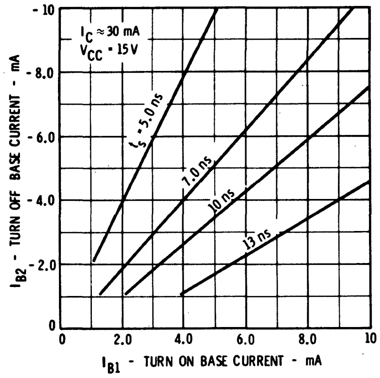


SWITCHING TIMES VERSUS AMBIENT TEMPERATURE

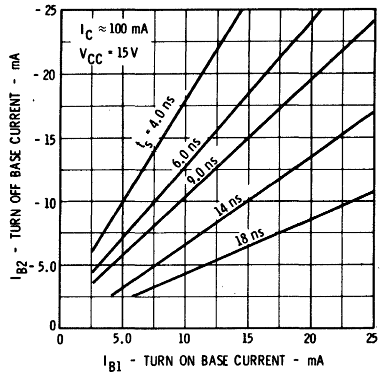


TYPICAL SWITCHING CHARACTERISTICS

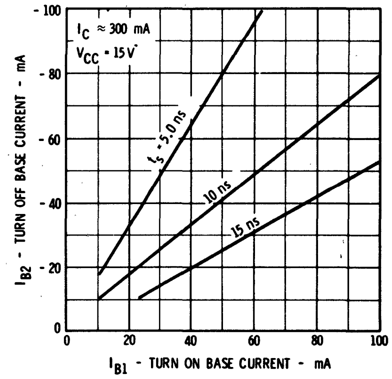
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



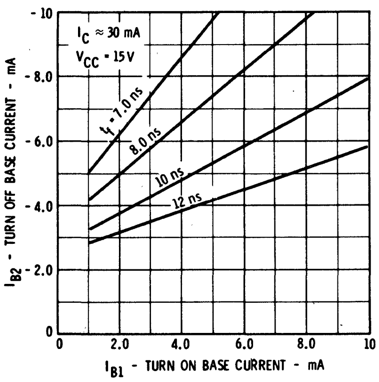
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



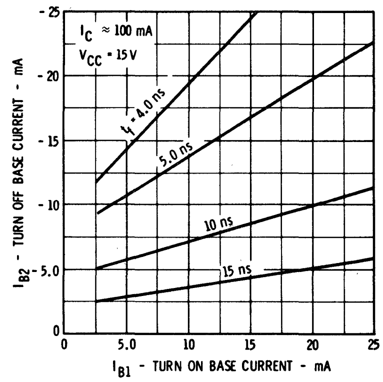
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



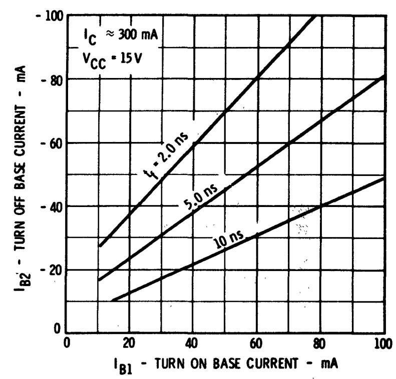
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



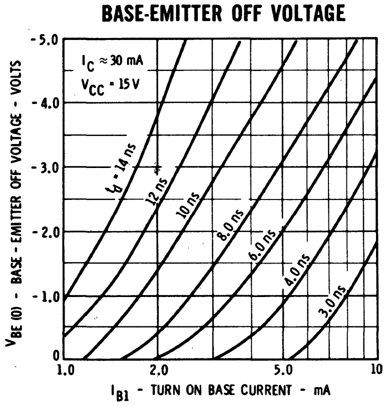
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



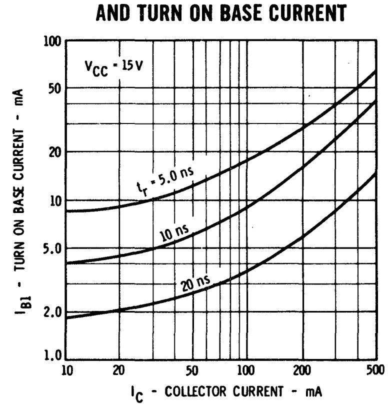
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



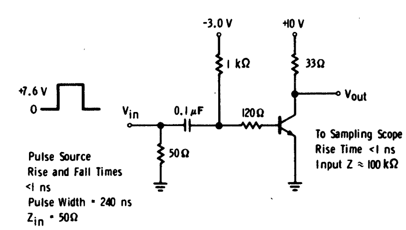
DELAY TIME VERSUS TURN ON BASE CURRENT AND BASE-EMITTER OFF VOLTAGE



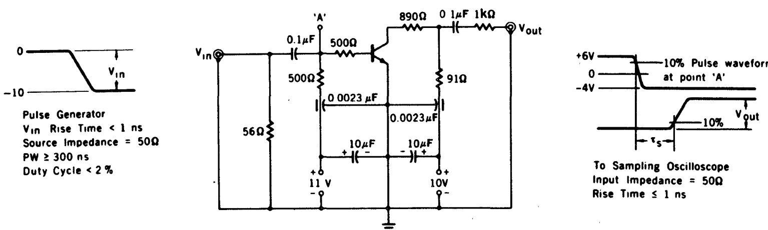
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



t_{on} — t_{off} MEASUREMENT CIRCUIT



CHARGE STORAGE TIME MEASUREMENT CIRCUIT



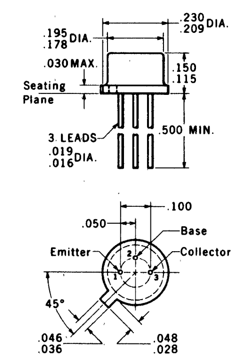
2N3014

NPN HIGH SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

- **HIGH SPEED . . . . . . $\tau_S = 18$ ns (MAX) AT 10 mA**
  . . . . . . $t_{on} = 16$ ns (MAX) AT 30 mA
  . . . . . . $t_{off} = 25$ ns (MAX) AT 30 mA
- **MEDIUM VOLTAGE . . . $LV_{CEO} = 20$ V (MIN)**
- **HIGH FREQUENCY . . . $f_T = 350$ MHz (MIN), 550 MHz (TYP) AT 30 mA**
- **LOW CAPACITANCE . . . $C_{obo} = 5.0$ pF (MAX) AT 5.0 V**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-52) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 0.41 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 60 second time limit)	+300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.2 Watts
at 100°C Case Temperature	0.68 Watt
at 25°C Ambient Temperature	0.36 Watt

Maximum Voltages and Current

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	5.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**3.5**	**5.5**			**$I_C = 30$ mA**	**$V_{CE} = 10$ V**
C_{obo}	**Open Circuit Output Capacitance**		**3.3**	**5.0**	**pF**	**$I_E = 0$**	**$V_{CB} = 5.0$ V**
C_{ibo}	Open Circuit Input Capacitance		6.5	8.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
I_{CES}	Collector Reverse Current		0.04	0.3	μA	$V_{CE} = 20$ V	$V_{BE} = 0$
I_{CES}(+125°C)	Collector Reverse Current		2.0	40	μA	$V_{CE} = 20$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	$I_C = 100$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	40			Volts	$I_C = 100$ μA	$V_{BE} = 0$
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	5.0			Volts	$I_E = 100$ μA	$I_C = 0$
τ_S	**Charge Storage Time Constant** (Note 6)		**8.0**	**18**	**ns**	**$I_C = I_{B1} \approx 10$ mA**	**$I_{B2} \approx -10$ mA**
t_{on}	**Turn On Time** (Note 6)		**11**	**16**	**ns**	**$I_C \approx 30$ mA**	**$I_{B1} \approx 3.0$ mA**
t_{off}	**Turn Off Time** (Note 6)		**16**	**25**	**ns**	**$I_C \approx 30$ mA**	**$I_{B1} \approx 3.0$ mA $I_{B2} \approx -3.0$ mA**

Additional Electrical Characteristics on page 2
Notes on page 2

*Planar is a patented Fairchild process.

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FAIRCHILD TRANSISTOR 2N3014

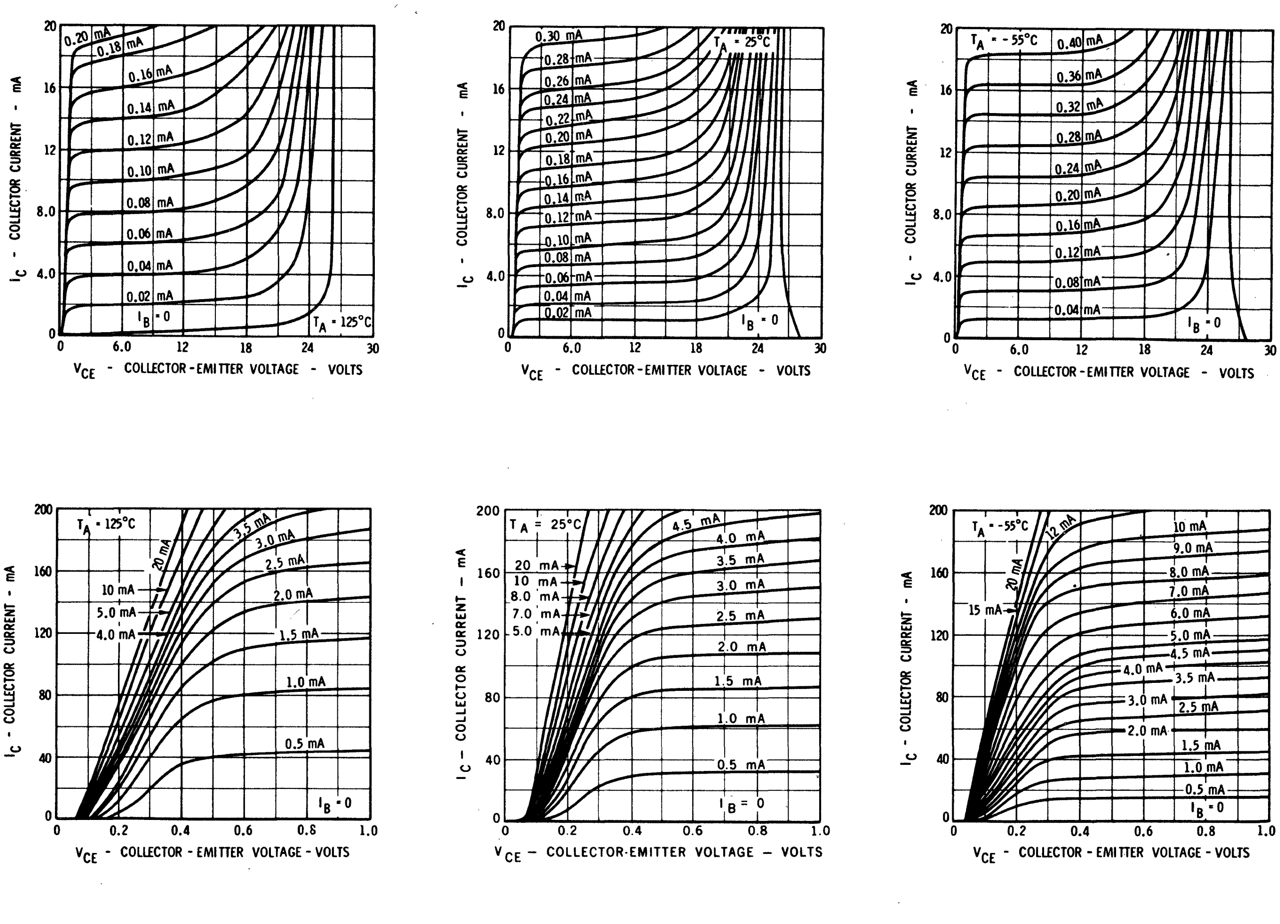
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 5)	30	60	120		$I_C = 30$ mA	$V_{CE} = 0.4$ V
h_{FE}	DC Pulse Current Gain (Note 5)	25	45			$I_C = 10$ mA	$V_{CE} = 0.4$ V
h_{FE}	DC Pulse Current Gain (Note 5)	25	55			$I_C = 100$ mA	$V_{CE} = 1.0$ V
$h_{FE}(-55°C)$	DC Pulse Current Gain (Note 5)	12	30			$I_C = 30$ mA	$V_{CE} = 0.4$ V
$V_{CE}(sat)$	Collector Saturation Voltage		0.15	0.18	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{CE}(sat)$	Collector Saturation Voltage		0.16	0.18	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
$V_{CE}(sat)$	Collector Saturation Voltage (+125°C)		0.19	0.25	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
$V_{CE}(sat)$	Collector Saturation Voltage		0.18	0.35	Volts	$I_C = 100$ mA	$I_B = 10$ mA
$V_{BE}(sat)$	Base Saturation Voltage	0.7	0.75	0.8	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{BE}(sat)$	Base Saturation Voltage	0.75	0.82	0.95	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
$V_{BE}(sat)$	Base Saturation Voltage		0.97	1.2	Volts	$I_C = 100$ mA	$I_B = 10$ mA

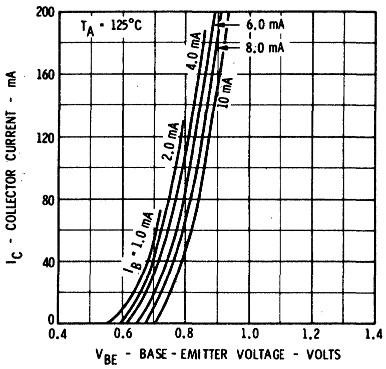
NOTES:

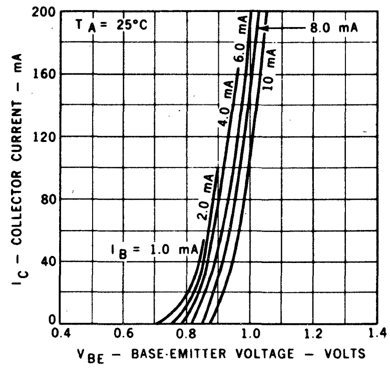
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature 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) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

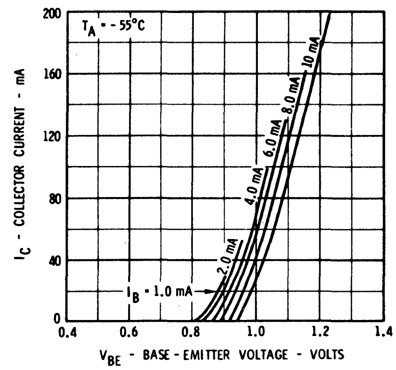
TYPICAL COLLECTOR CHARACTERISTICS



TYPICAL BASE CHARACTERISTICS

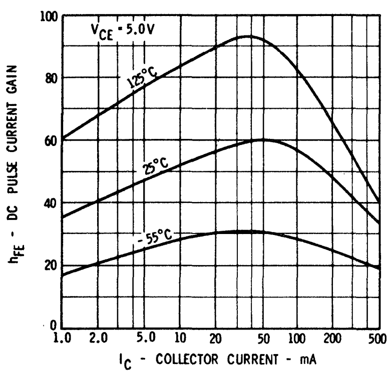




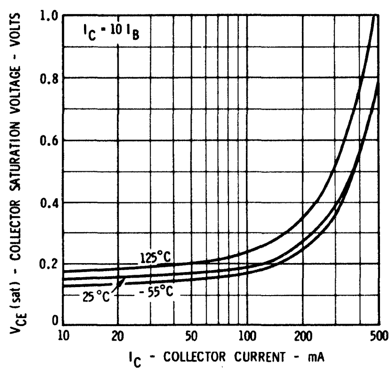


TYPICAL ELECTRICAL CHARACTERISTICS

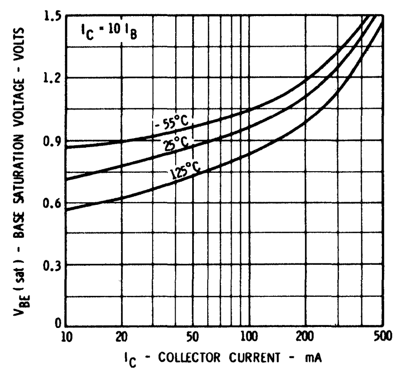
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



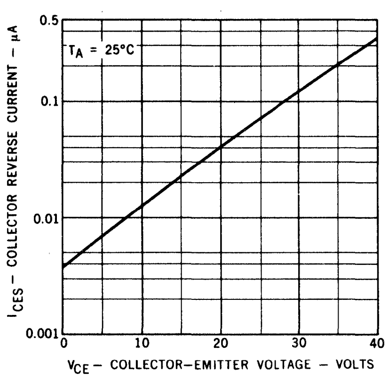
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



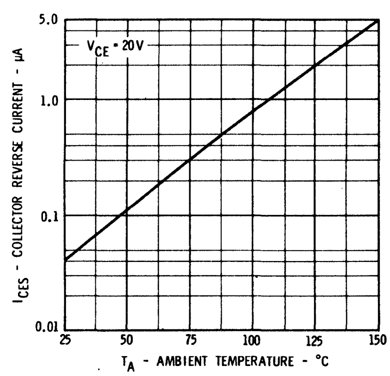
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



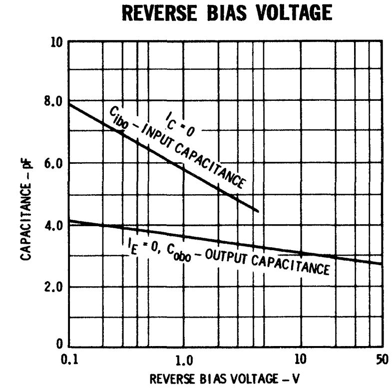
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



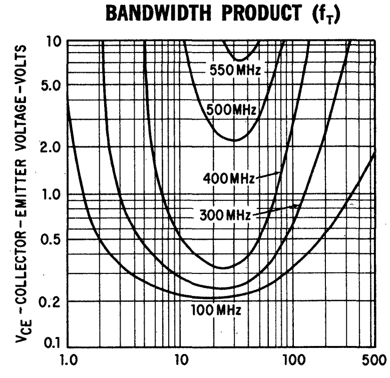
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



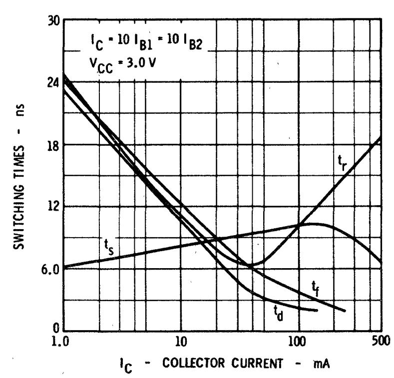
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



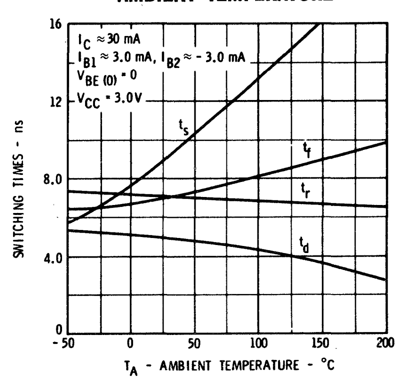
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



SWITCHING TIMES VERSUS COLLECTOR CURRENT

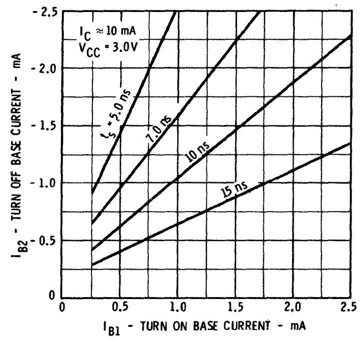


SWITCHING TIMES VERSUS AMBIENT TEMPERATURE

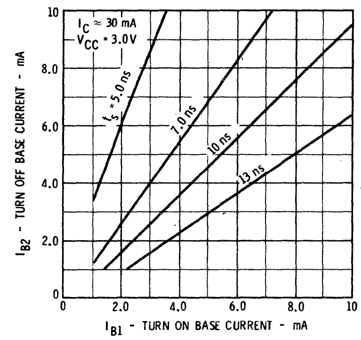


TYPICAL SWITCHING CHARACTERISTICS

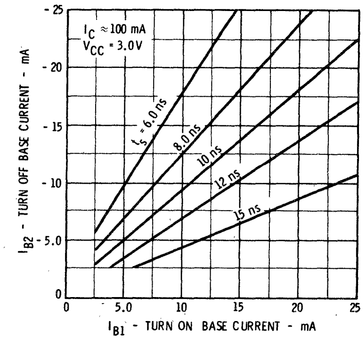
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



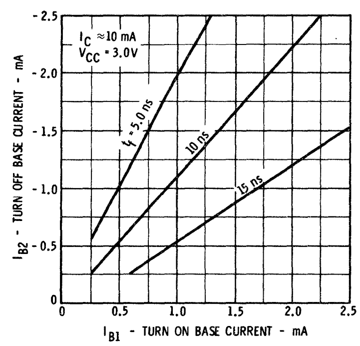
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



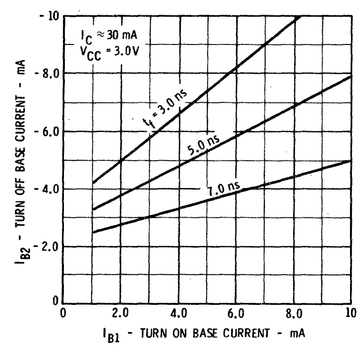
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



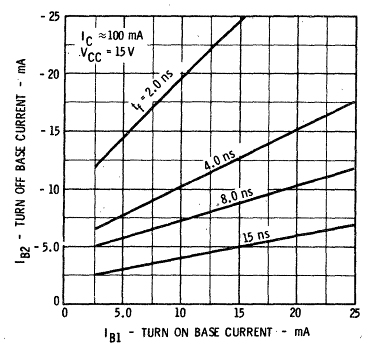
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



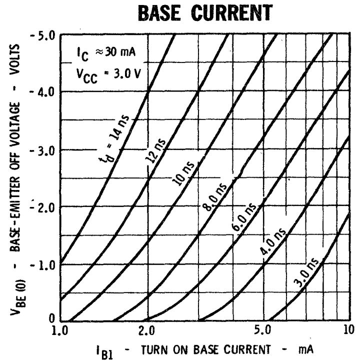
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



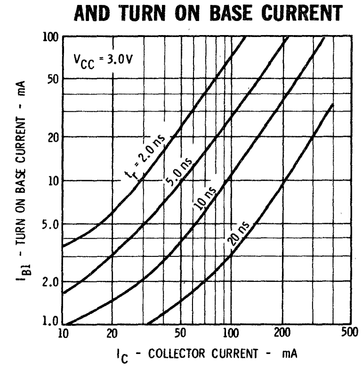
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



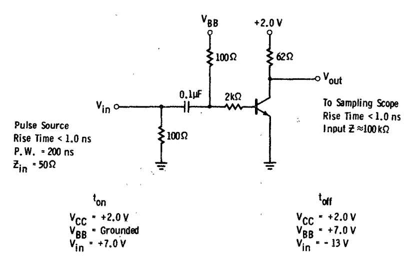
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



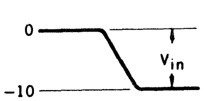
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



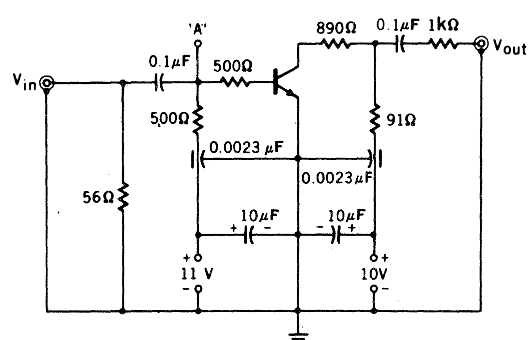
t_{ON} AND t_{OFF} TEST CIRCUIT

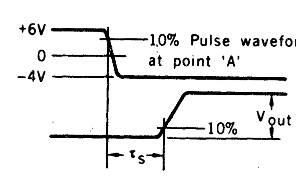


CHARGE STORAGE TIME MEASUREMENT CIRCUIT



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

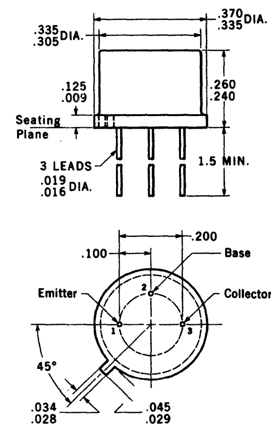
2N3015

FAIRCHILD NPN DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

HIGH SPEED SATURATED SWITCH

The 2N3015 is an NPN double-diffused silicon PLANAR epitaxial transistor designed primarily for high-speed commercial switching applications at collector currents to 500 milliamperes and collector voltages to 60 volts. It is an excellent core driver with switching times guaranteed at 300 and 500 mA, and an LV_{CEO} of 30 volts.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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]	3.0 Watts
at 25°C Ambient Temperature [Notes 2 and 3]	0.8 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	
h_{FE}	DC Pulse Current Gain [Note 5]	30	63	120		$I_C = 150$ mA	$V_{CE} = 10$ V
h_{FE}	DC Pulse Current Gain [Note 5]	10	50			$I_C = 300$ mA	$V_{CE} = 0.7$ V
V_{CE} (sat)	Collector Saturation Voltage [pulsed, see Note 5]		0.23	0.4	Volts	$I_C = 150$ mA	$I_B = 15$ mA
V_{CE} (sat)	Collector Saturation Voltage [pulsed, see Note 5]		0.46	1.0	Volts	$I_C = 500$ mA	$I_B = 50$ mA
V_{BE} (sat)	Base Saturation Voltage [pulsed, see Note 5]		0.85	1.2	Volts	$I_C = 150$ mA	$I_B = 15$ mA
V_{BE} (sat)	Base Saturation Voltage [pulsed, see Note 5]		1.12	1.6	Volts	$I_C = 500$ mA	$I_B = 50$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz	2.5	3.3			$I_C = 50$ mA	$V_{CE} = 10$ V
I_{CES}	Collector Reverse Current		0.05	0.2	μA	$V_{BE} = 0$	$V_{CE} = 30$ V
I_{CBO} (125°C)	Collector Cutoff Current		6.5	200	μA	$I_E = 0$	$V_{CB} = 30$ V
C_{obo}	Output Capacitance		5.0	8.0	pF	$I_E = 0$	$V_{CB} = 10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	60			Volts	$I_C = 100$ μA	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	30			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			Volts	$I_E = 100$ μA	$I_C = 0$
t_{on}	Turn On Time [Note 6]		22	40	nsec	$I_C \approx 300$ mA	$I_{B1} \approx 30$ mA
t_{on}	Turn On Time [Note 6]		22	40	nsec	$I_C \approx 500$ mA	$I_{B1} \approx 50$ mA
t_{off}	Turn Off Time [Note 6]		22	60	nsec	$I_C \approx 300$ mA, $I_{B1} \approx 30$ mA,	$I_{B2} \approx -30$ mA
t_{off}	Turn Off Time [Note 6]		22	60	nsec	$I_C \approx 500$ mA, $I_{B1} \approx 50$ mA,	$I_{B2} \approx -50$ mA

* Planar is a patented Fairchild process.

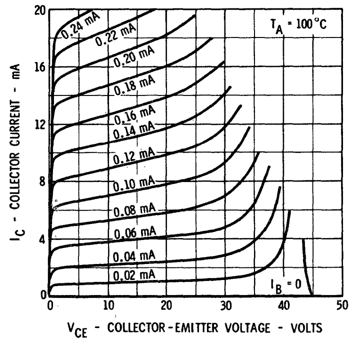
NOTES:
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 58.3°C/watt (derating factor of 17.2 mW/°C). Junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.6 mW/°C).

(Notes continued on page 4)

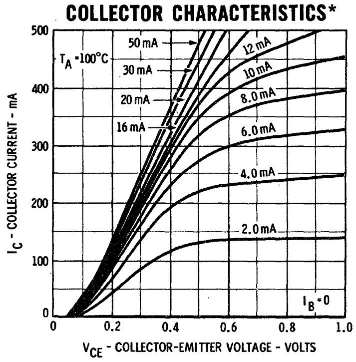
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

TYPICAL ELECTRICAL CHARACTERISTICS

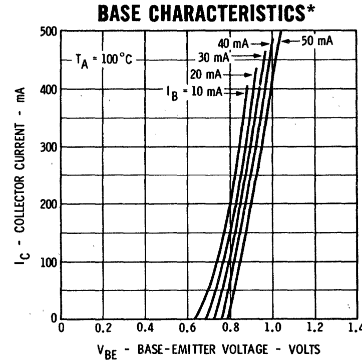
COLLECTOR CHARACTERISTICS*



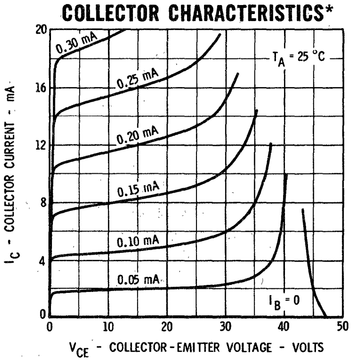
COLLECTOR CHARACTERISTICS*



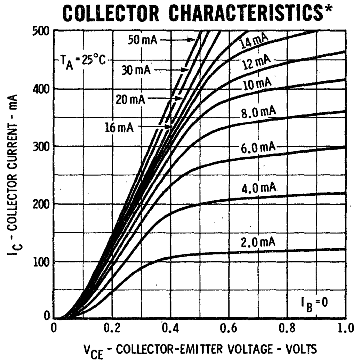
BASE CHARACTERISTICS*



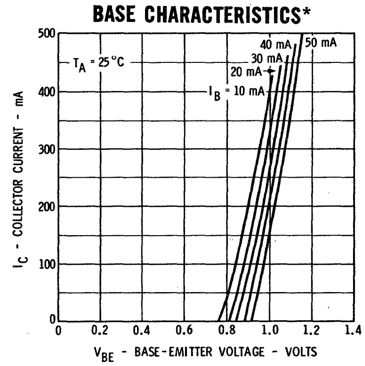
COLLECTOR CHARACTERISTICS*



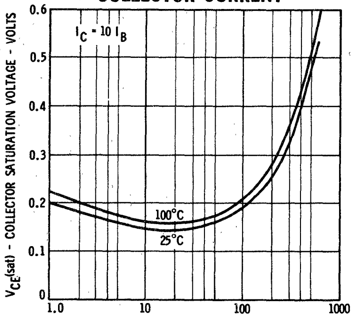
COLLECTOR CHARACTERISTICS*



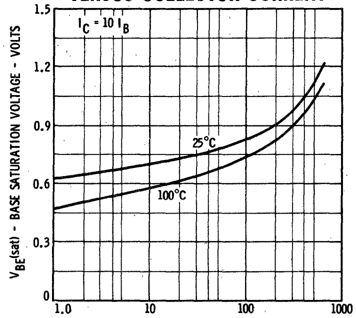
BASE CHARACTERISTICS*



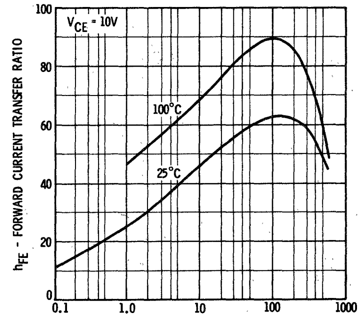
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



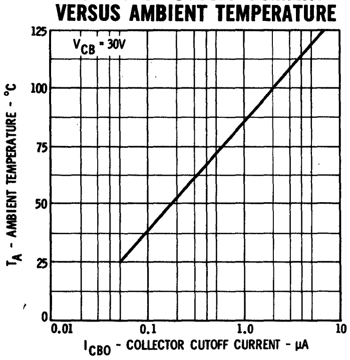
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



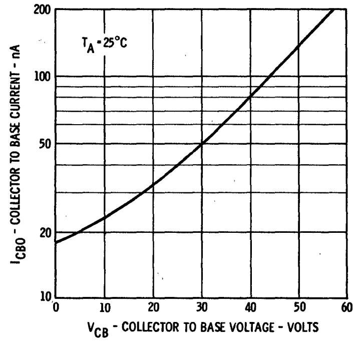
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

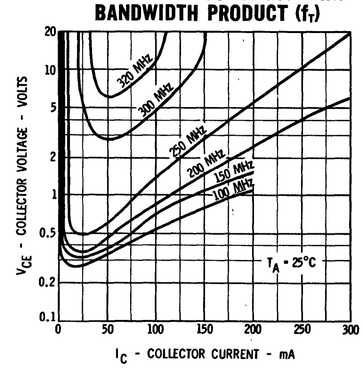
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



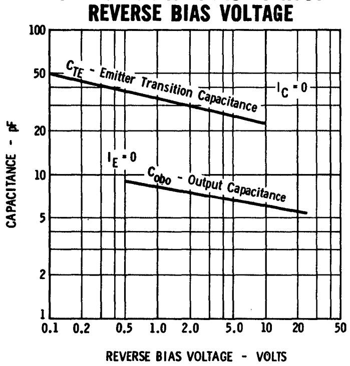
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



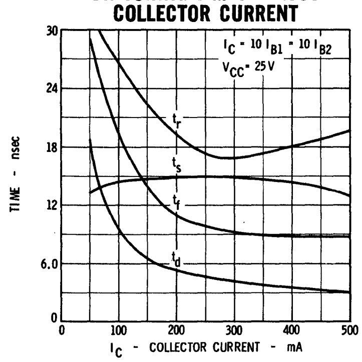
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



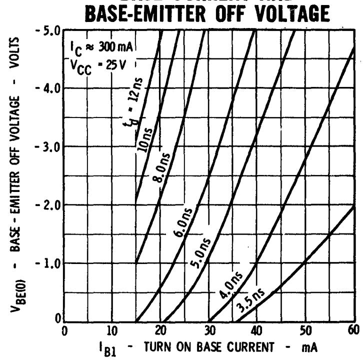
EMITTER TRANSISTION AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



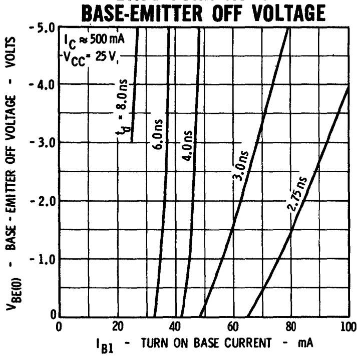
SWITCHING TIMES VERSUS COLLECTOR CURRENT



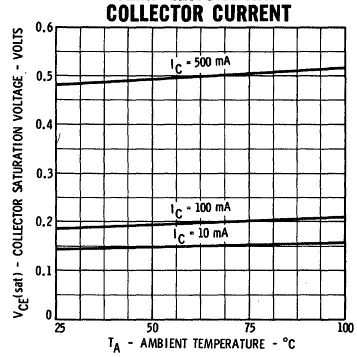
DELAY TIME VERSUS TURN ON BASE CURRENT AND BASE-EMITTER OFF VOLTAGE



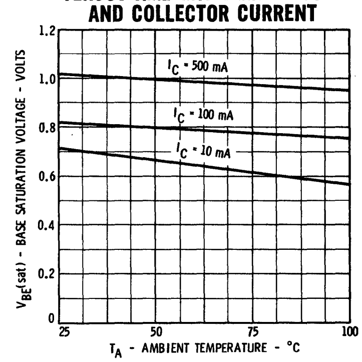
DELAY TIME VERSUS TURN ON BASE CURRENT AND BASE-EMITTER OFF VOLTAGE



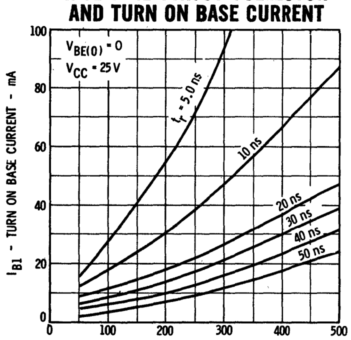
COLLECTOR SATURATION VOLTAGE VERSUS AMBIENT TEMPERATURE AND COLLECTOR CURRENT



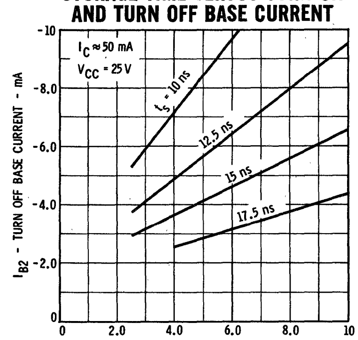
BASE SATURATION VOLTAGE VERSUS AMBIENT TEMPERATURE AND COLLECTOR CURRENT



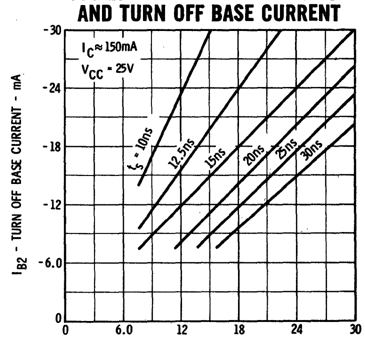
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



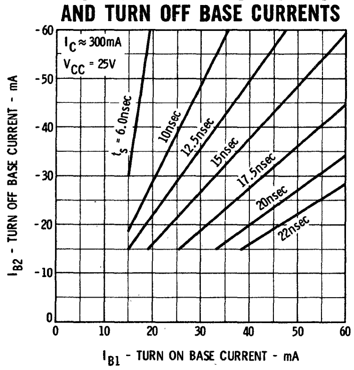
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



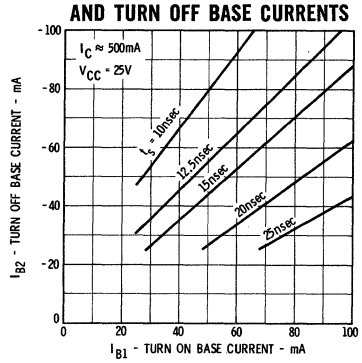
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



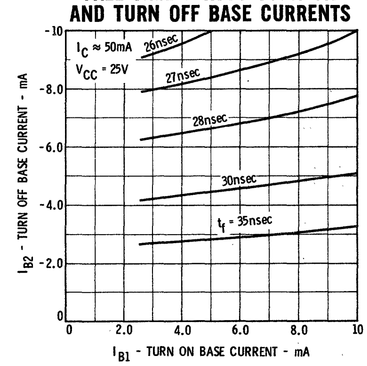
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



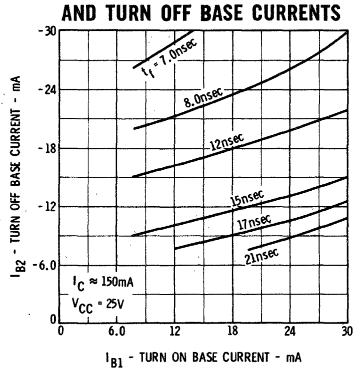
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



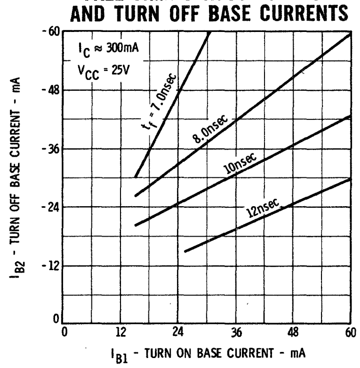
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



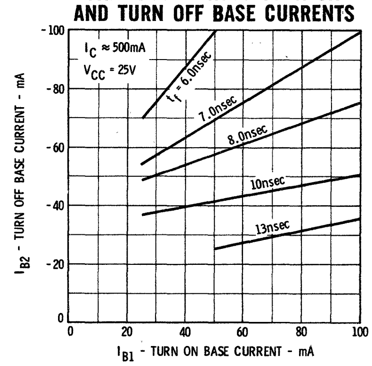
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



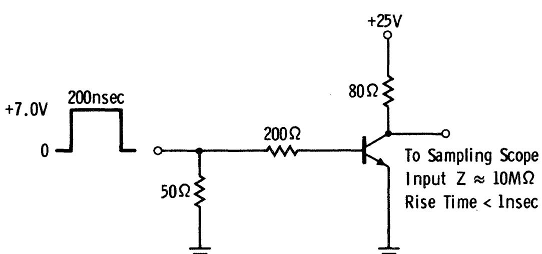
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

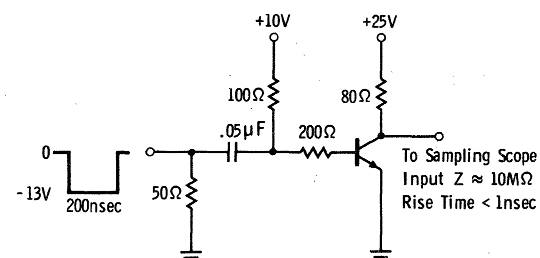


t_{on} TEST CIRCUIT ($I_C \approx$ 300 mA)



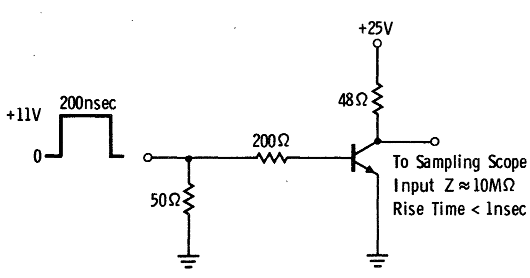
Rise time of input pulse < 2.0nsec
Input impedance ≈ 50Ω

t_{off} TEST CIRCUIT ($I_C \approx$ 300 mA)



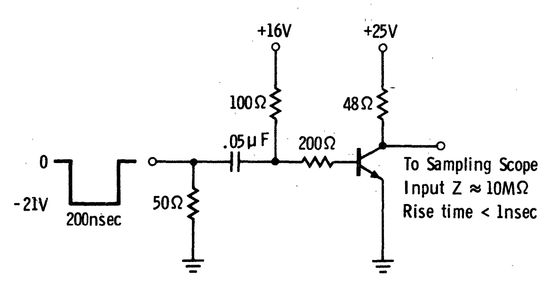
Rise Time of input pulse < 2.0nsec
Input impedance ≈ 50Ω

t_{on} TEST CIRCUIT ($I_C \approx$ 500 mA)



Rise time of input pulse < 2.0nsec
Input impedance ≈ 50Ω

t_{off} TEST CIRCUIT ($I_C \approx$ 500 mA)



Rise time of input pulse < 2.0nsec
Input impedance ≈ 50Ω

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuits for exact values of I_C, I_{B1}, and I_{B2}.

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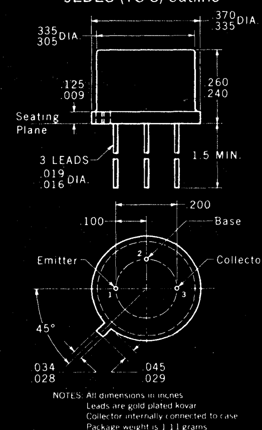
2N3019 • 2N3020

NPN HIGH VOLTAGE GENERAL PURPOSE AMPLIFIERS

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3019 and 2N3020 are NPN Silicon Planar Epitaxial Transistors designed primarily for amplifier and switching applications. These devices feature high breakdown voltages, low leakage currents, low capacity and a beta useful over an extremely wide current range. Switching operation at 1.0 ampere is permissible due to the low saturation voltage.

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



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, No Time Limit)	+300°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	5.0 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.8 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	140 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	80 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts

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

Symbol	Characteristic	2N3019 Min.	2N3019 Max.	2N3020 Min.	2N3020 Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	90		40	120		I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	100	300	40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain	50		30	100		I_C = 0.1 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50		30	100		I_C = 500 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	15		15			I_C = 1.0 A	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	40					I_C = 150 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.2		0.2	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.5		0.5	Volts	I_C = 500 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.1		1.1	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 Mc)	5.0		4.0			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance (f = 1 Mc)		12		12	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance (f = 1 Mc)		60		60	pf	I_C = 0	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		10		10	nA	I_E = 0	V_{CB} = 90 V
I_{CBO}(150°C)	Collector Cutoff Current		10		10	μA	I_E = 0	V_{CB} = 90 V
I_{EBO}	Emitter Cutoff Current		10		10	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	140		140		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	80		80		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0		7.0		Volts	I_C = 0	I_E = 100 μA
$r_b'C_c$	Collector-Base Time Constant (f = 4 Mc)		400		400	psec	I_C = 10 mA	V_{CB} = 10 V
NF	Noise Figure (Note 6)		4			db	I_C = 100 μA	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 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 350°C/Watt (derating factor of 28.6 mW/°C; junction-to- ambient thermal resistance of 218°C/Watt (derating factor of 4.6 mW/°C.
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μsec; duty cycle $\leq 1\%$.
(6) f = 1.0 Kc; R_S = 1 KΩ.

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

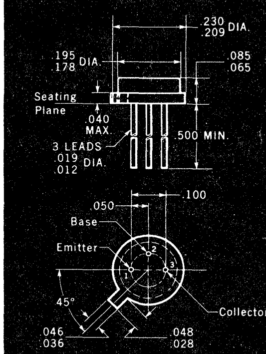
2N3056 · 2N3056A · 2N3057 · 2N3057A

NPN HIGH-VOLTAGE, HIGH-CURRENT AMPLIFIERS

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - These devices are NPN silicon Planar epitaxial transistors designed for use in high-current amplifier applications. Operation to one ampere plus collector to emitter voltage of 60 and 80 volts is permissible.

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 (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction 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)	5.0 Watts
at 100°C Case Temperature	(Notes 2 and 3)	2.8 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.4 Watt

Maximum Voltages and Current

			2N3056 2N3057	2N3056A 2N3057A
V_{CBO}	Collector to Base Voltage		100 Volts	140 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	60 Volts	80 Volts
V_{EBO}	Emitter to Base Voltage		7.0 Volts	7.0 Volts
I_C	Continuous Collector Current	(Note 2)	1.0 Amp	1.0 Amp

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

Symbol	Characteristic	2N3056 2N3056A Min.	2N3056 2N3056A Max.	2N3057 2N3057A Min.	2N3057 2N3057A Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	100	300		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	90			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	30	100	50			I_C = 100 μA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	100	50			I_C = 500 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)			40			I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	15		15			I_C = 1.0 A	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage (pulsed, see Note 5)		1.1		1.1	Volts	I_C = 150 mA	I_B = 15 mA
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	30	200	80	400		I_C = 1.0 mA	V_{CE} = 5.0 V
C_{obo}	Open Circuit Output Capacitance		12		12	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Open Circuit Input Capacitance		60		60	pf	I_C = 0	V_{EB} = 0.5 V
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0		7.0		Volts	I_E = 100 μA	I_C = 0
I_{EBO}	Emitter Cutoff Current		10		10	nA	I_C = 0	V_{EB} = 5.0 V
NF	Noise Figure (Note 6)				4.0	db	I_C = 100 μA	V_{CE} = 10 V

Additional Electrical Characteristics on page 2 **(See notes on back page)**

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

Symbol	Characteristic	2N3056 2N3057 Min.	2N3056 2N3057 Max.	2N3056A 2N3057A Min.	2N3056A 2N3057A Max.	Units	Test Conditions
BV_{CBO}	Collector to Base Breakdown Voltage	100		140		Volts	I_C = 100 µA, I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	60		80		Volts	I_C = 30 mA (pulsed), I_B = 0
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.25		0.2	Volts	I_C = 150 mA (pulsed), I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.7		0.5	Volts	I_C = 500 mA (pulsed), I_B = 50 mA
I_{CBO}	Collector Cutoff Current		10			nA	I_E = 0, V_{CB} = 60 V
I_{CBO}	Collector Cutoff Current				10	nA	I_E = 0, V_{CB} = 90 V
I_{CBO}(150°C)	Collector Cutoff Current		10			µA	I_E = 0, V_{CB} = 60 V
I_{CBO}(150°C)	Collector Cutoff Current				10	µA	I_E = 0, V_{CB} = 90 V
$r_b'C_c$	Collector-Base Time Constant (f = 4.0 MHz)		400	25	400	psec	I_C = 10 mA, V_{CB} = 10 V
h_{fe}	High Frequency Current Gain (2N3056 only) (f = 20 MHz)	4.0					I_C = 50 mA, V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (2N3056A only) (f = 20 MHz)			4.0	10		I_C = 50 mA, V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (2N3057 only) (f = 20 MHz)	5.0					I_C = 50 mA, V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (2N3057A only) (f = 20 MHz)			5.0	10		I_C = 50 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 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 35°C/watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 438°C/watt (derating factor of 2.28 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

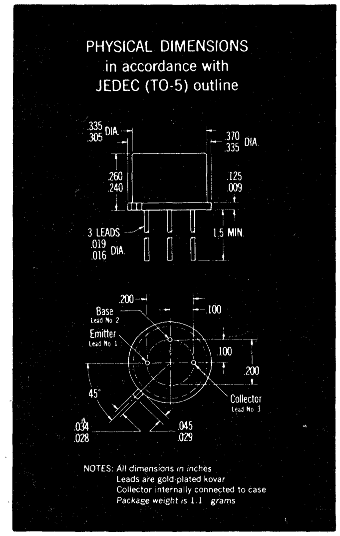
(6) f = 1.0 KHz, R_G = 1.0 KΩ.

2N3072 • 2N3073

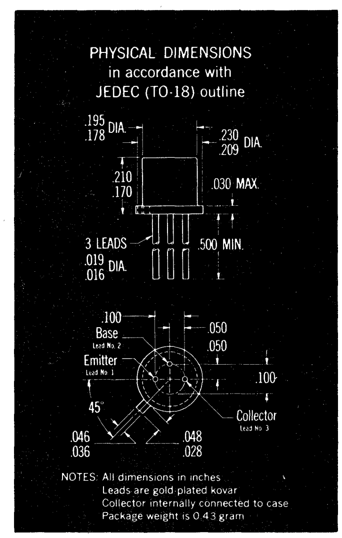
PNP VHF AMPLIFIERS, HIGH CURRENT SWITCHES

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

The **2N3072** and **2N3073** are PNP silicon PLANAR epitaxial transistors designed for digital and analog applications at current levels to 500 milliamperes. The high gain-bandwidth product, f_T, at high currents, makes them excellent units for line driving and memory applications.



2N3072



2N3073

ABSOLUTE MAXIMUM RATINGS [Note 1]

	2N3072	2N3073
Maximum Temperatures		
Storage Temperature	**−65°C** to **+200°C**	**−65°C** to **+200°C**
Operating Junction Temperature	**200°C** Maximum	**200°C** Maximum
Lead Temperature (Soldering, 60 sec time limit)	**300°C** Maximum	**300°C** Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	**3.0** Watts	**1.2** Watts
at 25°C Ambient Temperature [Notes 2 and 3]	**0.8** Watt	**0.36** Watt
Maximum Voltages and Current		
V_{CBO} Collector to Base Voltage	**−60** Volts	**−60** Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	**−60** Volts	**−60** Volts
V_{EBO} Emitter to Base Voltage	**−4.0** Volts	**−4.0** Volts
I_C Collector Current [Note 2]	**500** mA	**500** 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]	30	67	130		$I_C = 50$ mA	$V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	15	43			$I_C = 300$ mA	$V_{CE} = -2.0$ V
V_{BE} (sat)	Base Saturation Voltage		−0.9	−1.2	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{BE} (sat)	Base Saturation Voltage		−1.25	−2.0	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{CE} (sat)	Collector Saturation Voltage		−0.08	−0.25	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{CE} (sat)	Collector Saturation Voltage		−0.33	−1.0	Volts	$I_C = 300$ mA	$I_B = 30$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	1.3	2.0			$I_C = 50$ mA	$V_{CE} = -20$ V
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	−60			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
t_{on}	Turn On Time [Note 6]		17	40	nsec	$I_C \approx 300$ mA	$I_{B1} \approx 30$ mA
t_{off}	Turn Off Time [Note 6]		40	100	nsec	$I_C \approx 300$ mA,	$I_{B1} \approx 30$ mA, $I_{B2} \approx -30$ mA

Additional Electrical Characteristics on page 2.

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 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N3072 and 146°C/Watt (derating factor of 6.85 mW/°C) for the 2N3073. Junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C for the 2N3072 and 486°C/Watt (derating factor of 2.1 mW/°C) for the 2N3073.
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μSec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

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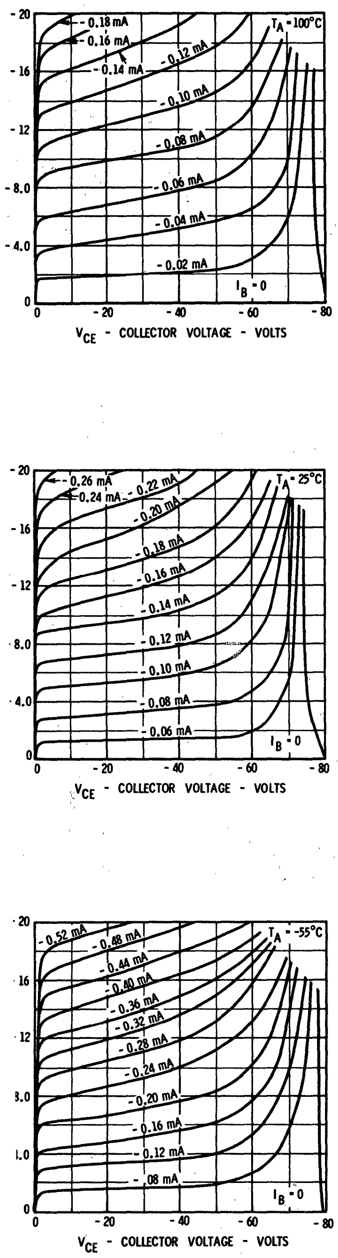
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

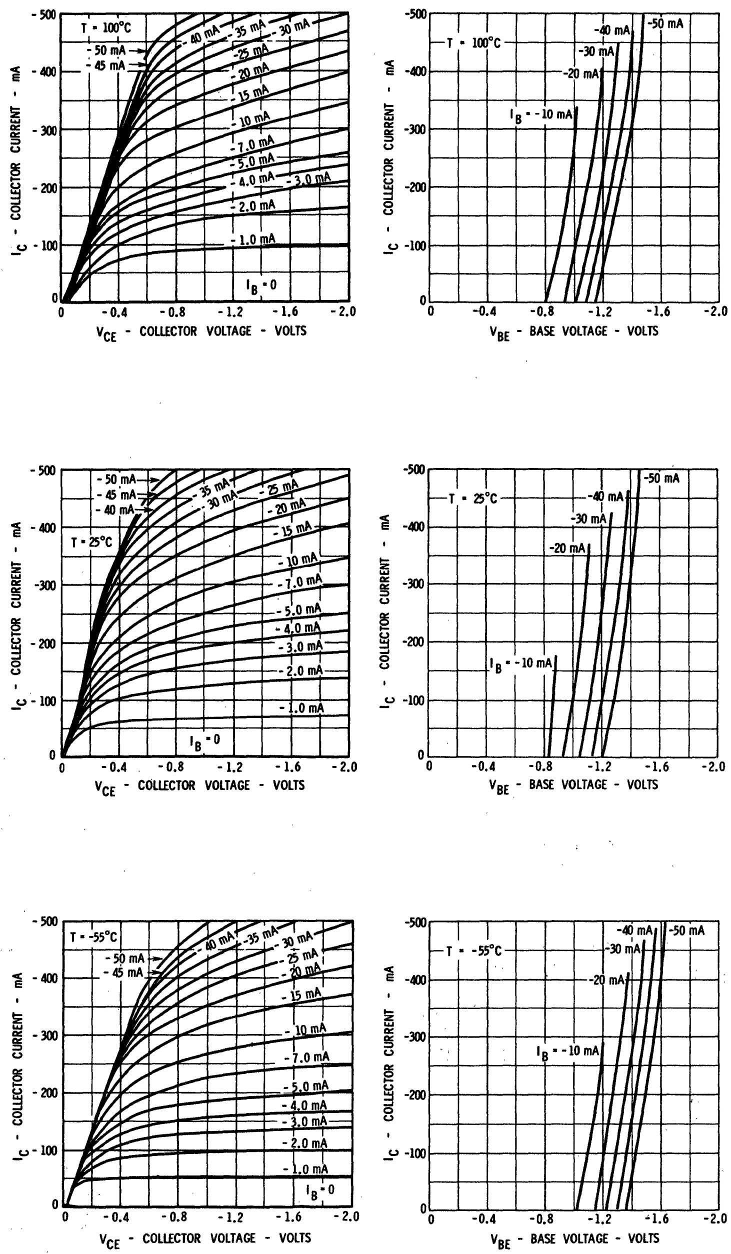
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	12	35			$I_C = 50$ mA	$V_{CE} = -1.0$ V
C_{ob}	Output Capacitance		7.0	10	pf	$I_E = 0$	$V_{CB} = -10$ V
I_{CES}	Collector Reverse Current		0.033	10	nA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current		0.3	10	μA	$V_{CE} = -30$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−60			Volts	$I_C = 100$ μA	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.0			Volts	$I_E = 100$ μA	$I_C = 0$

TYPICAL COLLECTOR AND BASE CHARACTERISTICS *

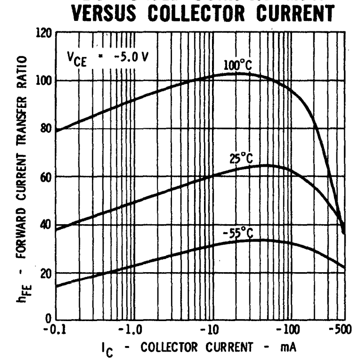
ACTIVE REGION



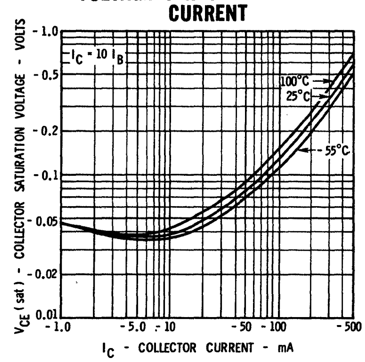
SATURATION REGION



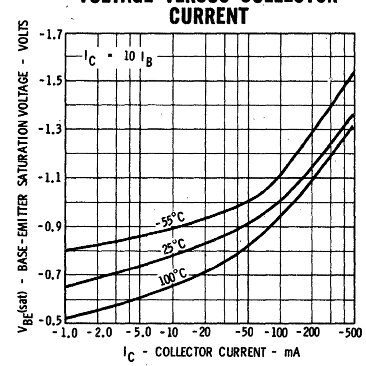
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



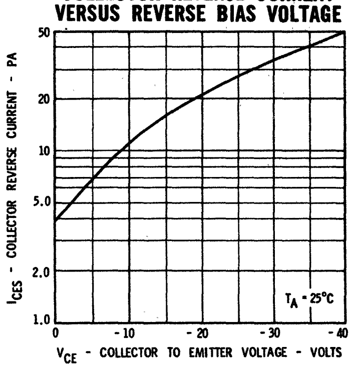
PULSED BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



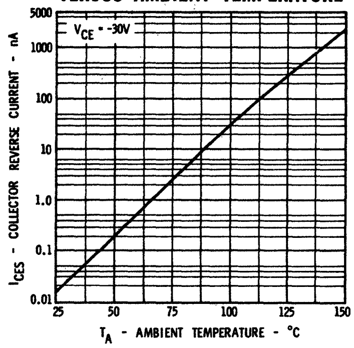
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

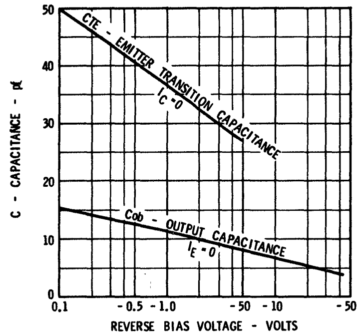
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



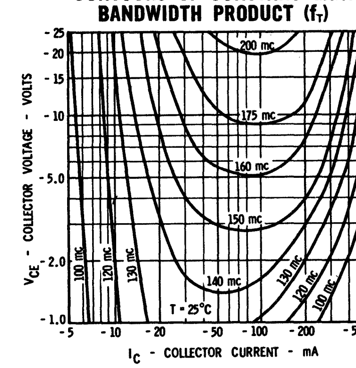
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



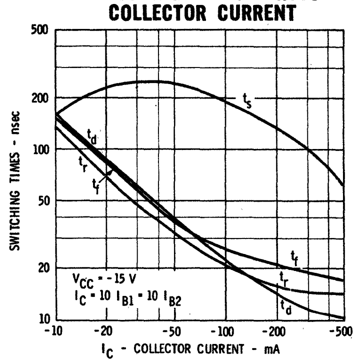
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



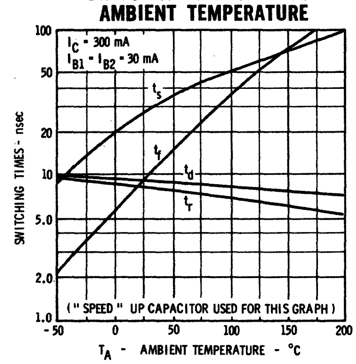
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



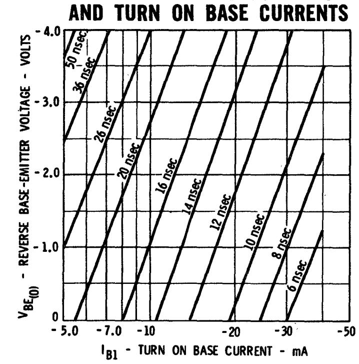
SWITCHING TIMES VERSUS COLLECTOR CURRENT



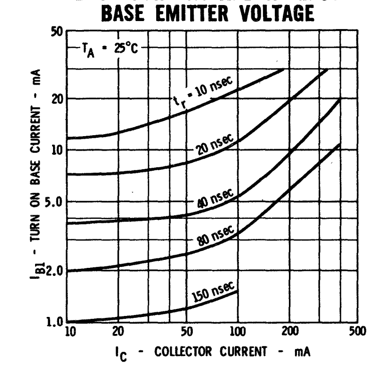
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



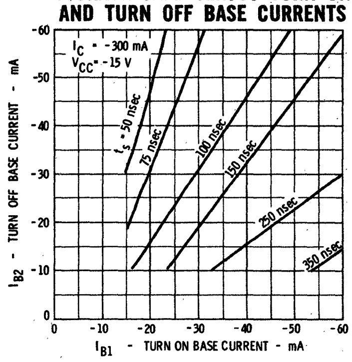
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



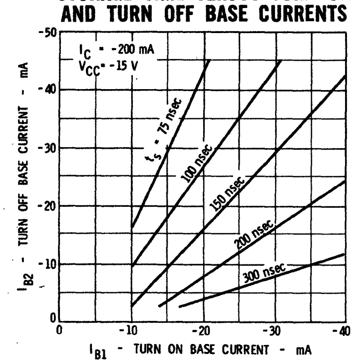
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



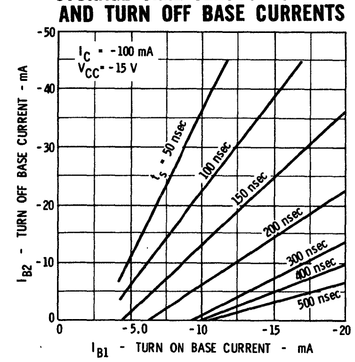
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



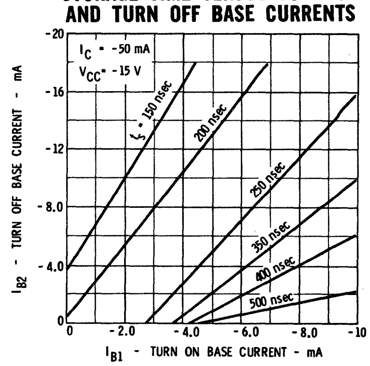
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



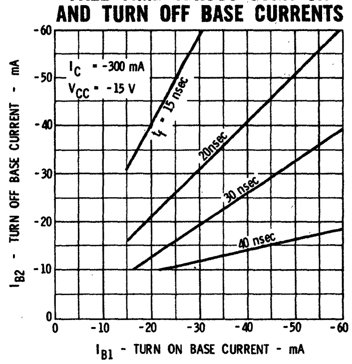
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



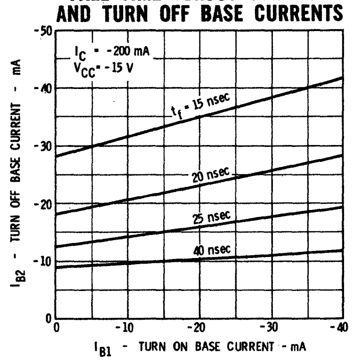
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



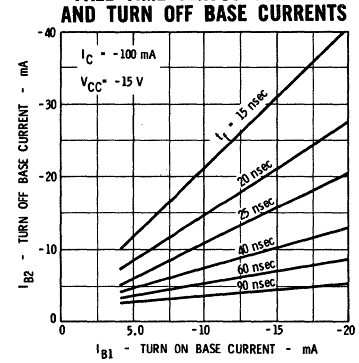
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



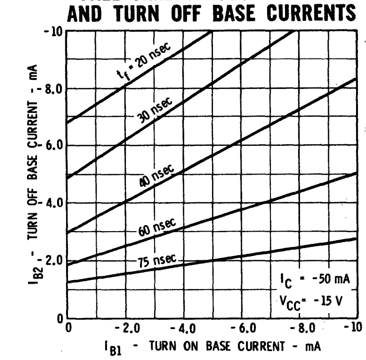
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

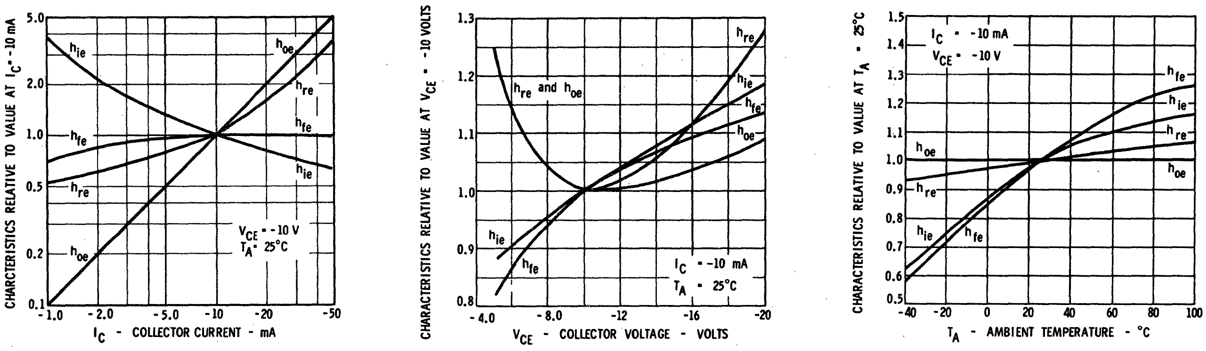


FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



All data for switching curves taken without a "speed-up" capacitor unless otherwise noted.

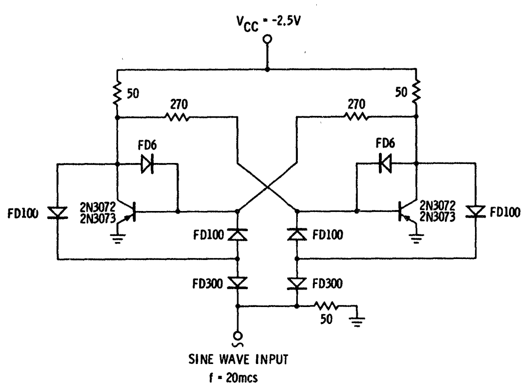
SMALL SIGNAL CHARACTERISTICS



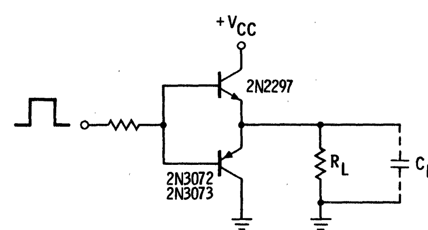
h PARAMETERS (f = 1 kc)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance		480	1500	ohms	I_C = 10 mA	V_{CE} = −10 V
h_{oe}	Output Conductance		80	1200	μmhos	I_C = 10 mA	V_{CE} = −10 V
h_{re}	Voltage Feedback Ratio		162	2600	x10^{-6}	I_C = 10 mA	V_{CE} = −10 V
h_{fe}	Small Signal Current Gain	25	74	180		I_C = 10 mA	V_{CE} = −10 V

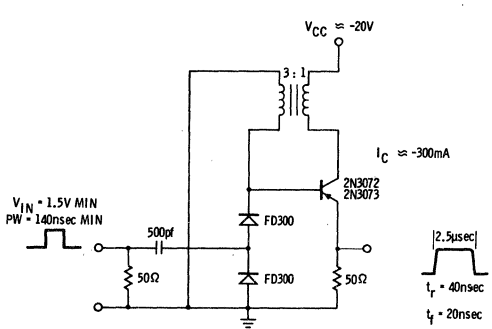
20 MC BINARY COUNTER



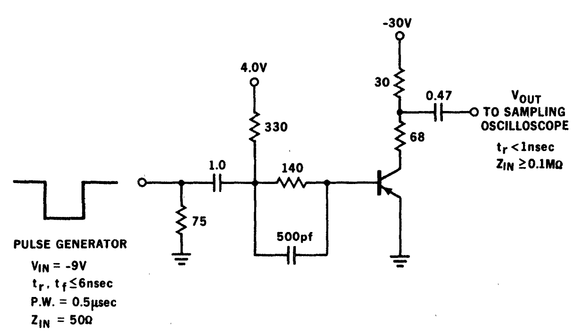
LINE DRIVER



MONOSTABLE BLOCKING OSCILLATOR



T_{ON} and T_{OFF} TEST CIRCUIT



FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

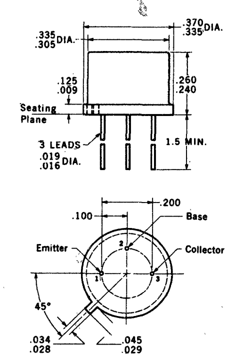
2N3107 • 2N3108 • 2N3109 • 2N3110

NPN HIGH-VOLTAGE, HIGH-CURRENT AMPLIFIERS AND SATURATED SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **HIGH VOLTAGE** . . . . **LV_{CEO} = 40 V (MIN) (2N3109/10); 60 V (MIN) (2N3107/8)**
- **LOW SATURATION VOLTAGE** . . . **V_{CE}(sat) = 1.0 V (MAX) AT 1.0 A**
- **LOW NOISE** . . . . **NF = 7.0 dB (MAX) AT 1.0 kHz**
- **MEDIUM SWITCHING SPEED** . . . **t_{on} = 200 ns (MAX) AT 150 mA**
  t_{off} = 600 ns (MAX) AT 150 mA
- **HIGH GAIN** . . . . **h_{FE} = 100 - 300 AT 150 mA**
  h_{FE} = 40 (MIN) AT 500 mA

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 second time limit)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	5.0 Watts
at 25°C Ambient Temperature	0.8 Watt

Maximum Voltages and Current		**2N3107 • 2N3108**	**2N3109 • 2N3110**
V_{CBO}	Collector to Base Voltage	100 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	60 Volts	40 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts	7.0 Volts

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

SYMBOL	CHARACTERISTICS	2N3107 • 2N3109 MIN.	TYP.	MAX.	2N3108 • 2N3110 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Pulse Current Gain** (Note 5)	**100**	**190**	**300**	40	70	120		**I_C = 150 mA**	V_{CE} = 1.0 V
h_{FE}	**DC Pulse Current Gain** (Note 5)	**40**	**90**		25	50			**I_C = 500 mA**	V_{CE} = 10 V
h_{FE}	DC Current Gain	35	75		20	40			I_C = 0.1 mA	V_{CE} = 10 V
h_{FE}(−55°C)	DC Pulse Current Gain (Note 5)	30	120		15	26			I_C = 150 mA	V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.86	1.1		0.86	1.1	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage (Notes 5 and 6)		1.5	2.0		1.5	2.0	Volts	I_C = 1.0 A	I_B = 100 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.16	0.25		0.16	0.25	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (Notes 5 and 6)		0.76	1.0		0.76	1.0	Volts	I_C = 1000 mA	I_B = 100 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.5	10		3.0	4.3			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Open Circuit Output Capacitance	(2N3107 only)		20	(2N3108 only)		20	pF	I_E = 0	V_{CB} = 10 V
C_{obo}	Open Circuit Output Capacitance	(2N3109 only)		25	(2N3110 only)		25	pF	I_E = 0	V_{CB} = 10 V
C_{ibo}	Open Circuit Input Capacitance		62	80		62	80	pF	I_E = 0	V_{EB} = 0.5 V
I_{CES}	Collector Reverse Current		0.4	10		0.4	10	nA	V_{CE} = 60 V	V_{EB} = 0
I_{CBO}(150°C)	Collector Cutoff Current		0.5	10		0.5	10	μA	V_{CB} = 60 V	I_E = 0
I_{EBO}	Emitter Cutoff Current		0.05	10		0.05	10	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	100	(2N3107 only)		100	(2N3108 only)		Volts	I_E = 0	I_C = 100 μA
BV_{CBO}	Collector to Base Breakdown Voltage	80	(2N3109 only)		80	(2N3110 only)		Volts	I_E = 0	I_C = 100 μA
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**60**	(2N3107 only)		**60**	(2N3108 only)		**Volts**	I_B = 0	**I_C = 30 mA**
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	40	(2N3109 only)		40	(2N3110 only)		Volts	I_B = 0	I_C = 30 mA
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0			7.0			Volts	I_C = 0	I_E = 100 μA
NF	**Noise Figure (f = 1.0 kHz)**		**3.5**	**7.0**		**3.5**	**7.0**	**dB**	**I_C = 30 μA, BW = 200 Hz**	**V_{CE} = 10 V, R_S = 1.0 kΩ**
t_{on}	**Turn On Time** (Note 7)		120	200		**120**	**200**	**ns**	**I_C ≈ 150 mA, I_{B2} ≈ −7.5 mA**	**I_{B1} ≈ 7.5 mA**
t_{off}	**Turn Off Time** (Note 7)			1000		**350**	**600**	**ns**	**I_C ≈ 150 mA, I_{B2} ≈ −7.5 mA**	**I_{B1} ≈ 7.5 mA**

Additional Electrical Characteristics on page 2 Notes on page 4

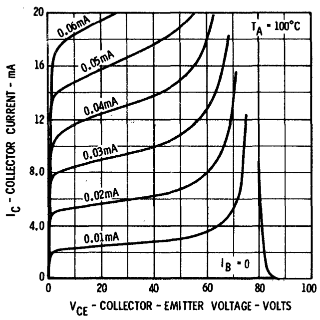
*Planar is a patented Fairchild process.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

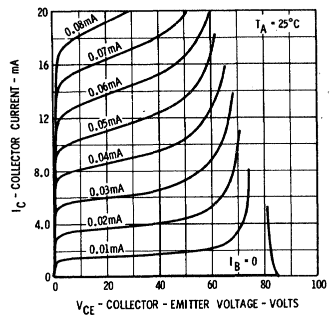
TYPICAL ELECTRICAL CHARACTERISTICS

2N3107

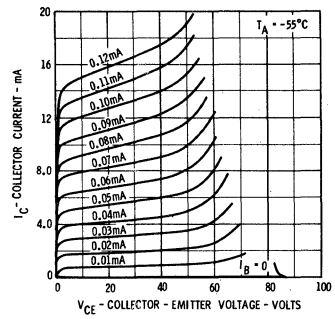
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*

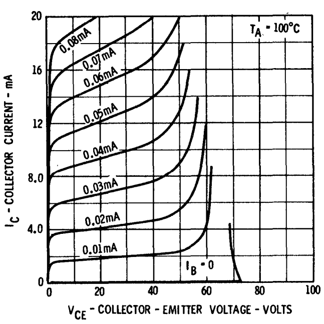


COLLECTOR CHARACTERISTICS*

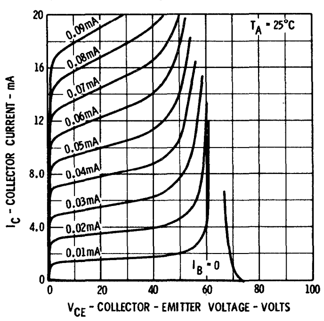


2N3109

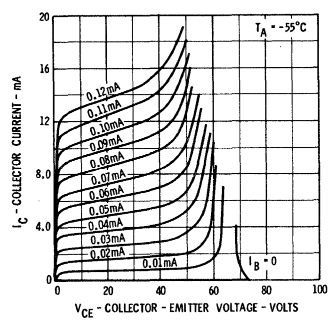
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*

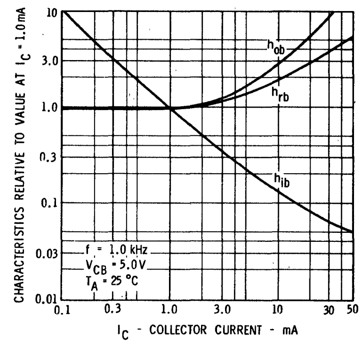


COLLECTOR CHARACTERISTICS*



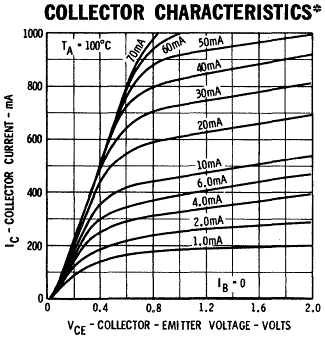
2N3107 THRU 2N3110

TYPICAL COMMON BASE CHARACTERISTICS

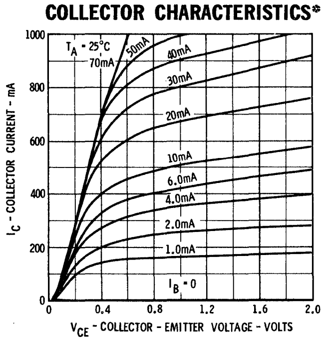


2N3107 • 2N3109

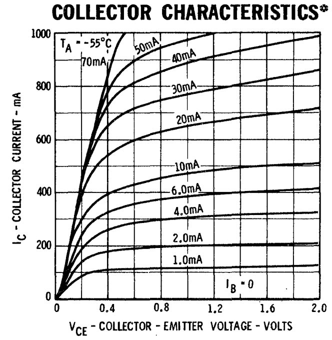
COLLECTOR CHARACTERISTICS*

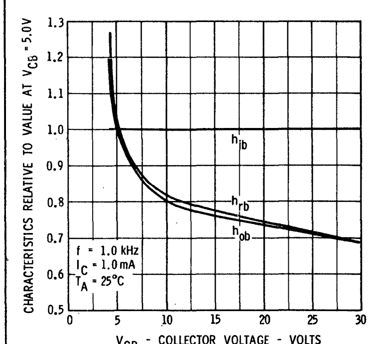


COLLECTOR CHARACTERISTICS*

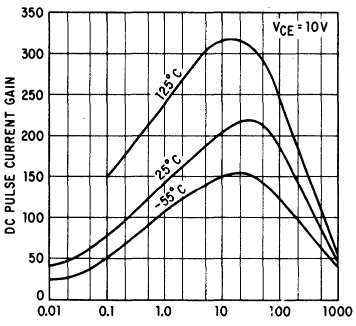


COLLECTOR CHARACTERISTICS*

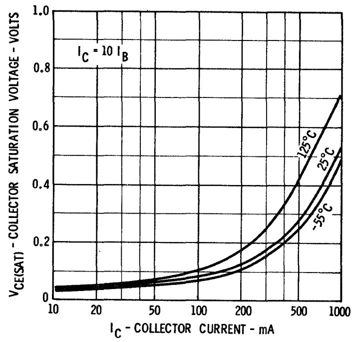




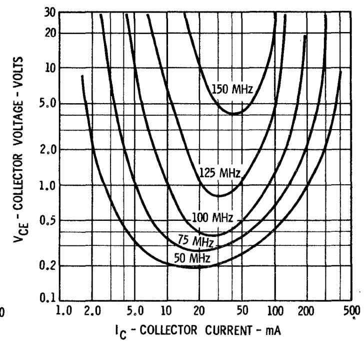
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

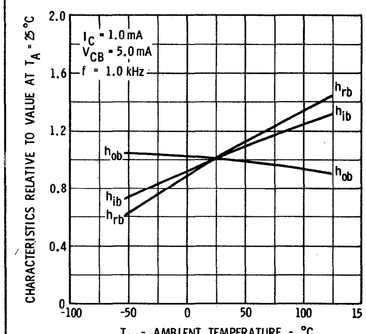


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



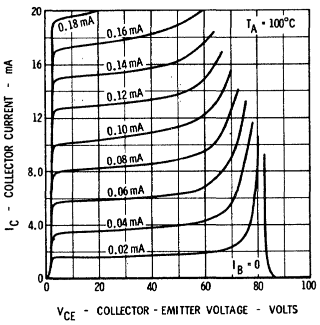


* Single family characteristics on Transistor Curve Tracer.

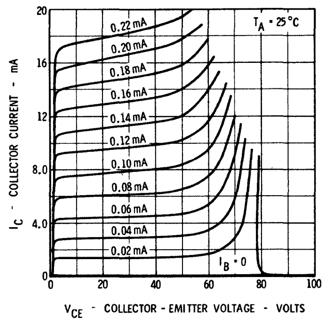
TYPICAL ELECTRICAL CHARACTERISTICS

2N3108

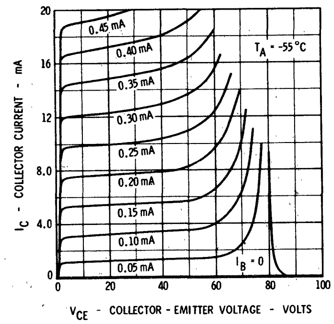
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*

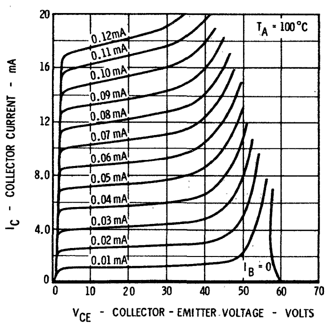


COLLECTOR CHARACTERISTICS*

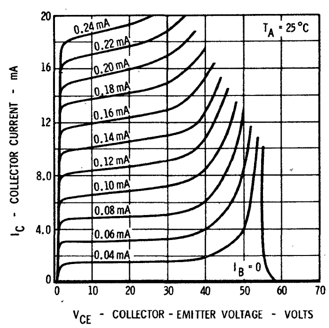


2N3110

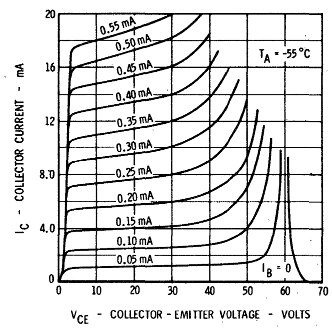
COLLECTOR CHARACTERISTICS*



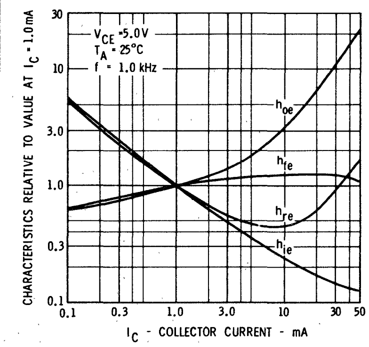
COLLECTOR CHARACTERISTICS*

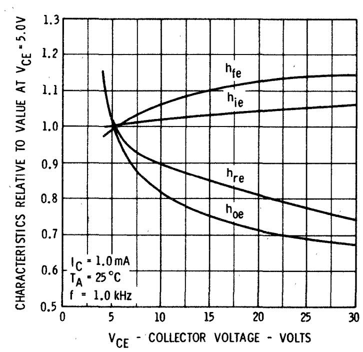


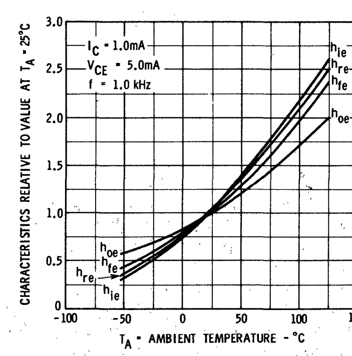
COLLECTOR CHARACTERISTICS*



2N3107 THRU 2N3110

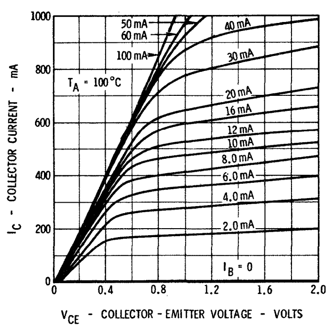




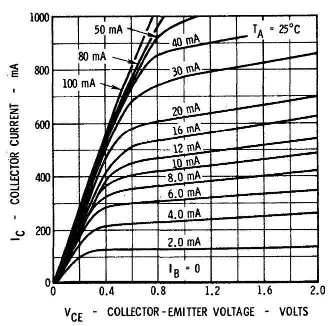


2N3108 • 2N3110

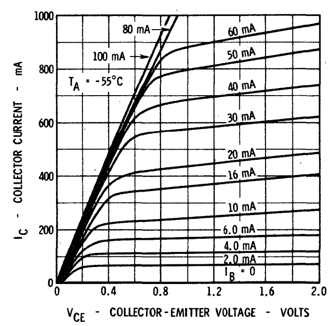
COLLECTOR CHARACTERISTICS*



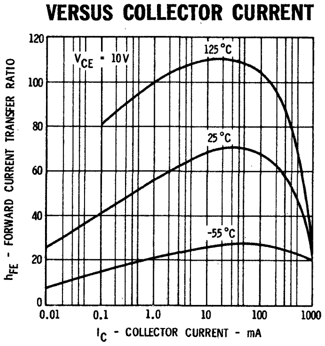
COLLECTOR CHARACTERISTICS*



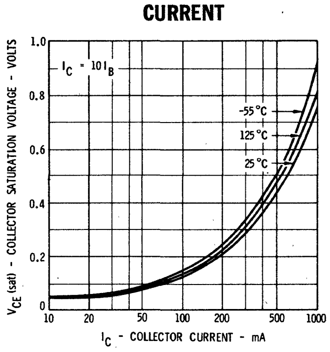
COLLECTOR CHARACTERISTICS*



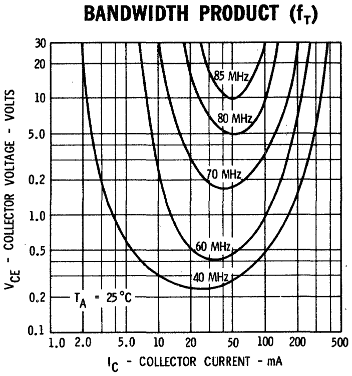
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

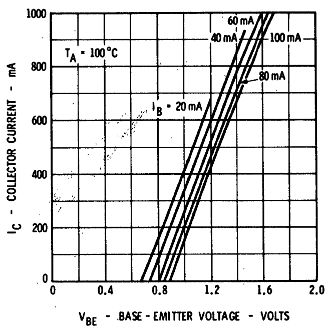


* Single family characteristics on Transistor Curve Tracer.

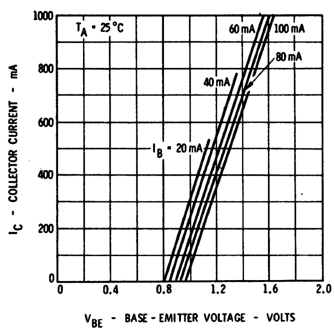
TYPICAL ELECTRICAL CHARACTERISTICS

2N3107 THRU 2N3110

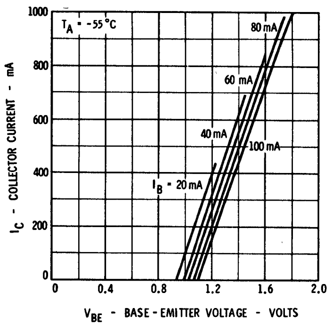
BASE CHARACTERISTICS*



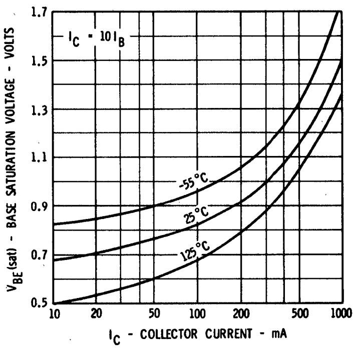
BASE CHARACTERISTICS*



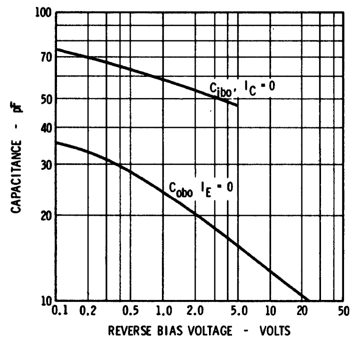
BASE CHARACTERISTICS*



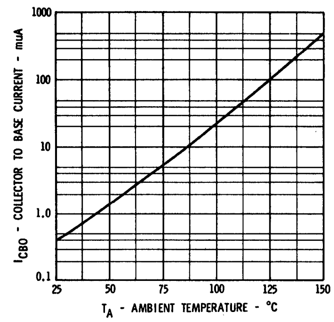
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE

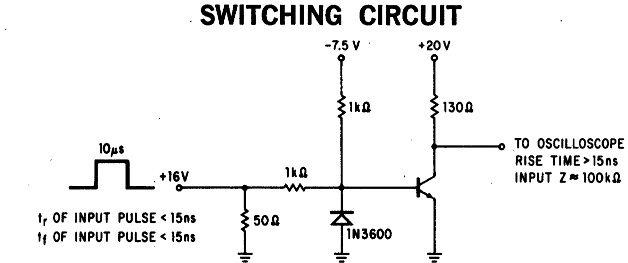


* Single family characteristics on Transistor Curve Tracer.

TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

SYMBOL	2N3107 2N3109 TYP.	2N3108 2N3110 TYP.	UNITS	CONDITIONS	
h_{ib}	27	27	ohms	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{ob}	0.12	0.12	μmhos	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{rb}	1.8	0.5	$X10^{-4}$	I_C = 1.0 mA	V_{CB} = 5.0 V
h_{ie}	5000	1800	ohms	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{oe}	20	8.0	μmhos	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{re}	6.0	2.1	$X10^{-4}$	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{fe}	170	60		I_C = 1.0 mA	V_{CE} = 5.0 V

SWITCHING 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 give a maximum junction temperature of 200°C and junction to case thermal resistance of 35°C/Watt (derating factor of 28.6 mW/°C); junction to ambient thermal resistance of 218°C/Watt (derating factor of 4.57 mW/°C).
(4) 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.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) Saturation voltage measured with 1/4" lead length.
(7) See test circuit for exact values of I_C, I_{B1}, and I_{B2}.

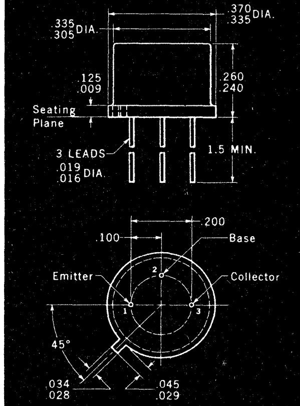
2N3114

NPN HIGH-VOLTAGE AMPLIFIER

DIFFUSED SILICON PLANAR TRANSISTOR

The 2N3114 is an NPN silicon PLANAR transistor primarily designed for high-voltage, medium-power amplifier applications. This device features a guaranteed minimum LV_{CEO} of 150 volts and a minimum f_T of 40 mc, and operates at current levels up to 100 mA.

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.10 grams

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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]	5.0 Watts
at 25°C Free Air Temperature [Notes 2 and 3]	0.8 Watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	150 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	150 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 Pulse Current Gain [Note 5]	30	60	120		$I_C = 30$ mA	$V_{CE} = 10$ V
h_{FE}	DC Current Gain	15	35			$I_C = 100$ μA	$V_{CE} = 10$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	12	24			$I_C = 30$ mA	$V_{CE} = 10$ V
V_{BE} (sat)	Base Saturation Voltage		0.8	0.9	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.3	1.0	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CBO}	Collector Cutoff Current		0.3	10	nA	$I_E = 0$	$V_{CB} = 100$ V
I_{CBO} (150°C)	Collector Cutoff Current		2.7	10	μA	$I_E = 0$	$V_{CB} = 100$ V
I_{EBO}	Emitter Cutoff Current			100	nA	$I_C = 0$	$V_{EB} = 4.0$ V
h_{fe}	Small Signal Current Gain (f = 1.0 kc)	25	50			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 mc)	2.0	2.7			$I_C = 30$ mA	$V_{CE} = 10$ V
C_{ob}	Output Capacitance		6.0	9.0	pf	$I_E = 0$	$V_{CB} = 20$ V
C_{TE}	Emitter Transition Capacitance		70	80	pf	$I_C = 0$	$V_{EB} = 0.5$ V
R_e (h_{ie})	Real Part of Input Impedance (f = 100 mc)			30	ohms	$I_C = 10$ mA	$V_{CE} = 10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	150			Volts	$I_C = 100$ μA	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	150			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			Volts	$I_E = 100$ 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 35°C/watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse conditions: Length = 300 μsec; duty cycle = 1%.

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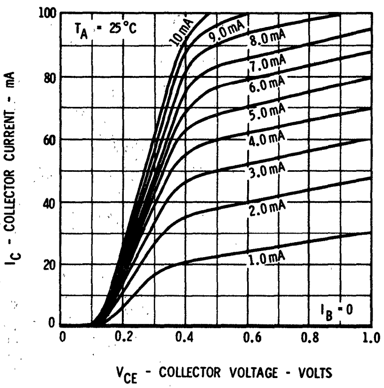
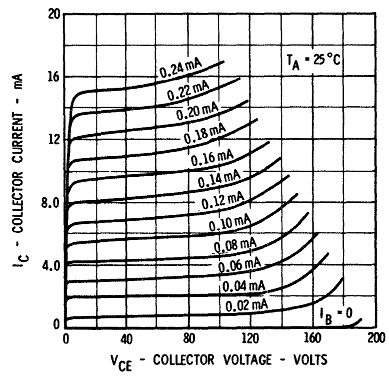
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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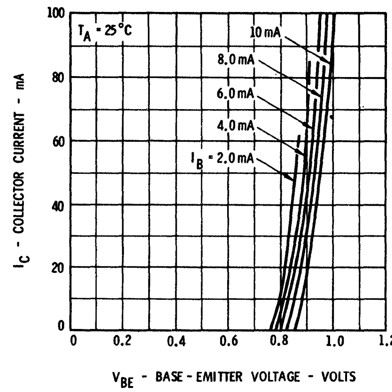

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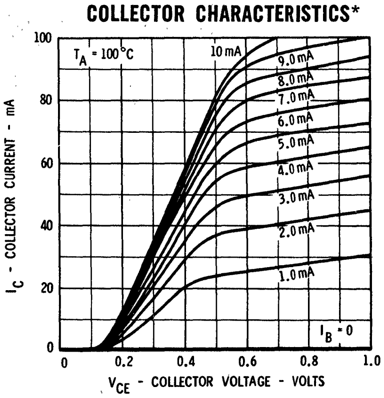

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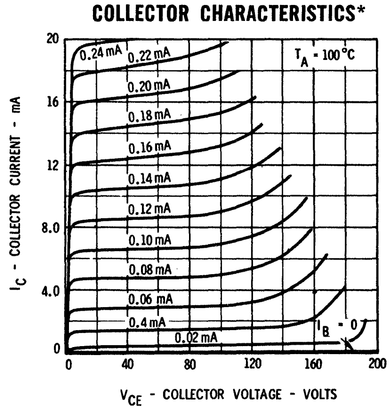
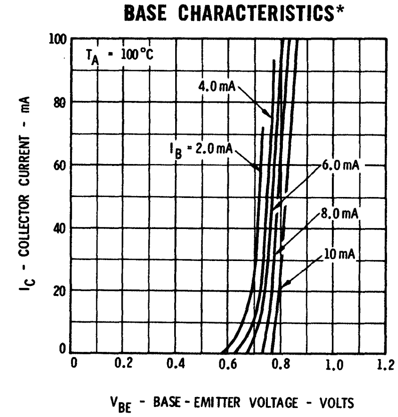


BASE CHARACTERISTICS*



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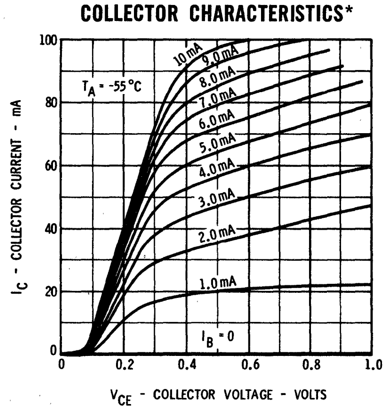

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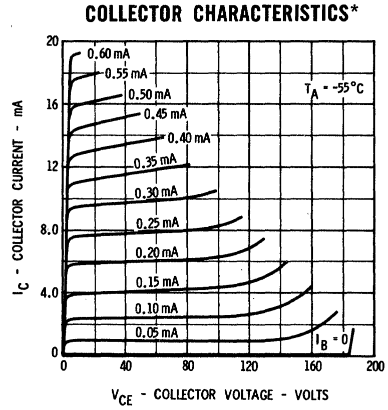
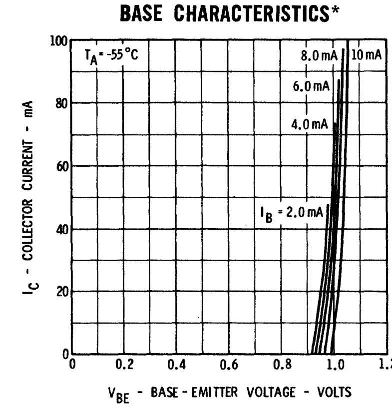


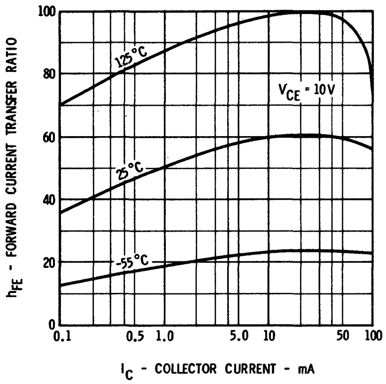
BASE CHARACTERISTICS*



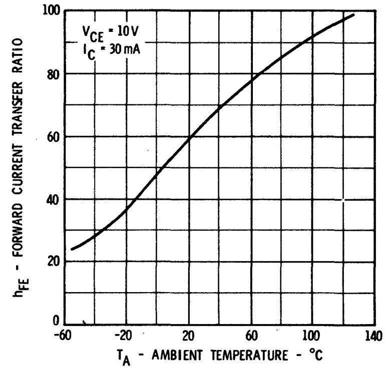
* Single family characteristics on Transistor Curve Tracer

TYPICAL ELECTRICAL CHARACTERISTICS

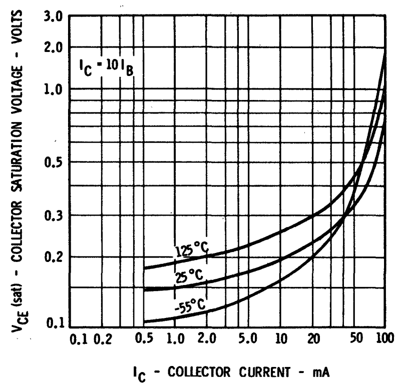
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



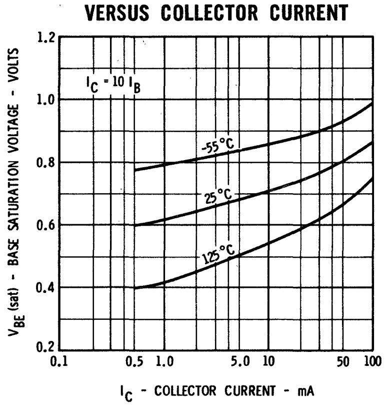
DC PULSED CURRENT GAIN VERSUS AMBIENT TEMPERATURE



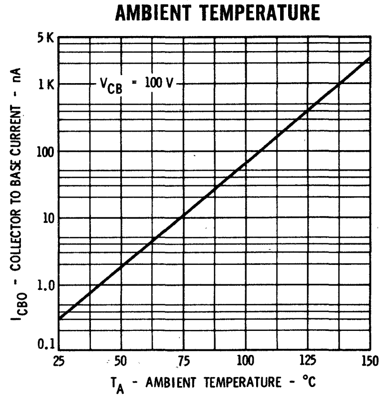
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



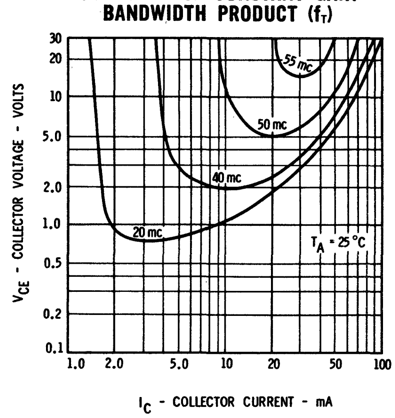
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



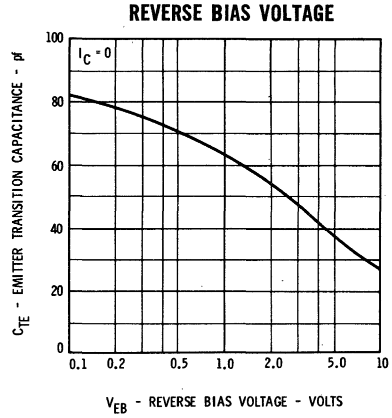
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



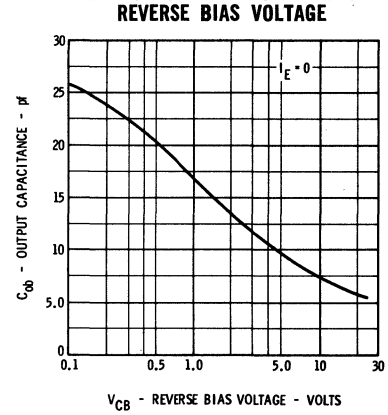
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



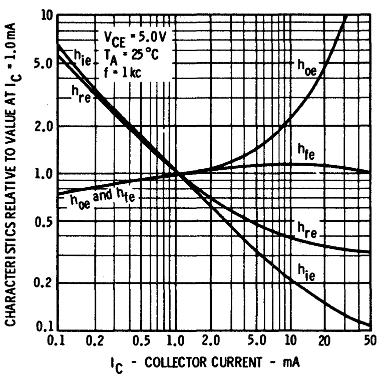
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

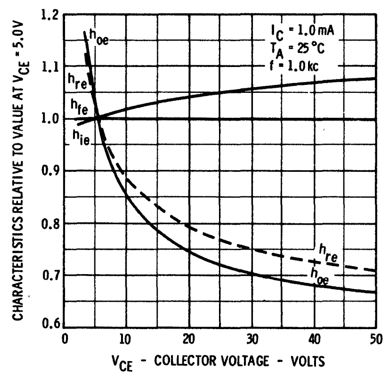


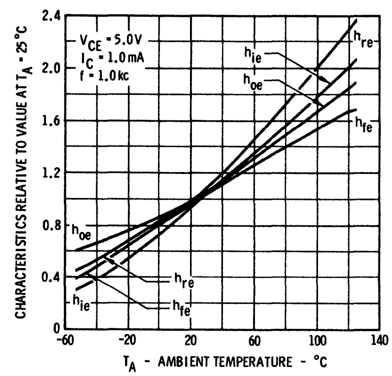
TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1.0 kc)

SYMBOL	CHARACTERISTIC	TYPICAL	UNITS	TEST CONDITIONS	
h_{fe}	Small Signal Current Gain	50		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ie}	Input Resistance	1.5	Kohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance	5.3	μmhos	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio	1.5	$\times 10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance	27	ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance	0.09	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{rb}	Voltage Feedback Ratio	0.25	$\times 10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V

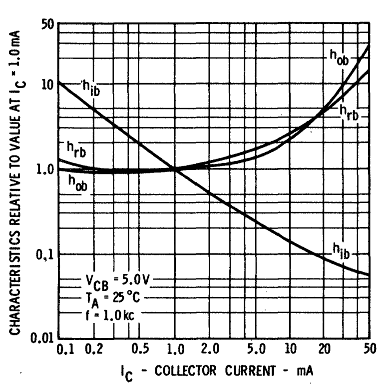
TYPICAL COMMON EMITTER CHARACTERISTICS

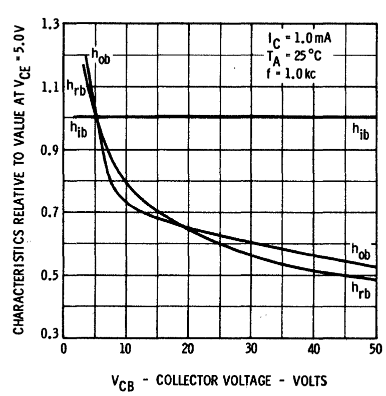


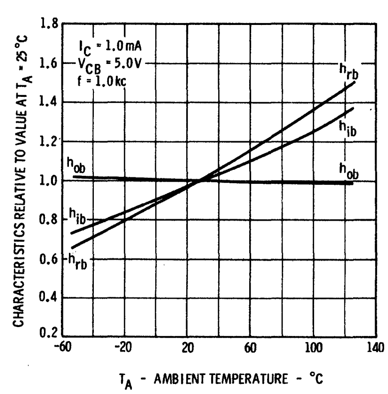




TYPICAL COMMON BASE CHARACTERISTICS







2N3117

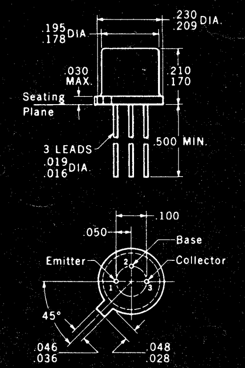
NPN VERY LOW-NOISE, LOW-LEVEL TYPE

DIFFUSED SILICON PLANAR TRANSISTOR

The 2N3117 is an NPN double-diffused silicon PLANAR transistor designed for use in high-performance, low-level, low-noise amplifiers from dc to 60 mc.

The very-low-noise characteristic over a wide range of source resistance makes this device ideal for transducer amplifiers. Also, high-beta at collector currents down to one microampere permits microwatt operation in applications where power supply drain is a factor, such as, solar cell power sources.

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 7]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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 8 and 9]	1.2 Watts
at 100°C Case Temperature [Notes 8 and 9]	0.68 Watt
at 25°C Ambient Temperature [Notes 8 and 9]	0.36 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	60 Volts
V_{CEO} Collector to Emitter Voltage [Note 6]	60 Volts
V_{EBO} Emitter to Base Voltage	6.0 Volts
I_C Collector Current	50 mA

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted).

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	250		500		$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	400				$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	300				$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	100				$I_C = 1.0\ \mu A$	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	DC Current Gain	50				$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
V_{BE} (on)	Emitter-Base On Voltage			0.7	Volts	$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage			0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
h_{fe}	High Frequency Current Gain (f = 30 mc)	2.0				$I_C = 0.5$ mA	$V_{CE} = 5.0$ V
I_{CBO}	Collector Cutoff Current			10	nA	$I_E = 0$	$V_{CB} = 45$ V
I_{CBO} (150°C)	Collector Cutoff Current			10	μA	$I_E = 0$	$V_{CB} = 45$ V
I_{EBO}	Emitter Cutoff Current			10	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{ob}	Output Capacitance			4.5	pf	$I_E = 0$	$V_{CB} = 5.0$ V
C_{TE}	Emitter Transition Capacitance			6.0	pf	$I_C = 0$	$V_{EB} = 0.5$ V
BV_{CBO}	Collector to Base Breakdown Voltage	60			Volts	$I_E = 0$	$I_C = 10\ \mu A$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 5 and 6]	60			Volts	$I_C = 10$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			Volts	$I_C = 0$	$I_E = 10\ \mu A$
NF	Narrow Band Noise Figure [Note 1]			1.0	db	$I_C = 5.0\ \mu A$	$V_{CE} = 5.0$ V
NF	Narrow Band Noise Figure [Note 2]			1.0	db	$I_C = 5.0\ \mu A$	$V_{CE} = 5.0$ V
NF	Narrow Band Noise Figure [Note 3]			4.0	db	$I_C = 30\ \mu A$	$V_{CE} = 5.0$ V
NF	Narrow Band Noise Figure [Note 4]			15	db	$I_C = 30\ \mu A$	$V_{CE} = 5.0$ V

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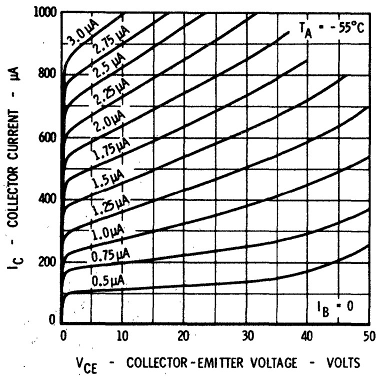
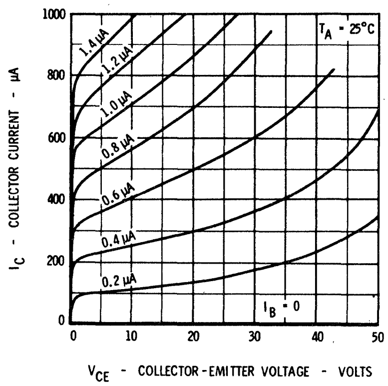
TYPICAL ELECTRICAL CHARACTERISTICS

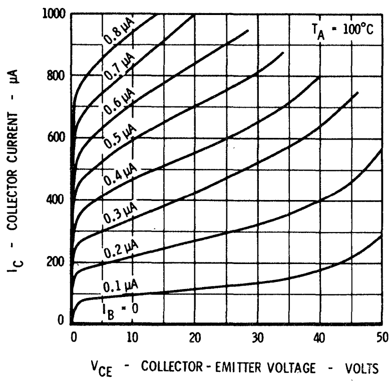
COLLECTOR CHARACTERISTICS



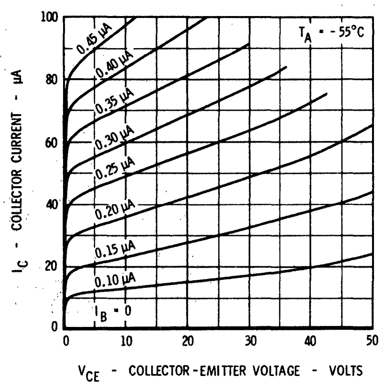
COLLECTOR CHARACTERISTICS



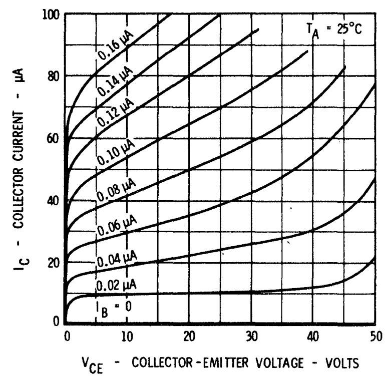
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



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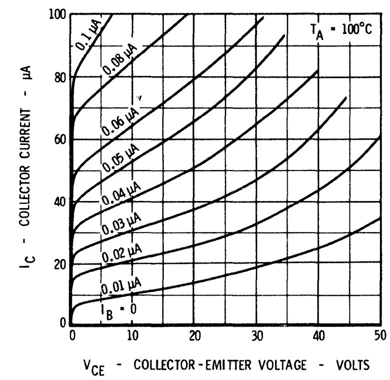
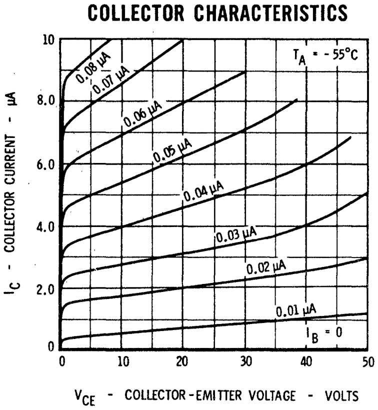
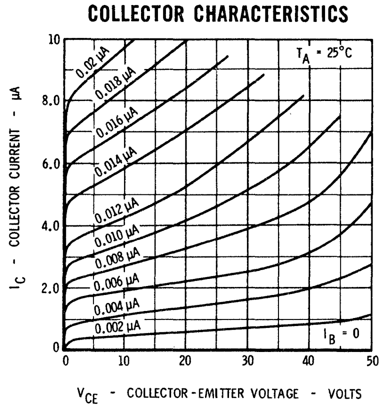


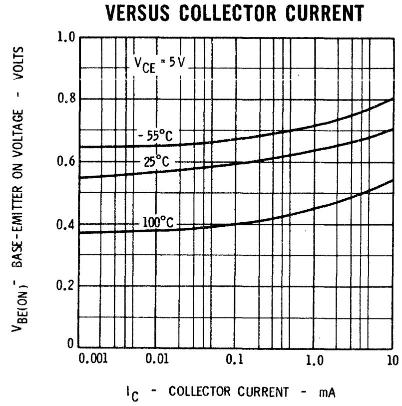
COLLECTOR CHARACTERISTICS



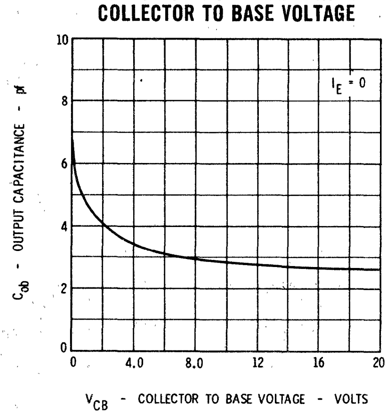
COLLECTOR CHARACTERISTICS



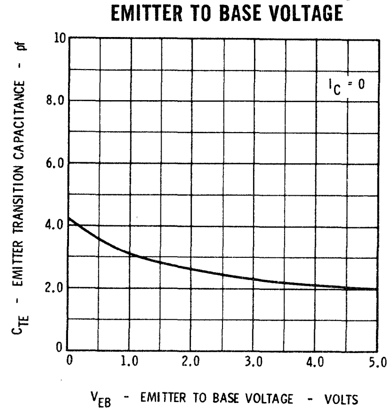
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



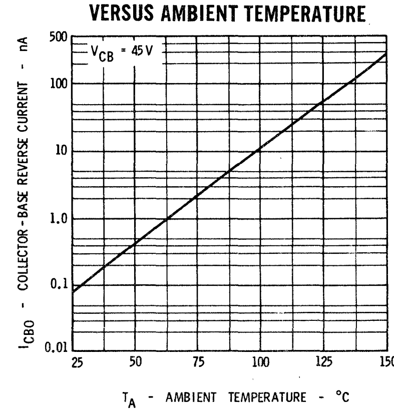
OUTPUT CAPACITANCE VERSUS COLLECTOR TO BASE VOLTAGE



INPUT CAPACITANCE VERSUS EMITTER TO BASE VOLTAGE

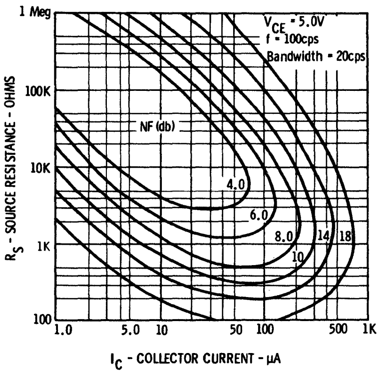


COLLECTOR-BASE REVERSE CURRENT VERSUS AMBIENT TEMPERATURE

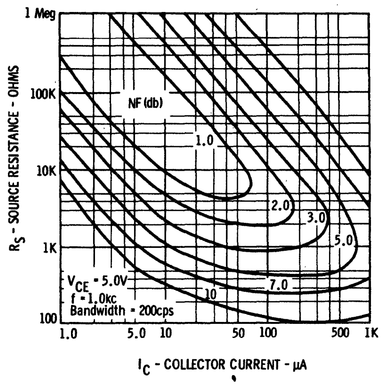


TYPICAL ELECTRICAL CHARACTERISTICS

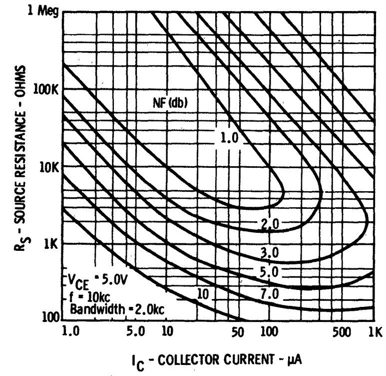
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



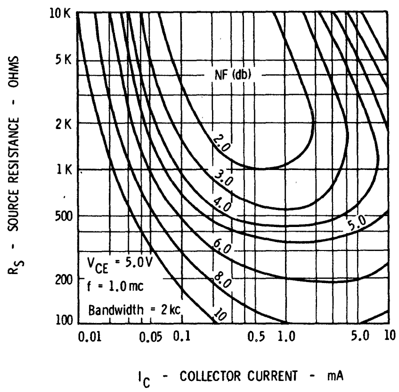
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



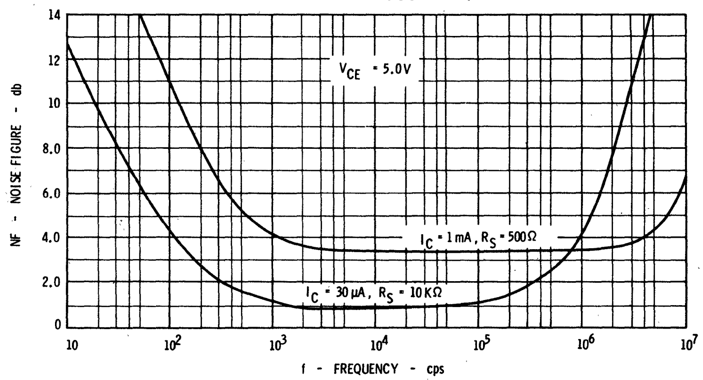
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



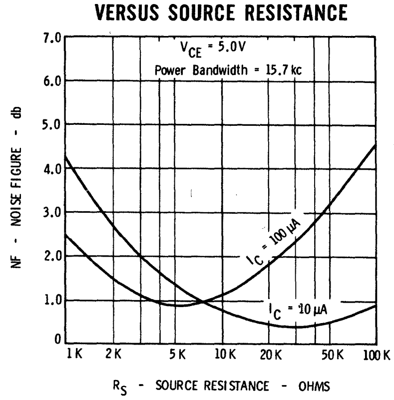
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



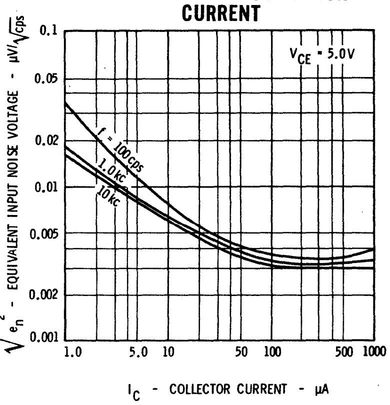
NOISE FIGURE VERSUS FREQUENCY



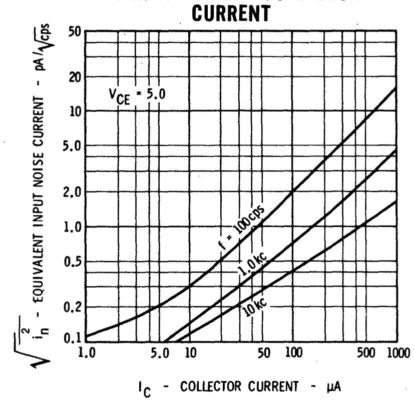
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



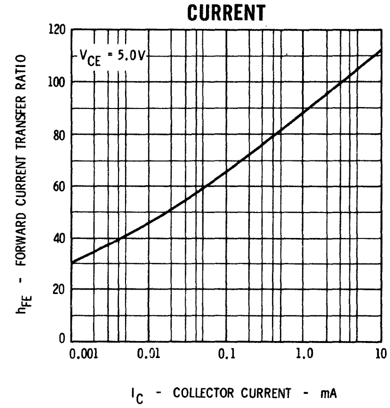
EQUIVALENT INPUT NOISE VOLTAGE VERSUS COLLECTOR CURRENT



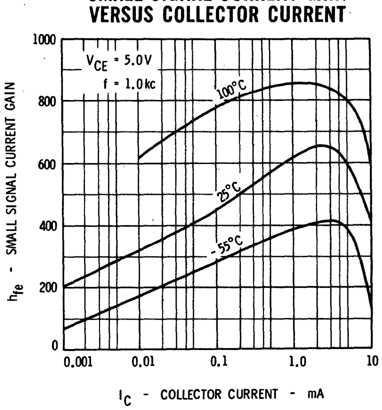
EQUIVALENT INPUT NOISE CURRENT VERSUS COLLECTOR CURRENT



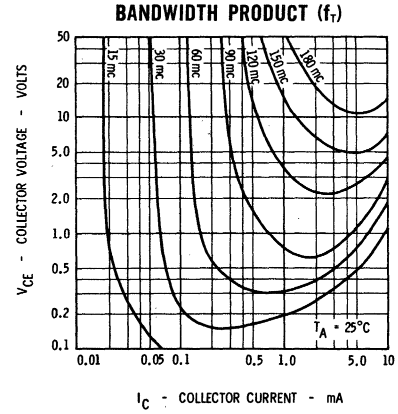
MINIMUM DC CURRENT GAIN AT −55°C VERSUS COLLECTOR CURRENT



SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT



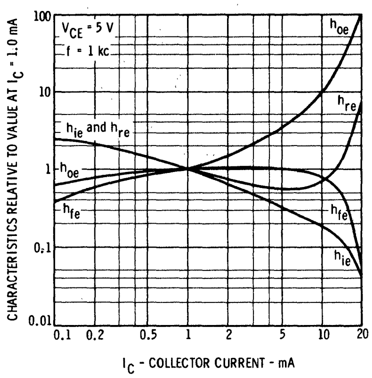
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

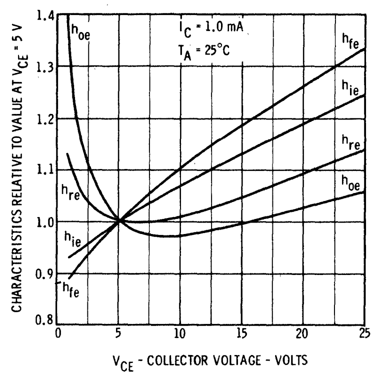


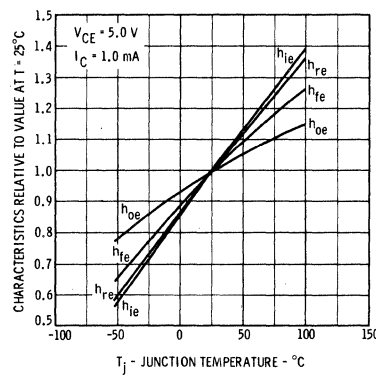
SMALL SIGNAL CHARACTERISTICS (f=1kc)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{ie}	Input Resistance	10	18	24	Kohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance		15	40	μmho	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio		425	800	$x10^{-6}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{fe}	Small Signal Current Gain	400	620	900		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

COMMON EMITTER CHARACTERISTICS

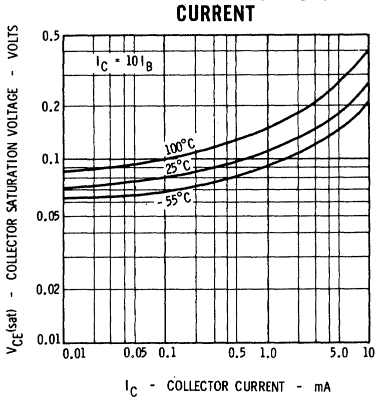




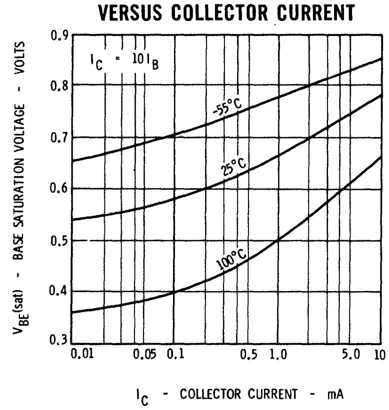


TYPICAL ELECTRICAL CHARACTERISTICS

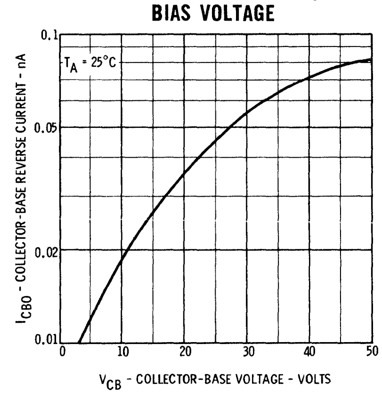
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



NOTES:

(1) R_S = 50 KΩ; f = 10 Kc; Power Bandwidth = 1.0 Kc.
(2) R_S = 50 KΩ; f = 1.0 Kc; Power Bandwidth = 200 cps.
(3) R_S = 10 KΩ; f = 100 cps; Power Bandwidth = 20 cps.
(4) R_S = 10 KΩ; f = 10 cps; Power Bandwidth = 2.0 cps.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1.0%.
(6) These ratings refer to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(7) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(8) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(9) 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).

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

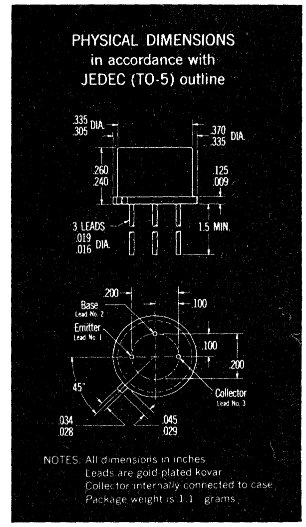
2N3120 · 2N3121

PNP VHF AMPLIFIERS, HIGH CURRENT SWITCHES

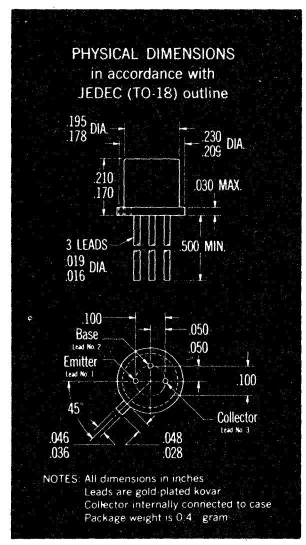
DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

The 2N3120 and 2N3121 are PNP silicon PLANAR epitaxial transistors designed for digital and analog applications at current levels to 500 milliamperes. The high gain-bandwidth product, f_T, at high currents, makes them excellent units for line driving and memory applications.

2N3120



2N3121



ABSOLUTE MAXIMUM RATINGS [Note 1]

	2N3120	2N3121
Maximum Temperatures		
Storage Temperature	**−65°C** to **+200°C**	**−65°C** to **+200°C**
Operating Junction Temperature	**200°C** Maximum	**200°C** Maximum
Lead Temperature (Soldering, 60 sec time limit)	**300°C** Maximum	**300°C** Maximum
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature [Notes 2 & 3]	**3.0** Watts	**1.2** Watts
at 25°C Ambient Temperature [Notes 2 & 3]	**0.8** Watt	**0.36** Watt
Maximum Voltages and Current		
V_{CBO} Collector to Base Voltage	**−45** Volts	**−45** Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	**−45** Volts	**−45** Volts
V_{EBO} Emitter to Base Voltage	**−4.0** Volts	**−4.0** Volts
I_C Collector Current [Note 2]	**500** mA	**500** 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]	**30**	**67**	**130**		$I_C = 50$ mA	$V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**15**	**43**			$I_C = 300$ mA	$V_{CE} = -2.0$ V
V_{BE} **(sat)**	Base Saturation Voltage		**−0.9**	**−1.2**	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{BE} **(sat)**	Base Saturation Voltage		**−1.35**	**−2.0**	Volts	$I_C = 500$ mA	$I_B = 50$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.08**	**−0.25**	Volts	$I_C = 50$ mA	$I_B = 2.5$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.6**	**−1.0**	Volts	$I_C = 500$ mA	$I_B = 50$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	**1.3**	**2.0**			$I_C = 50$ mA	$V_{CE} = -20$ V
V_{CEO} **(sust)**	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**−45**			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
t_{on}	Turn On Time [Note 6]		**17**	**40**	nSec	$I_C \approx 300$ mA	$I_{B1} \approx 30$ mA
t_{off}	Turn Off Time [Note 6]		**40**	**100**	nSec	$I_C \approx 300$ mA	$I_{B1} \approx 30$ mA, $I_{B2} \approx -30$ mA

Additional Electrical Characteristics on page 2.

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 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N3120 and 146°C/Watt (derating factor of 6.85 mW/°C) for the 2N3121. Junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C for the 2N3120 and 486°C/Watt (derating factor of 2.1 mW/°C) for the 2N3121.
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μSec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

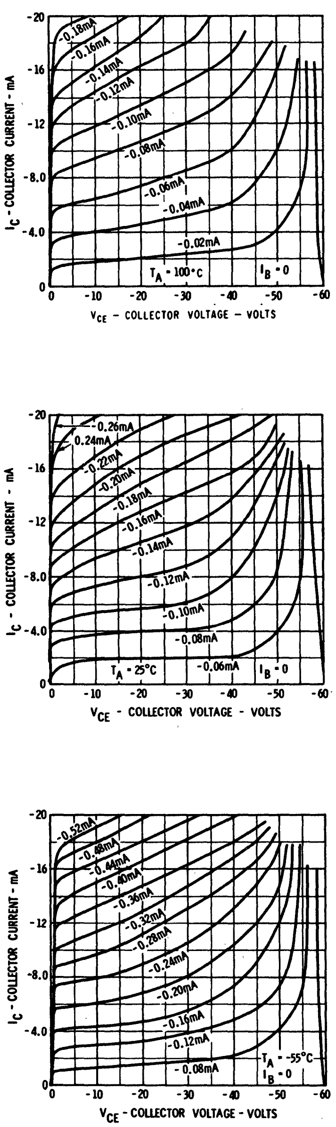
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

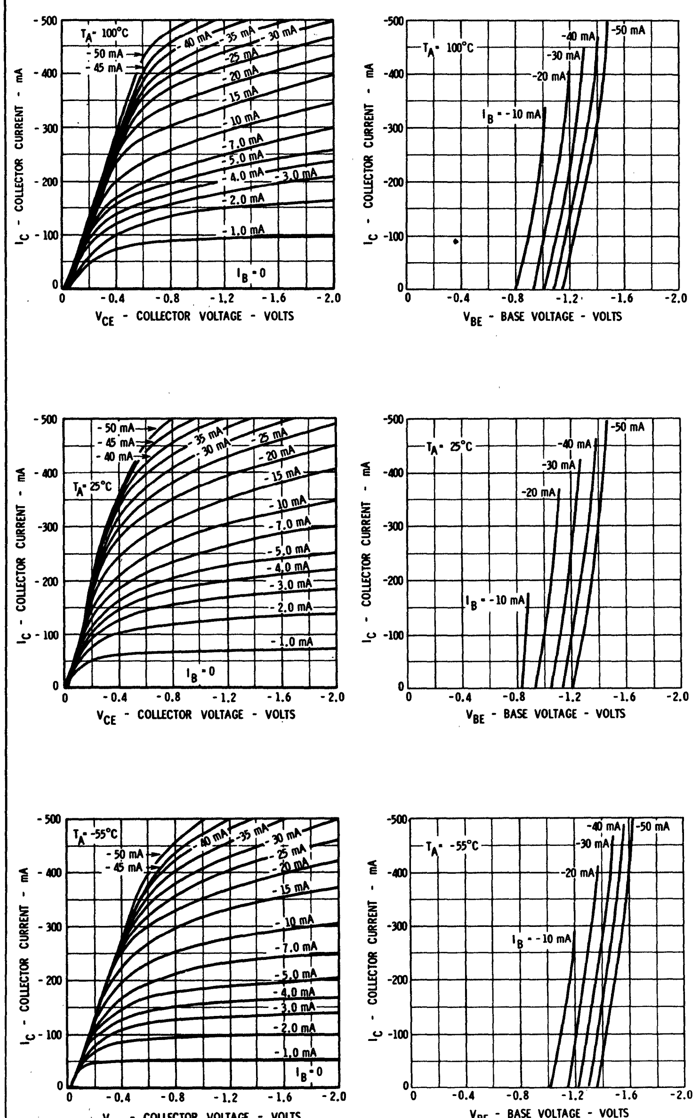
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	12	50			$I_C = 50$ mA	$V_{CE} = -1.0$ V
V_{CE} (sat)	Collector Saturation Voltage		−0.33	−0.5	Volts	$I_C = 300$ mA	$I_B = 30$ mA
C_{ob}	Output Capacitance		7.0	10	pf	$I_E = 0$	$V_{CB} = -10$ V
I_{CES}	Collector Reverse Current		0.033	10	nA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current		0.3	10	μA	$V_{CE} = -30$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−45			Volts	$I_C = 100$ μA	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.0			Volts	$I_E = 100$ μA	$I_C = 0$

TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

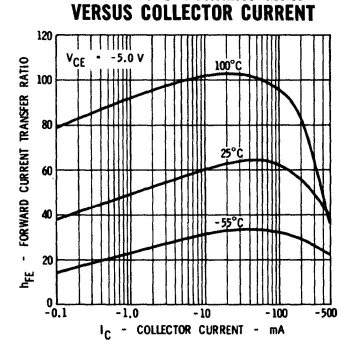
ACTIVE REGION



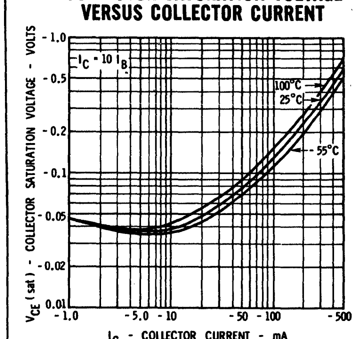
SATURATION REGION



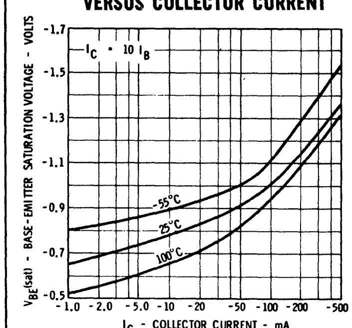
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



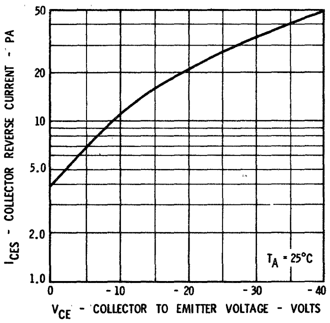
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



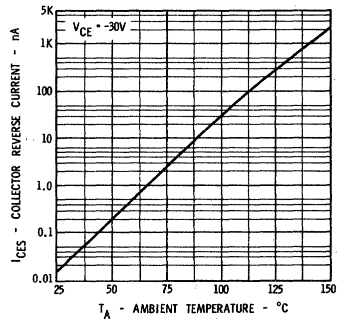
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

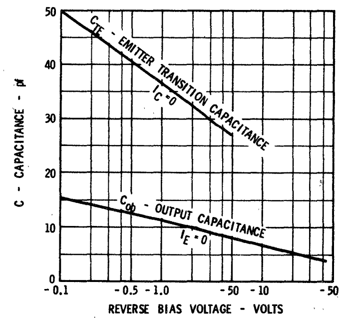
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



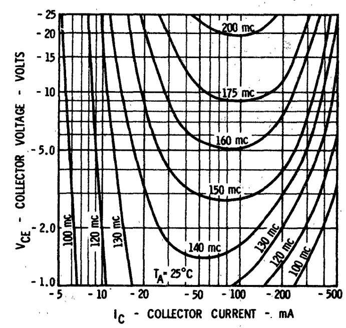
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



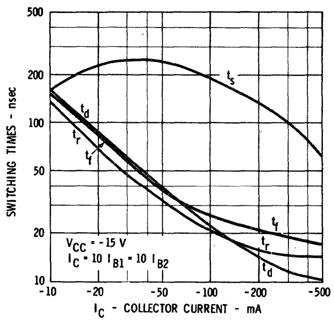
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



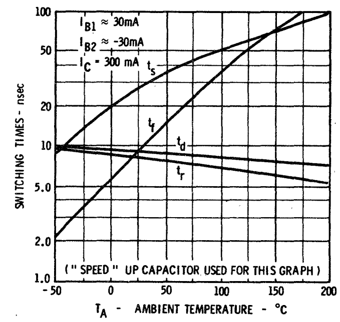
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



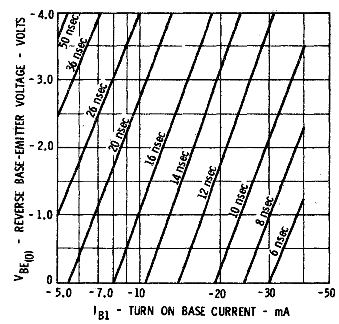
SWITCHING TIMES VERSUS COLLECTOR CURRENT



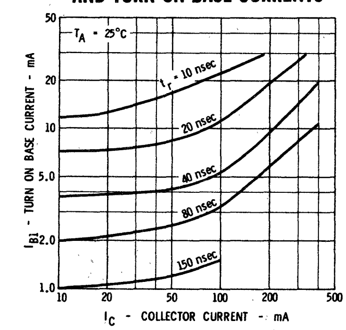
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



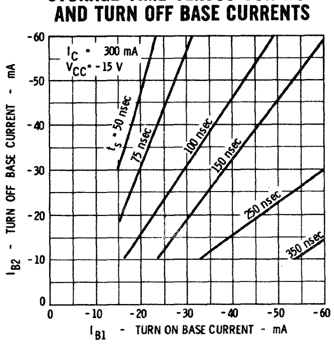
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



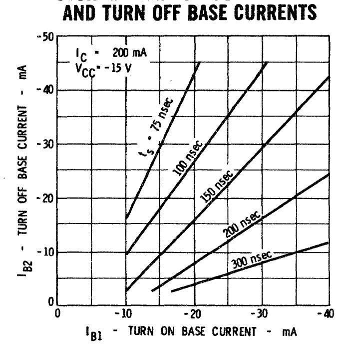
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



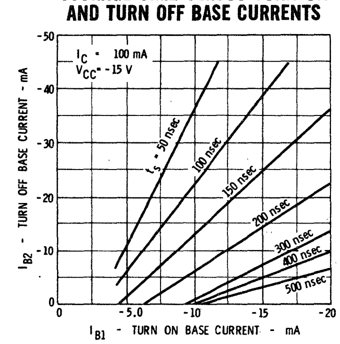
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



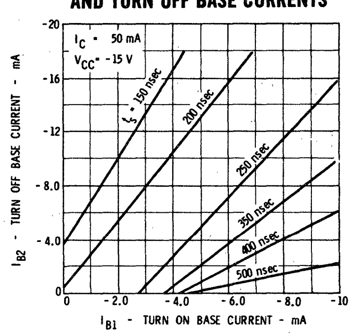
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



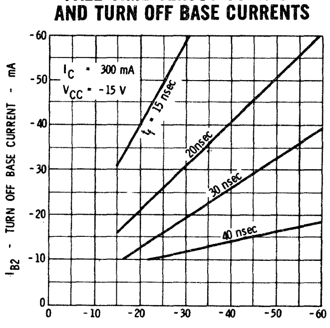
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



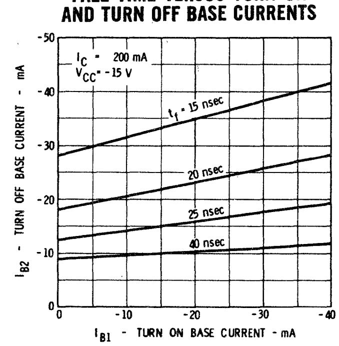
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



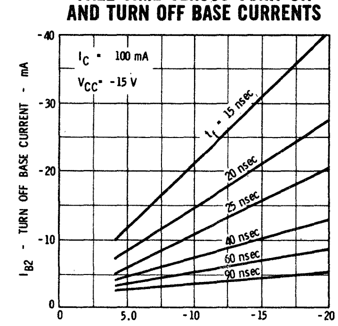
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



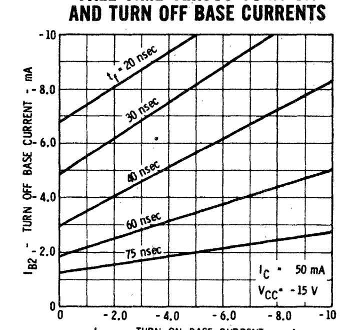
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

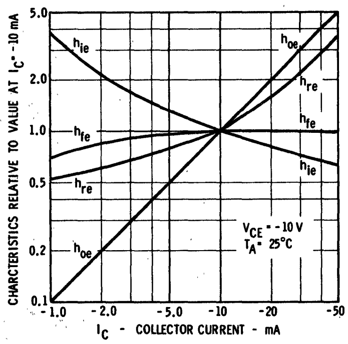


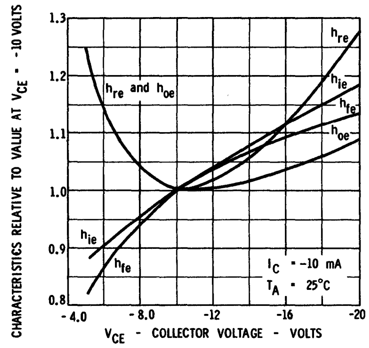
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

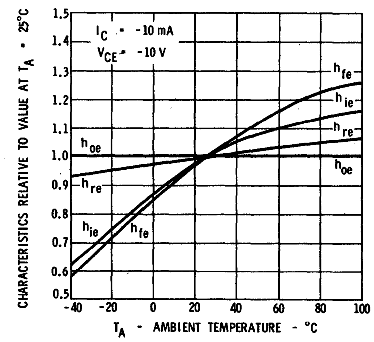


All data for switching curves taken without a "Speed-up" Capacitor unless otherwise noted.

SMALL SIGNAL CHARACTERISTICS



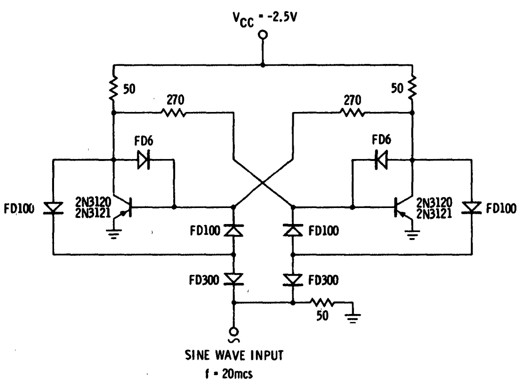




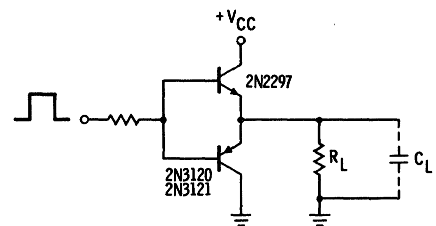
h PARAMETERS (f = 1 kc)

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{ie}	Input Resistance		480	1500	ohms	I_C = 10 mA V_{CE} = −10 V
h_{oe}	Output Conductance		80	1200	μmhos	I_C = 10 mA V_{CE} = −10 V
h_{re}	Voltage Feedback Ratio		162	2600	$x10^{-6}$	I_C = 10 mA V_{CE} = −10 V
h_{fe}	Small Signal Current Gain	25	74	180		I_C = 10 mA V_{CE} = −10 V

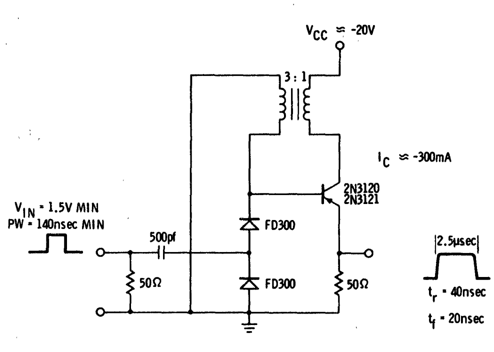
20 MC BINARY COUNTER



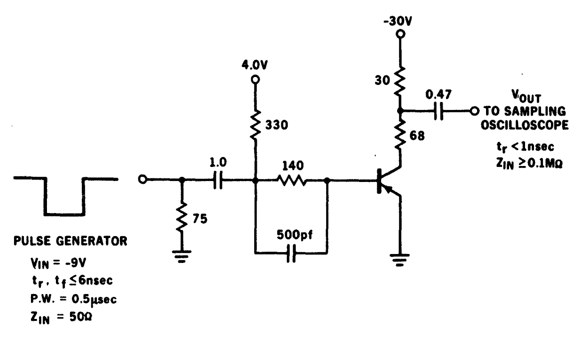
LINE DRIVER



MONOSTABLE BLOCKING OSCILLATOR



T_{ON} and T_{OFF} TEST CIRCUIT



FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

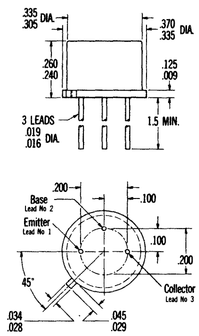
2N3137

NPN CLASS-C RF AMPLIFIER

DIFFUSED SILICON PLANAR*EPITAXIAL TRANSISTOR

The **2N3137** is an NPN silicon PLANAR epitaxial transistor designed primarily for service as a Class-C, RF power amplifier. Power output at 250 MHz is typically 0.5 watt with 100 mW drive. In addition to the large signal capabilities, the low-noise and high gain-bandwidth product characteristics of the 2N3137 provide excellent performance in a variety of small signal and linear amplifier applications.

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



NOTES All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction 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 6 and 7]	1.0 watt
25°C Ambient Temperature [Notes 6 and 7]	0.6 watt
Maximum Voltages	
V_{CBO} Collector to Base Voltage	40 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	20 Volts
V_{EBO} Emitter to Base Voltage	4.0 Volts

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]	20	70	120		$I_C = 50$ mA	$V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage		0.12	0.3	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CBO}	Collector Cutoff Current		0.12	50	nA	$I_E = 0$	$V_{CB} = 20$ V
I_{CBO} (150°C)	Collector Cutoff Current		0.10	50	μA	$I_E = 0$	$V_{CB} = 20$ V
BV_{CBO}	Collector to Base Breakdown Voltage	40			Volts	$I_E = 0$	$I_C = 100$ μA
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0			Volts	$I_C = 0$	$I_E = 100$ μA
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	20			Volts	$I_B = 0$	$I_C = 15$ mA (pulsed)
h_{fe}	High Frequency Current Gain (f = 100 MHz)	5.0	7.5			$I_C = 50$ mA	$V_{CE} = 10$ V
C_{obo}	Output Capacitance		2.8	3.5	pF	$I_E = 0$	$V_{CB} = 10$ V
G_{PE}	Amplifier Power Gain [Note 2] ($f_o = 250$ MHz)	6.0	7.0		dB	$I_C = 0$ (zero signal)	$V_{CE} = 20$ V (zero signal)
η	Collector Efficiency [Note 3] ($f_o = 250$ MHz)	40	60		%	$I_C = 0$ (zero signal)	$V_{CE} = 20$ V (zero signal)

* Planar is a patented Fairchild process.

OTES:

) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
) RF power-in = 100 mW (see test circuit).
) RF power-in = 100 mW. Conduction angle adjusted through R to obtain maximum efficiency with a minimum of 400 mW out. (See test circuit.)
) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 175°C/watt (derating factor of 5.71 mW/°C); junction-to-ambient thermal resistance of 292°C/watt (derating factor of 3.42 mW/°C).

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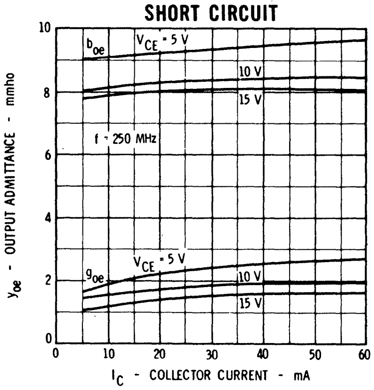
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

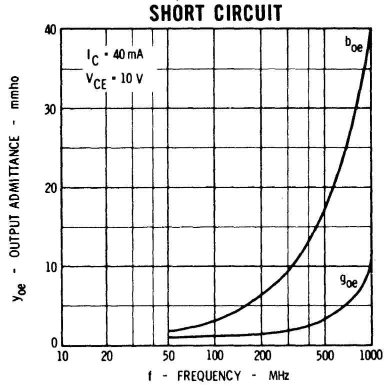
FAIRCHILD TRANSISTOR 2N3137

TYPICAL ELECTRICAL CHARACTERISTICS

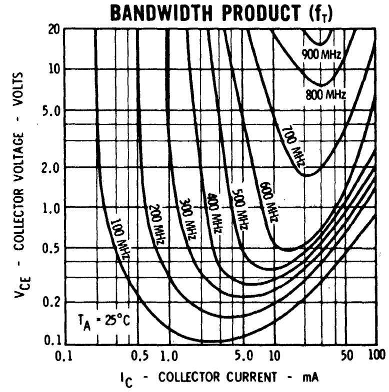
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT-INPUT SHORT CIRCUIT



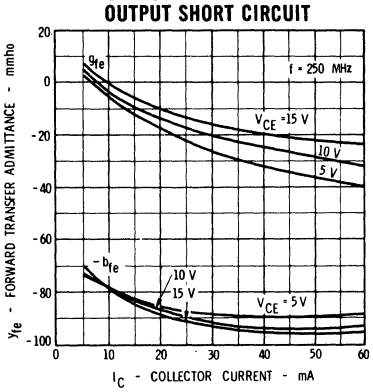
OUTPUT ADMITTANCE VERSUS FREQUENCY INPUT SHORT CIRCUIT



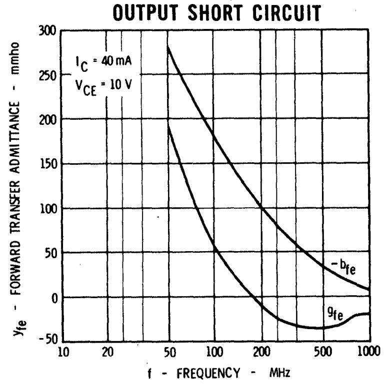
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



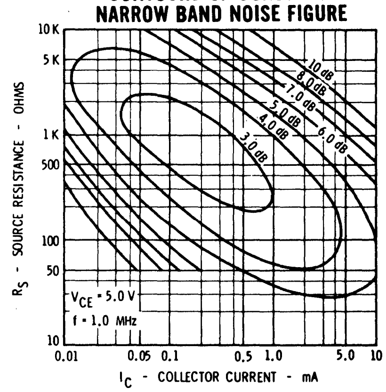
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT-OUTPUT SHORT CIRCUIT



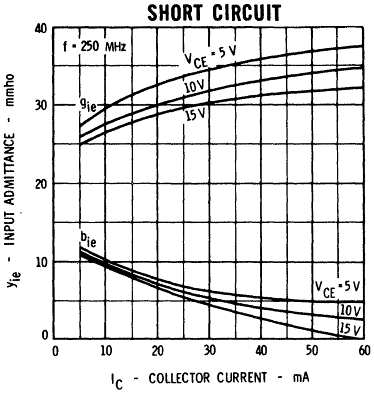
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



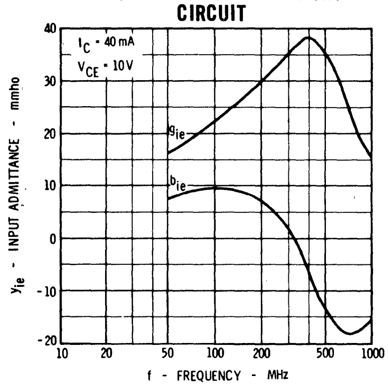
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



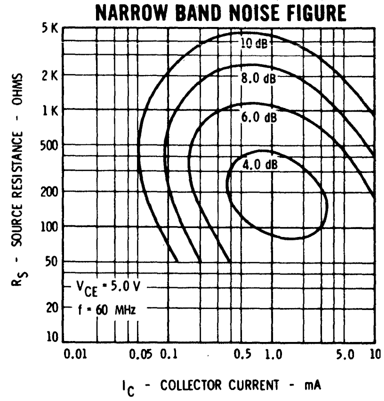
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT-OUTPUT SHORT CIRCUIT



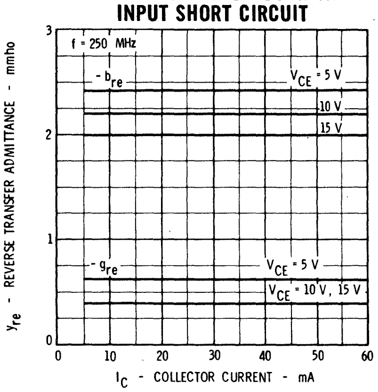
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



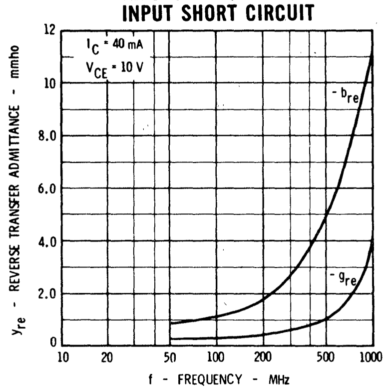
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



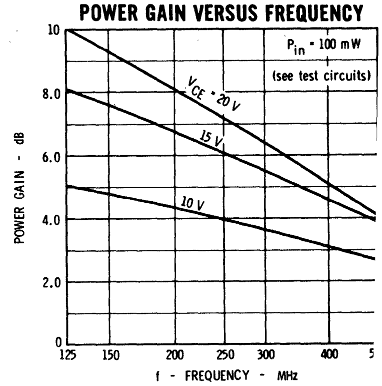
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT-INPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT

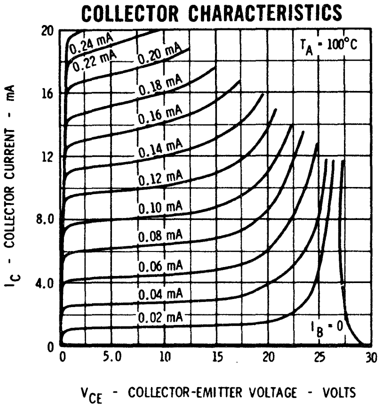


POWER GAIN VERSUS FREQUENCY

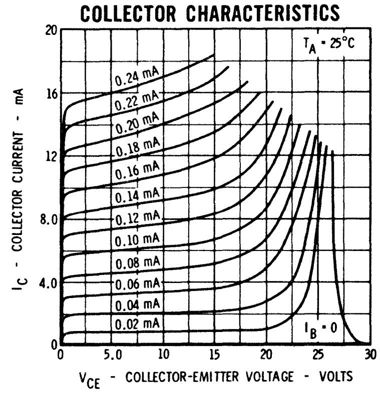


TYPICAL ELECTRICAL CHARACTERISTICS

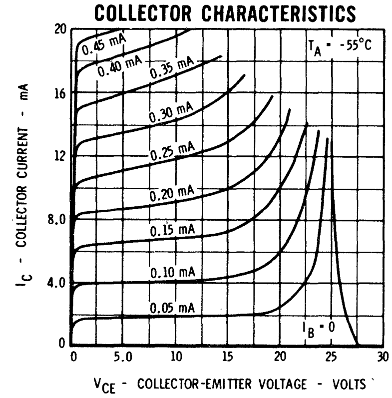
COLLECTOR CHARACTERISTICS



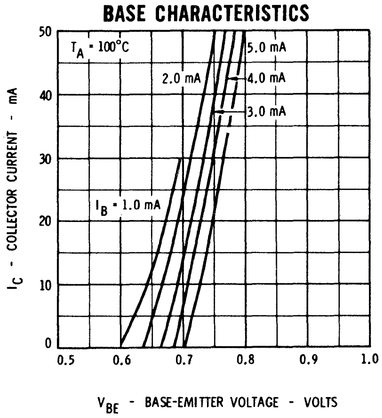
COLLECTOR CHARACTERISTICS



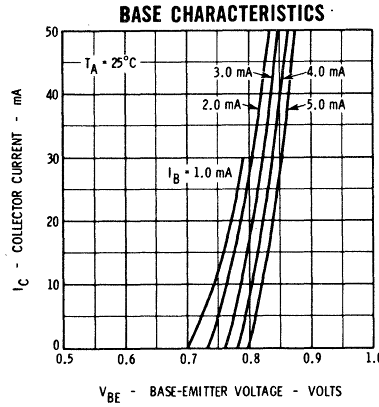
COLLECTOR CHARACTERISTICS



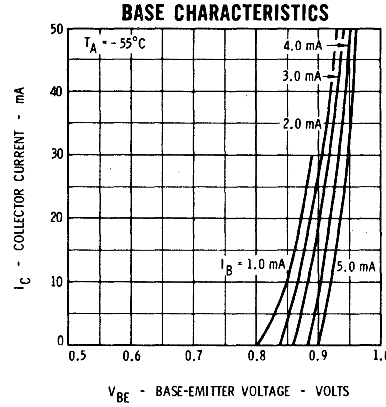
BASE CHARACTERISTICS



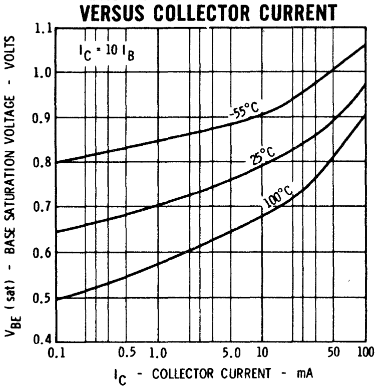
BASE CHARACTERISTICS



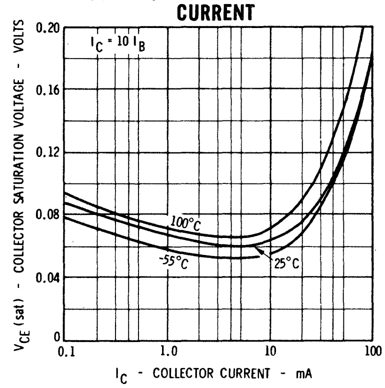
BASE CHARACTERISTICS



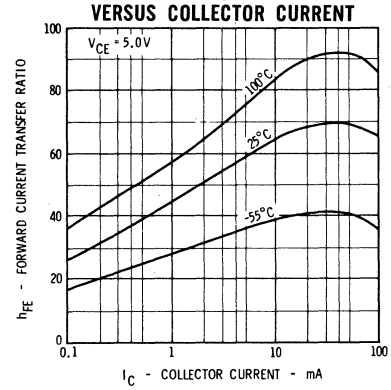
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



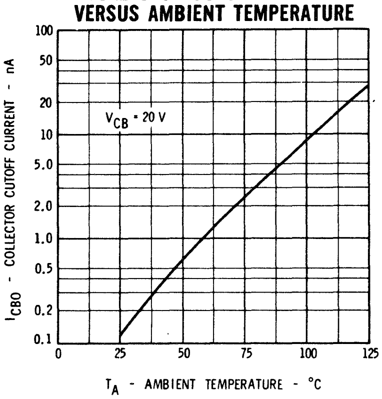
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



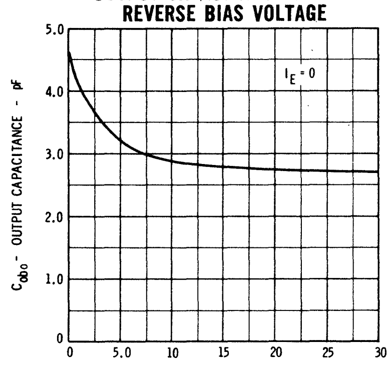
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



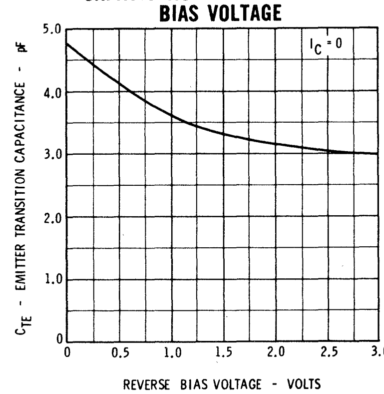
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

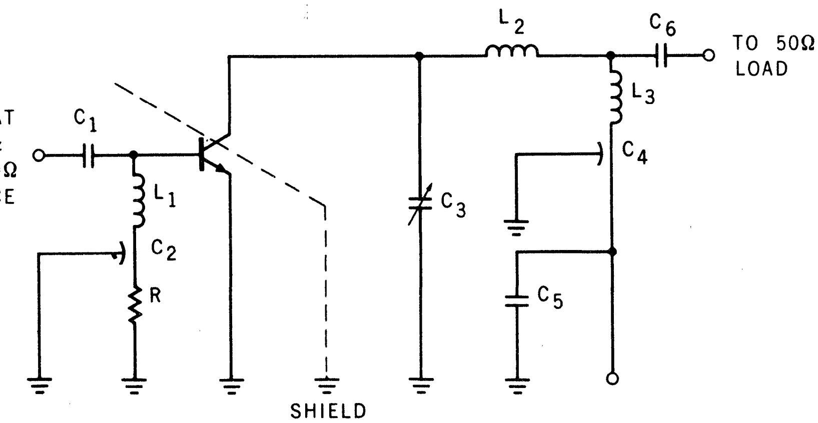


EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



FAIRCHILD TRANSISTOR 2N3137

125 MHz POWER AMPLIFIER



C_1 , C_2 , C_4 , C_6 = 1000 pF BUTTON MICA

C_3 = 2 - 8 pF

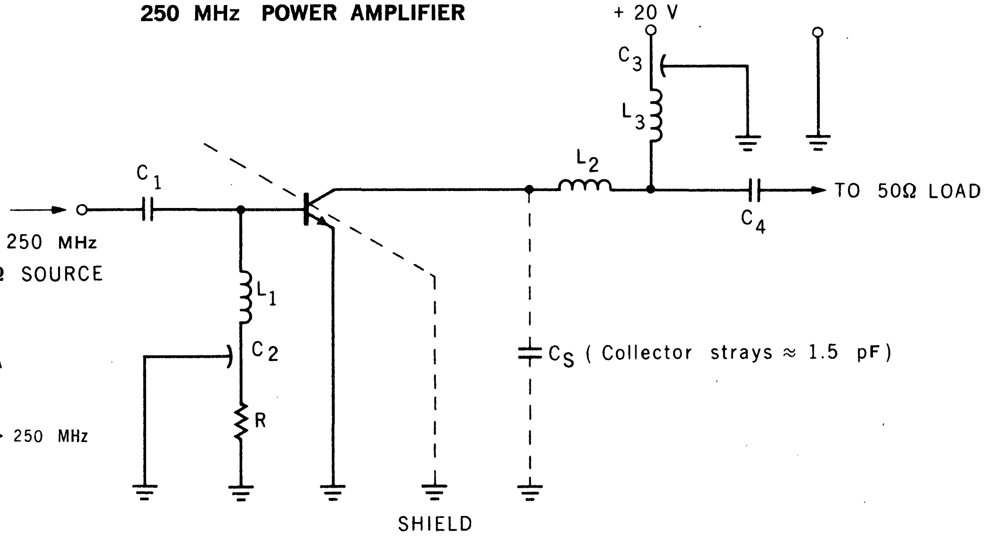
C_5 = 6 μF AT 50 V

L_1 L_3 = RFC fr > 125 MHz

L_2 = - 16 pF

R = 200 Ω

250 MHz POWER AMPLIFIER



C_1 = 120 pF

C_2 , C_3 , C_4 = 1000 pF BUTTON MICA

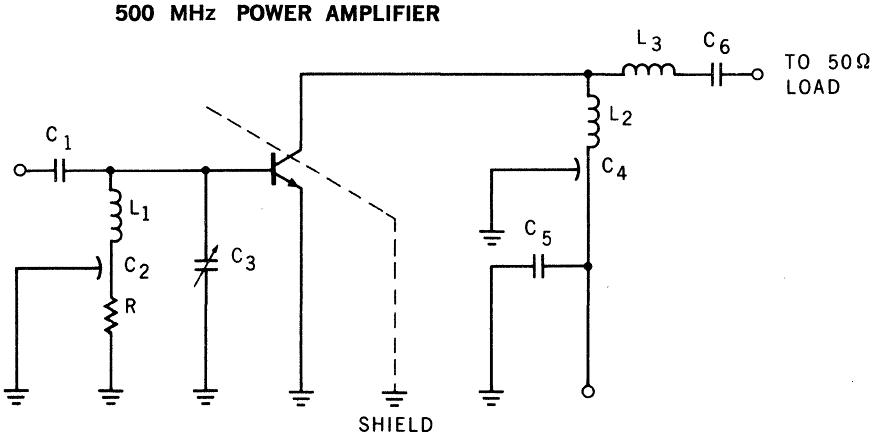
C_S (COLLECTOR STRAYS) ≈ 1.5 pF

L_1 ,L_3 = .47 μH (RF CHOKE) fr > 250 MHz

L_2 = -5.5 pF

R = 200 Ω

500 MHz POWER AMPLIFIER



C_1 = 10 pF

C_2 , C_4 , C_6 = 1000 pF BUTTON MICA

C_5 = 6 μF AT 50 V C_3 = 1 - 10 pF

L_1 = - 9 pF

L_2 = - 3.5 pF

L_3 = - 7.5 pF

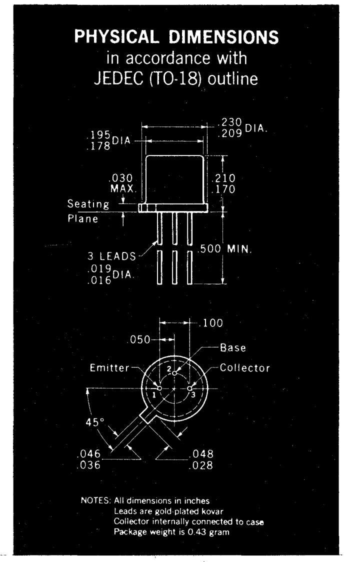
R = 20 Ω

2N3209

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

The **2N3209** is a 550 mc PNP diffused silicon PLANAR epitaxial transistor designed for saturated and non-saturated switching circuits requiring up to 200 milliamperes of collector current. It is suitable for 20 mc RF amplifiers, 10.7 mc IF amplifiers, 100 mc oscillator converter circuits.



ABSOLUTE MAXIMUM RATING [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+200°C**
Operating Junction 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 25°C Ambient Temperature [Notes 2 and 3]	**0.36** Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	**−20** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**−20** Volts
V_{EBO}	Emitter to Base Voltage	**−4.0** Volts
I_C	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]	**30**	**75**	**120**		$I_C = 30$ mA $V_{CE} = -0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**25**	**67**			$I_C = 10$ mA $V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**15**	**30**			$I_C = 100$ mA $V_{CE} = -1.0$ V
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.07**	**−0.15**	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.1**	**−0.2**	Volts	$I_C = 30$ mA $I_B = 3.0$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.28**	**−0.6**	Volts	$I_C = 100$ mA $I_B = 10$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	**4.0**	**5.5**			$I_C = 30$ mA $V_{CE} = -10$ V
V_{CEO} **(sust)**	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**−20**			Volts	$I_C = 10$ mA $I_B = 0$ (pulsed)
t_{on}	Turn On Time [Note 6]		**23**	**60**	nsec	$I_C \approx 30$ mA $I_{B1} \approx 1.5$ mA
t_{off}	Turn Off Time [Note 6]		**34**	**90**	nsec	$I_C \approx 30$ mA, $I_{B1} \approx I_{B2} \approx 1.5$ mA

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. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1} and I_{B2}.

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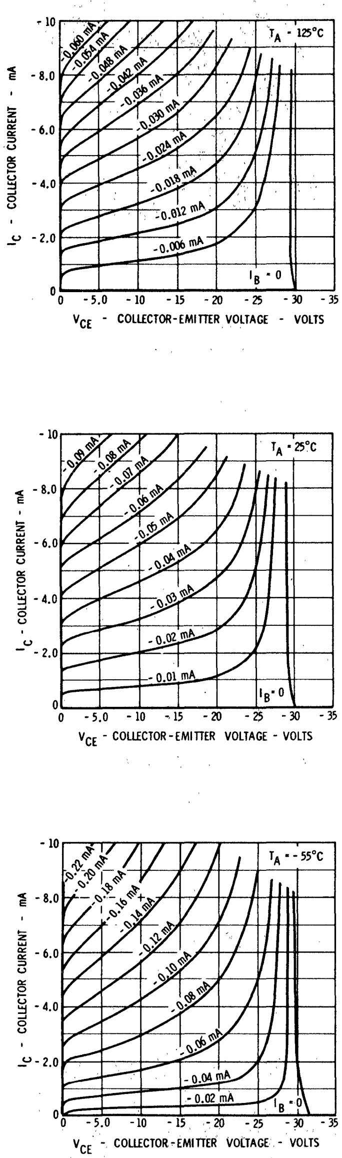
FAIRCHILD TRANSISTOR 2N3209

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

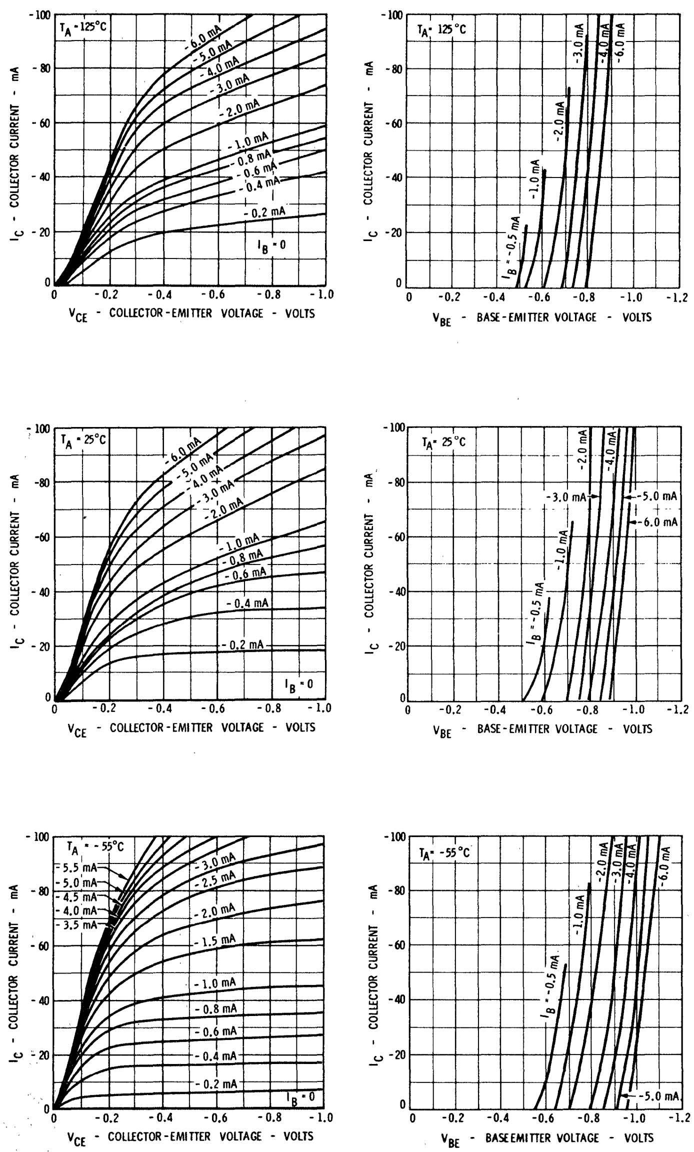
SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	**12**	**43**			$I_C = 30$ mA	$V_{CE} = -0.5$ V
V_{BE} (sat)	Base Saturation Voltage	**−0.78**	**−0.92**	**−0.98**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE} (sat)	Base Saturation Voltage	**−0.85**	**−1.1**	**−1.2**	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{BE} (sat)	Base Saturation Voltage		**−1.4**	**−1.7**	Volts	$I_C = 100$ mA	$I_B = 10$ mA
I_{CES}	Collector Reverse Current		**0.05**	**80**	nA	$V_{CE} = -10$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current		**0.025**	**10**	μA	$V_{CE} = -10$ V	$V_{BE} = 0$
C_{ob}	Output Capacitance		**3.0**	**5.0**	pf	$V_{CB} = -5.0$ V	$I_E = 0$
C_{TE}	Emitter Transition Capacitance		**3.8**	**6.0**	pf	$V_{EB} = -0.5$ V	$I_C = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	**−20**			Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	**−20**			Volts	$I_C = 10$ μA	$V_{EB} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	**−4.0**			Volts	$I_E = 100$ μA	$I_C = 0$

TYPICAL COLLECTOR AND BASE CHARACTERISTICS

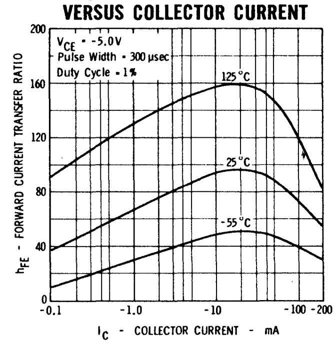
ACTIVE REGION



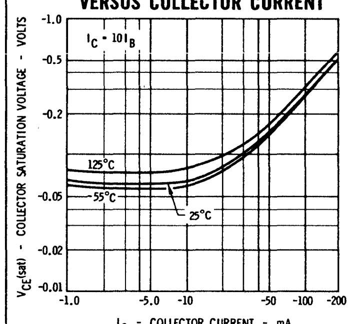
SATURATION REGION



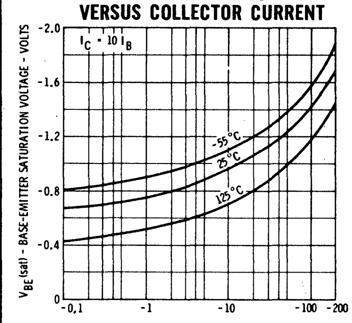
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

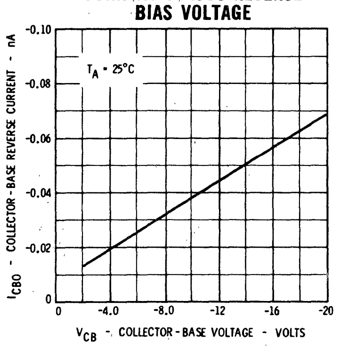


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

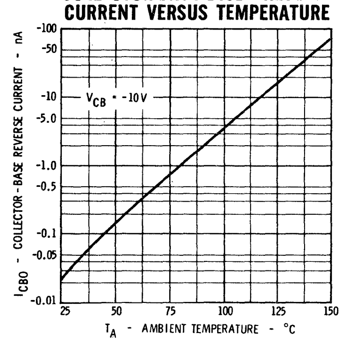


TYPICAL ELECTRICAL CHARACTERISTICS

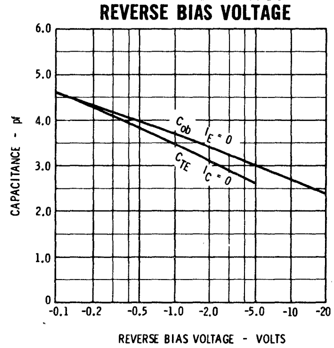
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



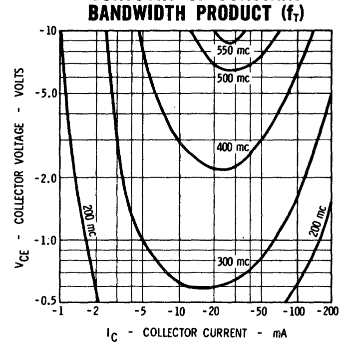
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



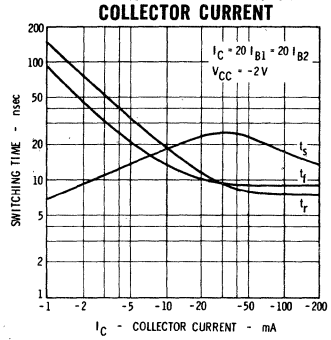
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



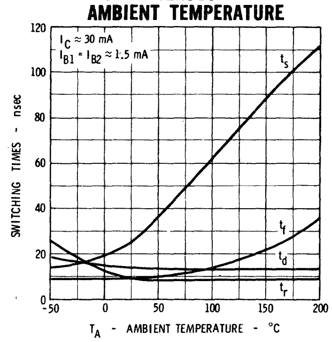
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



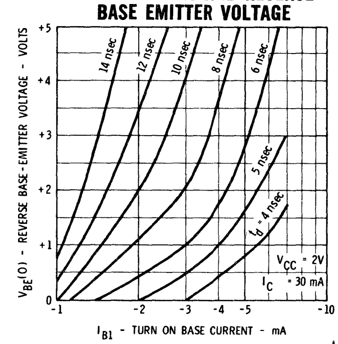
SWITCHING TIMES VERSUS COLLECTOR CURRENT



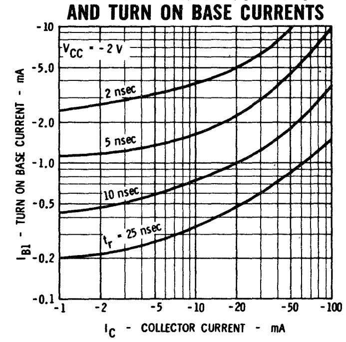
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



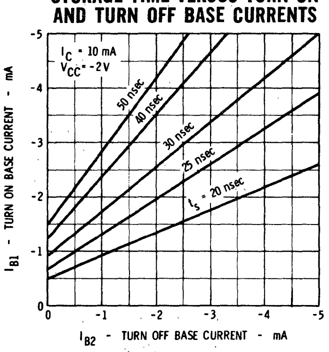
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



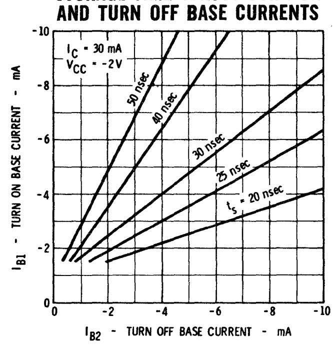
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



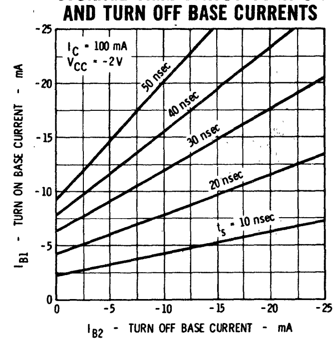
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



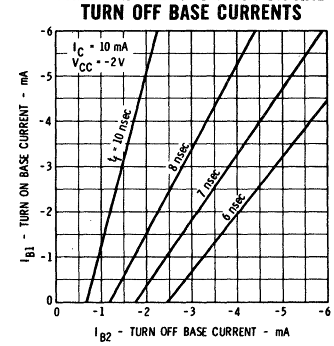
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



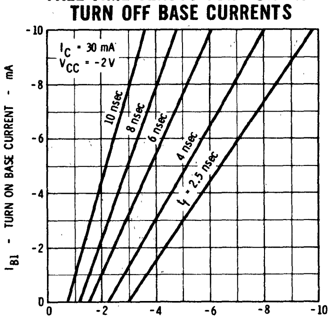
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



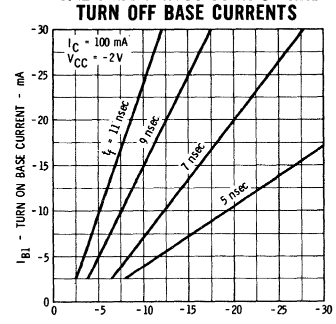
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



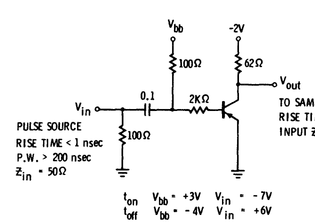
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

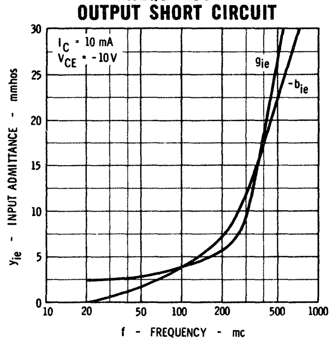


SWITCHING TIME TEST CIRCUIT

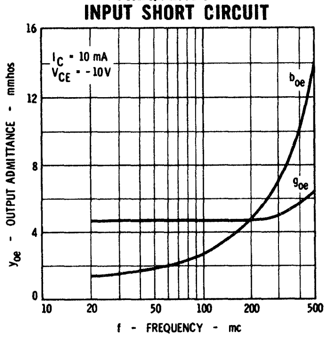


TYPICAL COMMON EMITTER "Y" PARAMETERS

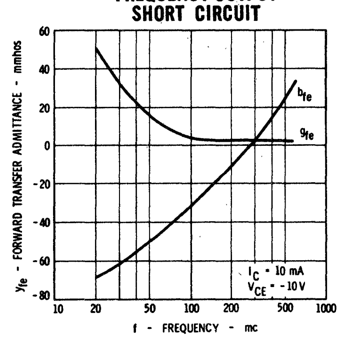
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



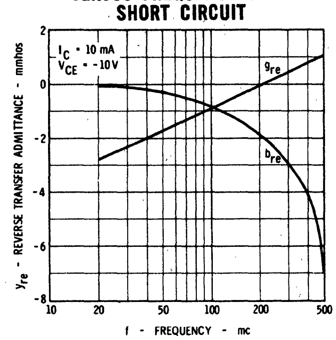
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



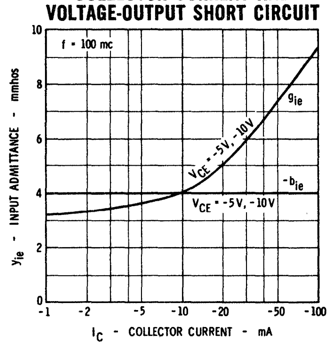
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



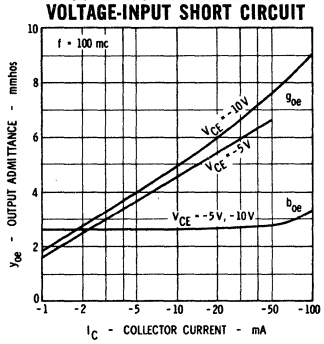
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



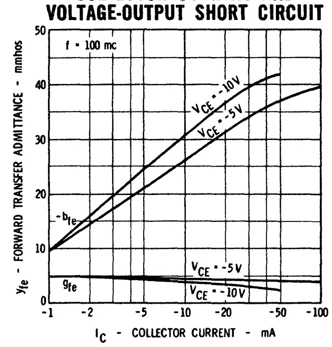
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



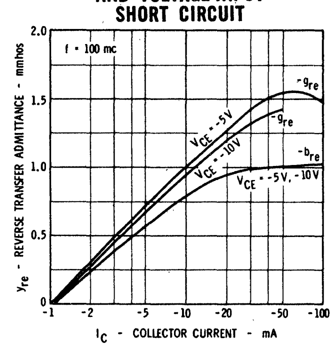
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



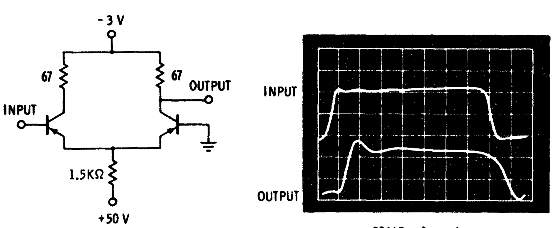
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT

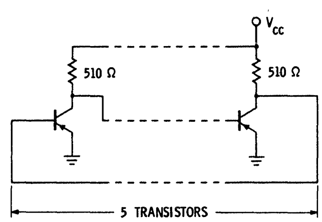


NON SATURATED SWITCHING PERFORMANCE



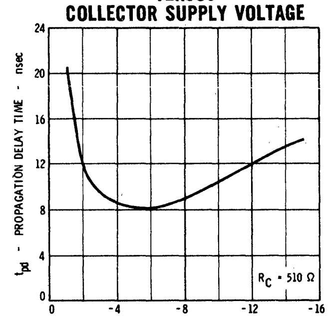
SCALE = 2 nsec/cm

FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY

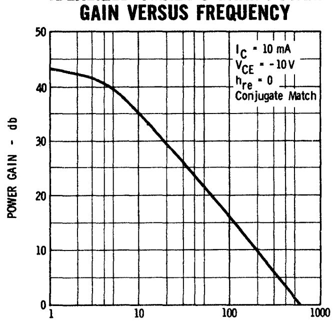


$$t_{pd} = \frac{1}{10 f_{osc}}$$

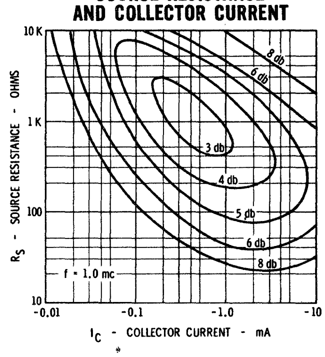
PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



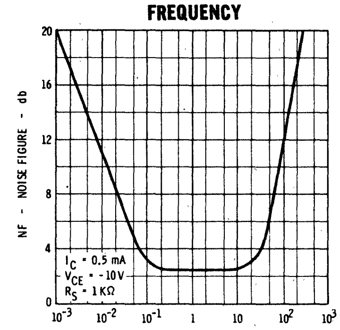
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



NOISE FIGURE VERSUS FREQUENCY



2N3250 • 2N3251

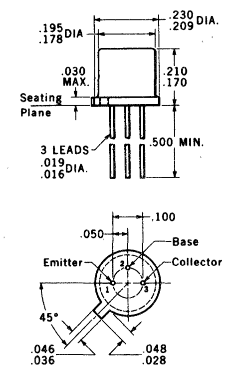
PNP HIGH SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N4034 • 2N4035

GENERAL DESCRIPTION - The 2N3250 and 2N3251 are High-Gain, High-Voltage Silicon PNP Transistors suitable for a wide range of applications including high-voltage switching; low-noise, low-current requirements; and high-gain RF applications.

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 Maximum
Lead Temperature (Soldering, 60 Second Time Limit)	300°C Maximum

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 and Current

V_{CBO}	Collector to Base Voltage	-50 Volts
V_{CEO}	Collector to Emitter Voltage	-40 Volts
V_{EBO}	Emitter to Base Voltage	-5.0 Volts
I_C	Collector Current	200 mA

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

Symbol	Characteristic	2N3250 Min.	2N3250 Max.	2N3251 Min.	2N3251 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain	40		80			I_C = 100 μA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	50	150	100	300		I_C = 10 mA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	15		30			I_C = 50 mA V_{CE} = -1.0 V
V_{CE}(sat)	Collector Saturation Voltage		-0.25		-0.25	Volt	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage	-0.6	-0.9	-0.6	-0.9	Volt	I_C = 10 mA I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5		3.0			I_C = 10 mA V_{CE} = -20 V
$r_b'C_c$	Collector Base Time Constant (f = 31.8 MHz)		250		250	ps	I_C = 10 mA V_{CE} = -20 V
NF	Noise Figure (f = 100 Hz)		6.0		6.0	dB	I_C = 100 μA V_{CE} = -5.0 V
t_d	Delay Time		35		35	ns	I_C = 10 mA I_{B1} = 1.0 mA
t_r	Rise Time		35		35	ns	I_C = 10 mA I_{B1} = 1.0 mA
t_s	Storage Time		175		200	ns	I_C = 10 mA I_{B1} = I_{B2} = 1.0 mA
t_f	Fall Time		50		50	ns	I_C = 10 mA I_{B1} = I_{B2} = 1.0 mA

Additional Electrical Characteristics on page 2

*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 145°C/Watt (derating factor of 6.9 mW/°C); junction-to-ambient thermal resistance of 486°C/Watt (derating factor of 2.1 mW/°C).

(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

(5) Pulse conditions: Length = 300 μs ; duty cycle = 1%.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

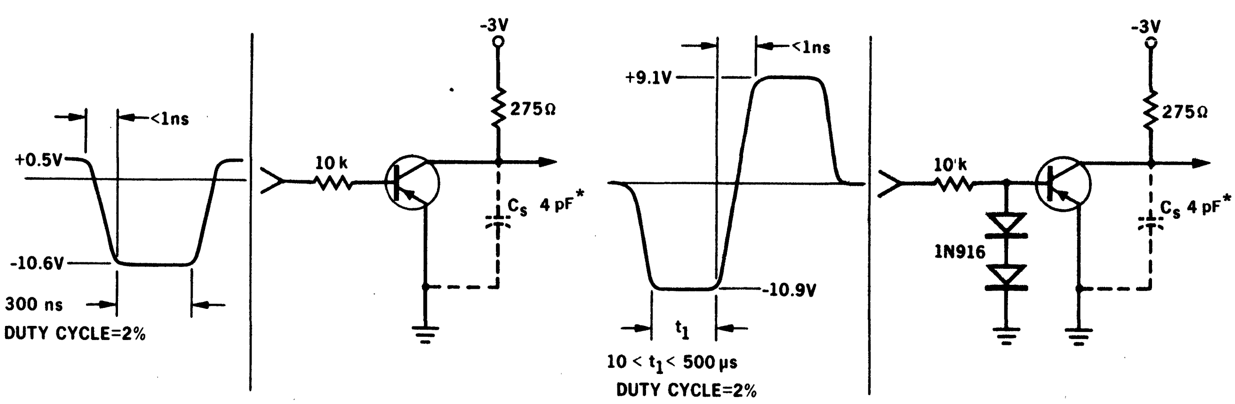
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

FAIRCHILD TRANSISTORS 2N3250 • 2N3251

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

Symbol	Characteristic	2N3250 Min.	2N3250 Max.	2N3251 Min.	2N3251 Max.	Units	Test Conditions	
C_{obo}	Output Capacitance		6.0		6.0	pF	I_E = 0	V_{CB} = -10 V
C_{TE}	Emitter Transition Capacitance		8.0		8.0	pF	I_C = 0	V_{BE} = -1.0 V
h_{FE}	DC Pulse Current Gain	45		90			I_C = 1.0 mA	V_{CE} = -1.0 V
V_{CE}(sat)	Collector Saturation Voltage		-0.5		-0.5	Volt	I_C = 50 mA	I_B = 5.0 mA
V_{BE}(sat)	Base Saturation Voltage		-1.2		-1.2	Volts	I_C = 50 mA	I_B = 5.0 mA
BV_{CEO}	Collector-to-Emitter Breakdown Voltage (Notes 4 and 5)	-40		-40		Volts	I_C = 10 mA	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-50		-50		Volts	I_C = 10 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		-5.0		Volts	I_C = 0	I_E = 10 μA
I_{CEX}	Collector Current		20		20	nA	V_{CE} = -40 V	V_{BE} = 3.0 V
I_{BL}	Base Current		50		50	nA	V_{CE} = -40 V	V_{BE} = 3.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	50	200	100	400		I_C = 1.0 mA	V_{CE} = -10 V
h_{re}	Voltage Feedback Ratio (f = 1 kHz)		10		20	$x10^{-4}$	I_C = 1.0 mA	V_{CE} = -10 V
h_{ie}	Input Impedance (f = 1 kHz)	1.0	6.0	2.0	12	kΩ	I_C = 1.0 mA	V_{CE} = -10 V
h_{oe}	Output Admittance (f = 1 kHz)	4.0	40	10	60	μmho	I_C = 1.0 mA	V_{CE} = -10 V

FIG. 1 DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT • FIG. 2 STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



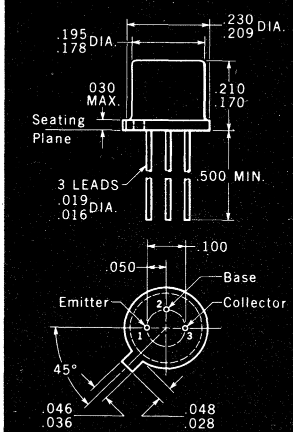
***TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS**

2N3250A • 2N3251A

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

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

GENERAL DESCRIPTION - The 2N3250A and 2N3251A are PNP silicon Planar epitaxial transistors designed primarily for fast high voltage switching and high-gain RF applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 Second Time Limit)	300°C Maximum

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 and Current

V_{CBO}	Collector to Base Voltage	-60 Volts
V_{CEO}	Collector to Emitter Voltage	-60 Volts
V_{EBO}	Emitter to Base Voltage	-5.0 Volts
I_C	Collector Current	200 mA

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

Symbol	Characteristic	2N3250A Min.	2N3250A Max.	2N3251A Min.	2N3251A Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain	40		80			I_C = 100 μA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	50	150	100	300		I_C = 10 mA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	15		30			I_C = 50 mA V_{CE} = -1.0 V
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		-0.25		-0.25	Volt	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	-0.6	-0.9	-0.6	-0.9	Volt	I_C = 10 mA I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5		3.0			I_C = 10 mA V_{CE} = -20 V
$r_b'C_c$	Collector Base Time Constant (f = 31.8 MHz)		250		250	ps	I_C = 10 mA V_{CE} = -20 V
NF	Noise Figure (f = 100 Hz)		6.0		6.0	dB	I_C = 100 μA V_{CE} = -5.0 V
t_d	Delay Time		35		35	ns	I_C = 10 mA I_{B1} = 1.0 mA
t_r	Rise Time		35		35	ns	I_C = 10 mA I_{B1} = 1.0 mA
t_s	Storage Time		175		200	ns	I_C = 10 mA I_{B1} = I_{B2} = 1.0 mA
t_f	Fall Time		50		50	ns	I_C = 10 mA I_{B1} = I_{B2} = 1.0 mA

Additional Electrical Characteristics on page 2

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 145°C/Watt (derating factor of 6.9 mW/°C); junction to ambient thermal resistance of 486°C/Watt (derating factor of 2.1 mW/°C).

(4) Rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

(5) Pulse conditions: Length = 300 μsec; duty cycle = 1%.

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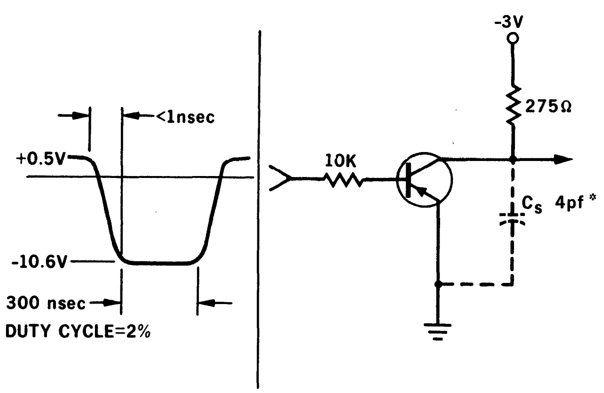
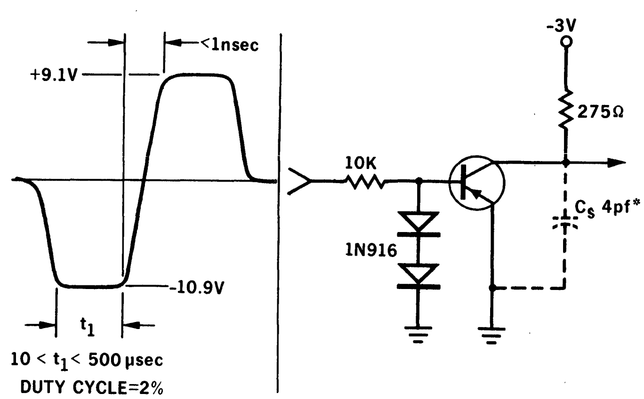
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

Symbol	Characteristic	2N3250A Min.	2N3250A Max.	2N3251A Min.	2N3251A Max.	Units	Test Conditions
C_{obo}	Output Capacitance		6.0		6.0	pF	I_E = 0 V_{CB} = -10 V
C_{ibo}	Input Capacitance		8.0		8.0	pF	I_C = 0 V_{BE} = -1.0 V
h_{FE}	DC Pulse Current Gain	45		90			I_C = 1.0 mA V_{CE} = -1.0 V
V_{CE}(sat)	Pulsed Collector Saturation Voltage		-0.5		-0.5	Volt	I_C = 50 mA I_B = 5.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage		-1.2		-1.2	Volts	I_C = 50 mA I_B = 5.0 mA
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-60		-60		Volts	I_C = 10 mA (pulsed) I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-60		-60		Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		-5.0		Volts	I_C = 0 I_E = 10 μA
I_{CEX}	Collector Current		20		20	nA	V_{CE} = -40 V V_{BE} = +3.0 V
I_{BL}	Base Current		50		50	nA	V_{CE} = -40 V V_{BE} = +3.0 V
h_{fe}	Small Signal Current Gain (f = 1 kHz)	50	200	100	400		I_C = 1.0 mA V_{CE} = -10 V
h_{re}	Voltage Feedback Ratio (f = 1 kHz)		10		20	$x10^{-4}$	I_C = 1.0 mA V_{CE} = -10 V
h_{ie}	Input Impedance (f = 1 kHz)	1.0	6.0	2.0	12	kΩ	I_C = 1.0 mA V_{CE} = -10 V
h_{oe}	Output Admittance (f = 1 kHz)	4.0	40	10	60	μmho	I_C = 1.0 mA V_{CE} = -10 V

FIG. 1 DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT • FIG. 2 STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT





*TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS

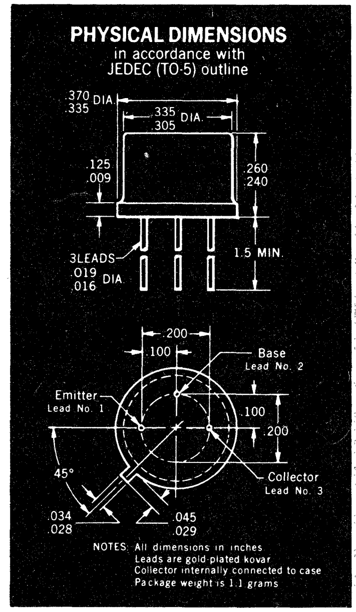
2N3252 • 2N3253 • 2N3444

NPN SWITCHING TYPE

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3724 · 2N3725

GENERAL DESCRIPTION - The 2N3252, 2N3253, and 2N3444 are Double Diffused Silicon NPN Transistors packaged in the JEDEC TO-5 outline. They are designed for high-speed switching, high-frequency amplifier applications, and may be used as core drivers, relay drivers, and pulse generators.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +200°C
Operating Junction Temperature		+200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	2N3252 · 2N3253	+300°C Maximum
Lead Temperature (Soldering, 10 sec Time Limit)	2N3444	+240°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	5.0 Watts
at 25°C Ambient Temperature	1.0 Watt

Maximum Voltages and Currents		2N3252	2N3253	2N3444
V_{CBO}	Collector to Base Voltage	60 Volts	75 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage	30 Volts	40 Volts	50 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts	5.0 Volts	5.0 Volts
I_C	Collector Current	1.0 Amp	1.0 Amp	1.0 Amp

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

		2N3252		2N3253		2N3444			
Symbol	Characteristic	Min.	Max.	Min.	Max.	Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	30		25		20			I_C = 150 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	90			20	60		I_C = 500 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)			25	75				I_C = 375 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	25				15			I_C = 1.0 A V_{CE} = 5.0 V
h_{FE}	DC Pulse Current Gain (Note 5)			20					I_C = 750 mA V_{CE} = 5.0 V
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		1.0		1.0		1.0	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	0.7	1.3	0.7	1.3	0.7	1.3	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		1.8		1.8		1.8	Volts	I_C = 1.0 A I_B = 100 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.3		0.35		0.35	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.5		0.6		0.6	Volts	I_C = 500 mA I_B = 50 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		1.0		1.2		1.2	Volts	I_C = 1.0 A I_B = 100 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.0		1.75		1.5			I_C = 50 mA V_{CE} = 10 V
C_{ibo}	Input Capacitance		80		80		80	pf	I_C = 0 V_{EB} = 0.5 V
C_{obo}	Output Capacitance		12				12	pf	I_E = 0 V_{CB} = 10 V
C_{obo}	Output Capacitance				12			pf	I_E = 0 V_{CB} = 20 V

Notes and 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 Free Air Temperature unless otherwise noted)

Symbol	Characteristic	2N3252 Min.	2N3252 Max.	2N3253 Min.	2N3253 Max.	2N3444 Min.	2N3444 Max.	Units	Test Conditions	
I_{CEX}	Collector Reverse Current				500		500	nA	V_{CE} = 60 V	V_{EB} = 4.0 V
I_{CEX}	Collector Reverse Current		500					nA	V_{CE} = 40 V	V_{EB} = 4.0 V
I_{CBO}	Collector Reverse Current				500		500	nA	I_E = 0	V_{CB} = 60 V
I_{CBO}	Collector Reverse Current		500					nA	I_E = 0	V_{CB} = 40 V
I_{CBO}(100°C)	Collector Reverse Current				75		75	μA	I_E = 0	V_{CB} = 60 V
I_{CBO}(100°C)	Collector Reverse Current		75					μA	I_E = 0	V_{CB} = 40 V
I_{BL}	Base Current				500		500	nA	V_{CE} = 60 V	V_{OB} = 4.0 V
I_{BL}	Base Current		500					nA	V_{CE} = 40 V	V_{OB} = 4.0 V
I_{EBO}	Emitter Cutoff Current		50		50		50	nA	I_C = 0	V_{EB} = 4.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		75		80		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	30		40		50		Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter Breakdown Voltage	5.0		5.0		5.0		Volts	I_C = 0	I_E = 10 μA
Q_T	Total Control Charge (see Fig. 3)		5.0		5.0		5.0	ncoul	I_C = 500 mA	I_B = 50 mA
t_d	Delay Time (see Fig. 1)		15		15		15	nsec	I_C = 500 mA	I_{B1} = 50 mA
t_r	Rise Time (see Fig. 1)		30		35		35	nsec	I_C = 500 mA	I_{B1} = 50 mA
t_s	Storage Time (see Fig. 2)		40		40		40	nsec	I_C = 500 mA	$I_{B1} = I_{B2}$ = 50 mA
t_f	Fall Time (see Fig. 2)		30		30		30	nsec	I_C = 500 mA	$I_{B1} = I_{B2}$ = 50 mA

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 operation.

(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 35°C/Watt (derating factor of 28.6 mW/°C); junction to ambient thermal resistance of 175°C/Watt (derating factor of 5.7 mW/°C).

(4) Rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

(5) Pulse conditions: Length = 300 μsec; duty cycle ≤ 1%.

FIGURE 1 - EQUIVALENT CIRCUIT FOR MEASURING DELAY AND RISE TIMES

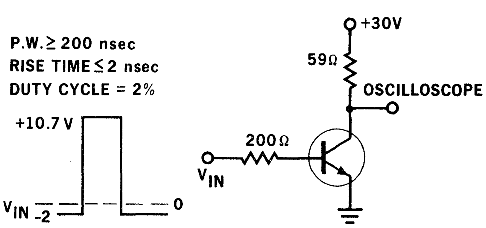


FIGURE 2 - EQUIVALENT CIRCUIT FOR MEASURING STORAGE AND FALL TIMES

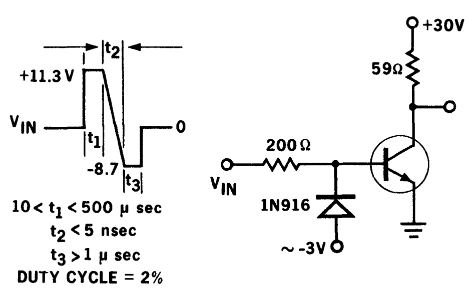
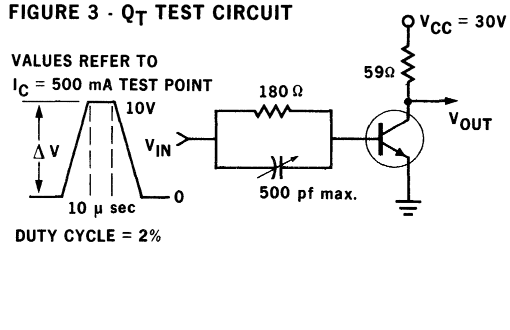


FIGURE 3 - Q_T TEST CIRCUIT



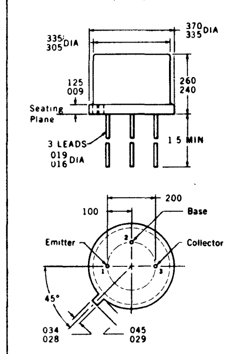
2N3299 · 2N3300 · 2N3301 · 2N3302

NPN RF AMPLIFIERS AND HIGH-SPEED SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3299 through 2N3302 are NPN Silicon Planar Epitaxial Transistors designed to cover a wide range of RF amplifier and high-speed switching applications. These devices feature a minimum LV_{CEO} of 30 volts, a minimum f_T of 250MHz at I_C = 50 mA, V_{CE} = 10 volts, together with a maximum V_{CE}(sat) of 0.6 volt at 500 mA and h_{FE} specified from 100 μA to 500 mA collector current.

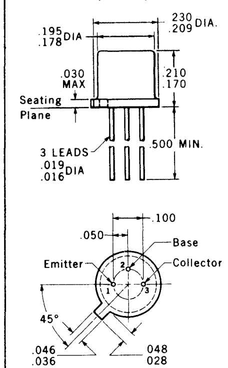
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-5) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

2N3299 · 2N3300

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

2N3301 · 2N3302

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +300°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, No Time Limit)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

	2N3299 2N3300	2N3301 2N3302
Total Dissipation at 25°C Case Temperature	3.0 Watts	1.8 Watts
at 25°C Ambient Temperature	0.8 Watt	0.36 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	60 Volts	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	30 Volts	30 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts	5.0 Volts

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

Symbol	Characteristic	2N3299 2N3301 Min.	Typ.	Max.	2N3300 2N3302 Min.	Typ.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	40	75	120	100	220	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	20	40		35	80			I_C = 100 μA V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage		0.4	0.6		0.4	0.6	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Base Saturation Voltage		1.1	1.5		1.1	1.5	Volts	I_C = 500 mA I_B = 50 mA
V_{CEO}(sust)	Collector to Emitter Sustaining voltage (Notes 4 and 5)	30			30			Volts	I_C = 10 mA I_B = 0 (pulsed)
I_{CES}	Collector Reverse Current		0.2	10		0.2	10	nA	V_{CE} = 50 V V_{EB} = 0
h_{FE}	DC Pulse Current Gain (Note 5)	35	70		75	205			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	25	58		50	140			I_C = 1.0 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20	62		50	125			I_C = 500 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20	50		50	75			I_C = 150 mA V_{CE} = 1.0 V

NOTES:

*Planar is a patented Fairchild process.

(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 for the 2N3299 and 2N3300 of 58.3°C/Watt (derating factor of 17.2 mW/°C); for the 2N3301 and 2N3302 97.3°C/Watt (derating factor of 10.3 mW/°C). Junction-to-ambient thermal resistance for the 2N3299 and 2N3300 of 219°C/Watt (derating factor of 4.56 mW/°C); for the 2N3301 and 2N3302 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. For more information send for Fairchild Publication APP-4/2.

(5) Pulse Conditions: length = 300 μs ; duty cycle ≤ 2%.

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

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

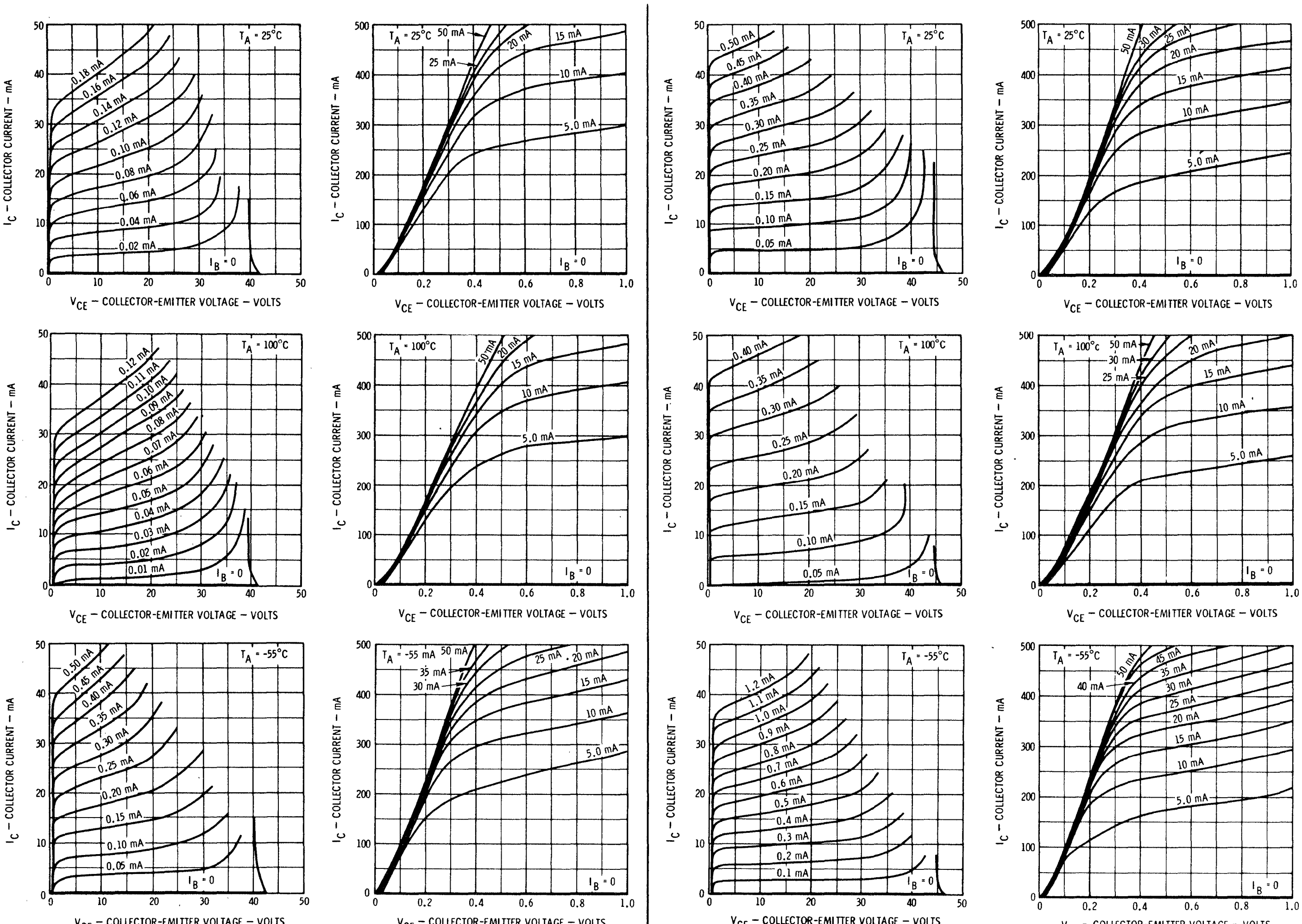
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	2N3299 2N3301 Min.	Typ.	Max.	2N3300 2N3302 Min.	Typ.	Max.	Units	Test Conditions
V_{CE}(sat)	Collector Saturation Voltage		0.14	0.22		0.14	0.22	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage		0.9	1.1		0.9	1.1	Volts	I_C = 150 mA I_B = 15 mA
I_{CES}(150°C)	Collector Reverse Current		0.2	10		0.2	10	μA	V_{CE} = 50 V V_{EB} = 0
I_{EBO}	Emitter Cutoff Current		0.1	10		0.1	10	nA	I_C = 0 V_{EB} = 3.0 V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5	4.0		2.5	4.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Output Capacitance		6.0	8.0		6.0	8.0	pF	I_E = 0 V_{CB} = 10 V
C_{ibo}	Emitter Transition Capacitance		14	20		14	20	pF	I_C = 0 V_{EB} = 2.0 V
t_{on}	Turn On Time (Note 6)		14	60		14	60	ns	I_C ≈ 300 mA I_{B1} ≈ 30 mA
t_{off}	Turn Off Time (Note 6)		80	150		80	150	ns	I_C ≈ 300 mA, I_{B1} ≈ 30 mA, I_{B2} ≈ -30 mA
BV_{CBO}	Collector to Base Breakdown Voltage	60			60			Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			5.0			Volts	I_E = 10 μA I_C = 0

TYPICAL COLLECTOR CHARACTERISTICS *

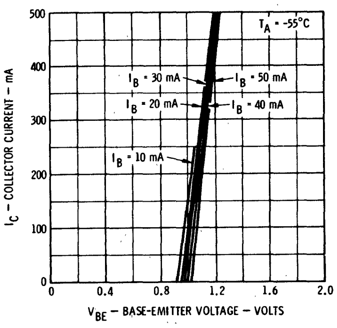
2N3300 • 2N3302   2N3299 • 2N3301

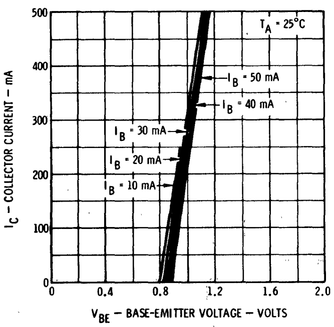
ACTIVE REGION   **ACTIVE REGION**   **SATURATION REGION**

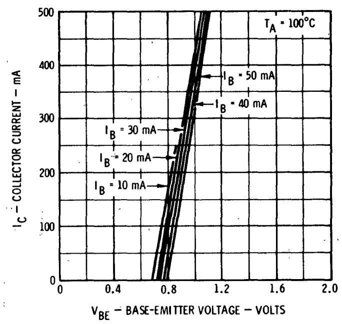


* Single family characteristics on Curve Tracer.

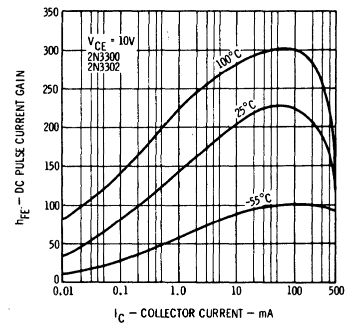
TYPICAL BASE CHARACTERISTICS





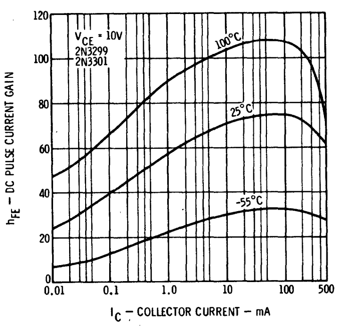


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

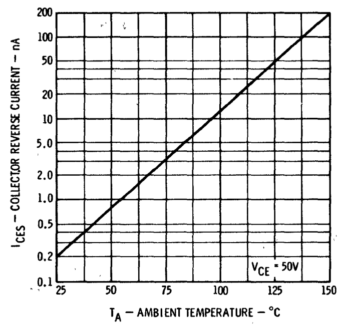


TYPICAL ELECTRICAL CHARACTERISTICS

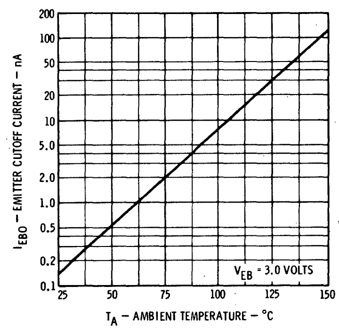
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



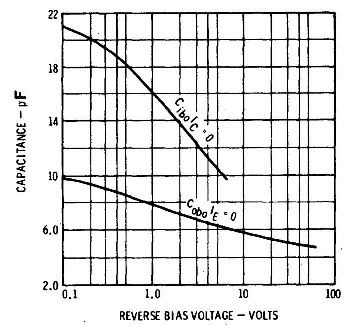
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



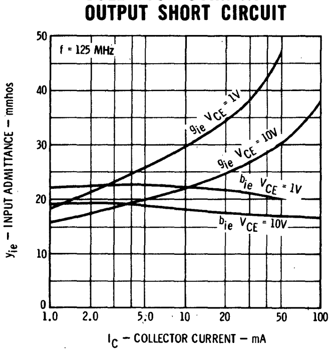
EMITTER CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



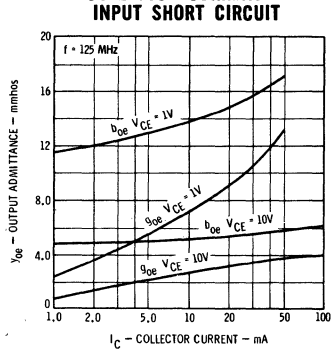
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



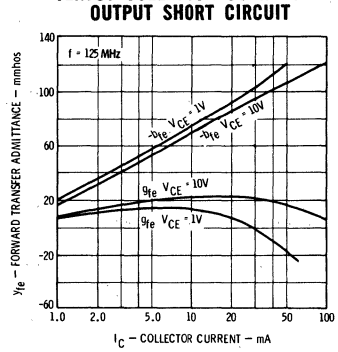
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



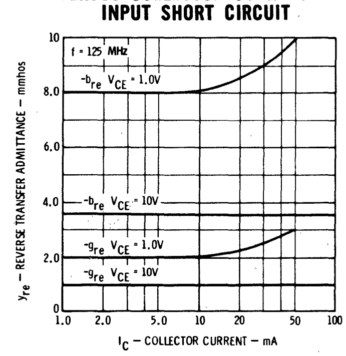
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



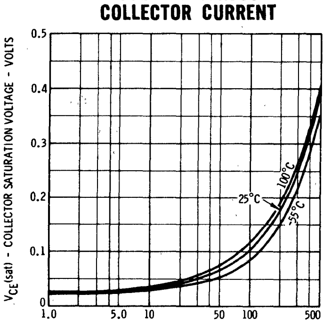
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



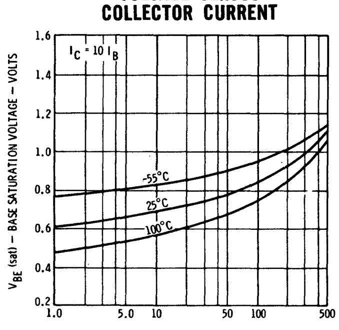
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



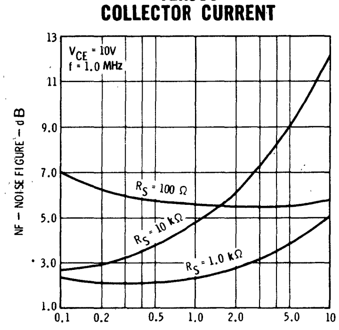
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



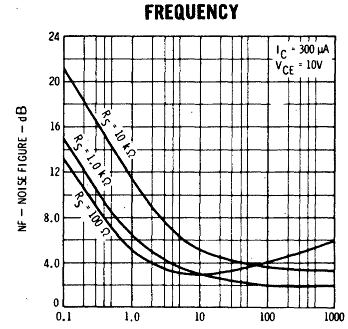
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



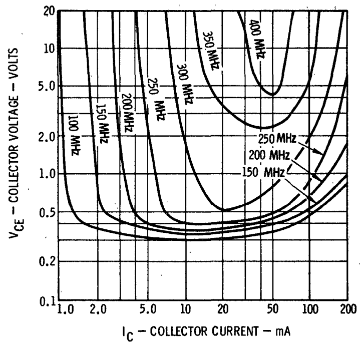
NOISE FIGURE VERSUS COLLECTOR CURRENT



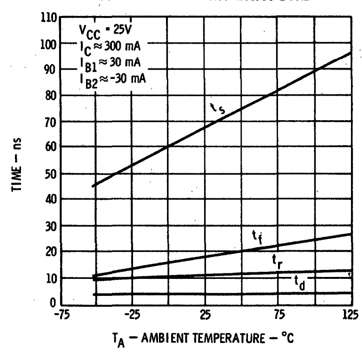
NOISE FIGURE VERSUS FREQUENCY



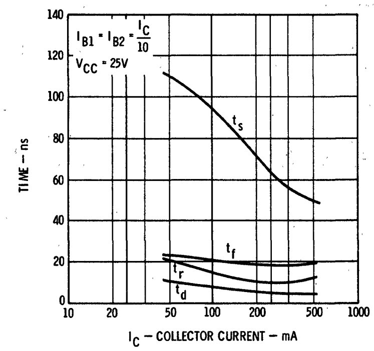
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



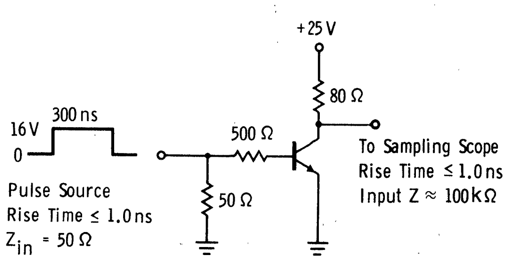
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



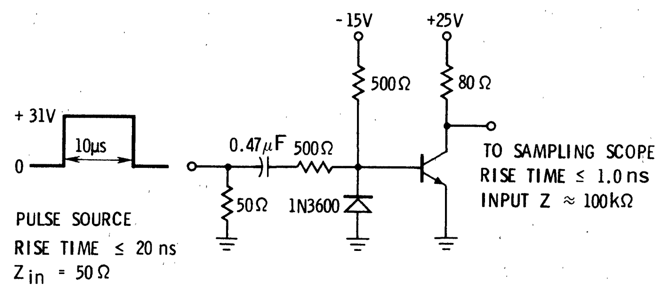
SWITCHING TIMES VERSUS COLLECTOR CURRENT



t_{on} TEST CIRCUIT



t_{off} TEST CIRCUIT



TYPICAL SMALL SIGNAL CHARACTERISTICS (f=1 kHz)

		V_{CE} = 1.0V, I_C = 10mA	V_{CE} = 10V, I_C = 10mA	V_{CE} = 1.0V, I_C = 50mA	V_{CE} = 10V, I_C = 50mA	Units
	2N3299 • 2N3301					
h_{ie}	Input Resistance	380	460	170	350	Ohms
h_{oe}	Output Conductance	410	55	950	405	µmhos
h_{re}	Voltage Feedback Ratio	2250	130	2650	500	x10^{-6}
h_{fe}	Small Signal Current Gain	72	90	48	97	
	2N3300 • 2N3302					
h_{ie}	Input Resistance	780	950	190	880	Ohms
h_{oe}	Output Conductance	440	83	1300	660	µmhos
h_{re}	Voltage Feedback Ratio	1900	205	5400	1500	x10^{-6}
h_{fe}	Small Signal Current Gain	140	170	53	220	

FAIRCHILD SEMICONDUCTOR

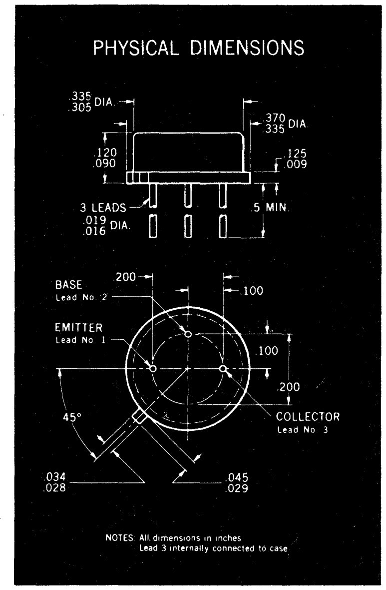
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N3303

NPN HIGH-SPEED, HIGH-CURRENT, SWITCH

SILICON PLANAR EPITAXIAL TRANSISTOR

The **2N3303** is a very high speed high current switch specifically designed for use as a thin film memory driver. The special characteristics of this device that make it uniquely optimum for this application are a 450 mc minimum f_T and a maximum V_{CE} (sat) of 0.7 V at 1.0 A.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	**−65°C** to **+200°C**
Operating Junction 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]	**3.0** Watts
at 25°C Ambient Temperature [Notes 2 and 3]	**0.6** Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	**25** Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	**12** Volts
V_{EBO} Emitter to Base Voltage	**4.0** Volts
I_C Collector Current	**1.0** Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
t_{on}	Turn On Time [Note 6]		**10**	**15**	nsec	$I_C \approx 1000$ mA $I_{B1} \approx 100$ mA
t_{off}	Turn Off Time [Note 6]		**15**	**25**	nsec	$I_C \approx 1000$ mA $I_{B1} \approx 100$ mA $I_{B2} \approx -100$ mA
τ_S	Charge Storage Time [Note 6]			**15**	nsec	$I_C \approx 100$ mA $I_{B1} \approx 100$ mA $I_{B2} \approx -100$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	**4.5**	**6.5**			$I_C = 100$ mA $V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage		**0.18**	**0.23**	Volts	$I_C = 100$ mA $I_B = 10$ mA
V_{CE} (sat)	Collector Saturation Voltage		**0.24**	**0.33**	Volts	$I_C = 300$ mA $I_B = 30$ mA
V_{CE} (sat)	Collector Saturation Voltage		**0.51**	**0.7**	Volts	$I_C = 1000$ mA $I_B = 100$ mA
h_{FE}	DC Pulse Current Gain [Note 5]	**30**	**60**	**120**		$I_C = 300$ mA $V_{CE} = 0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**30**	**50**			$I_C = 100$ mA $V_{CE} = 0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**20**	**45**			$I_C = 10$ mA $V_{CE} = 0.5$ V

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 58.3°C/watt (derating factor of 17.2 mW/°C); junction-to-ambient thermal resistance of 291.6°C/watt (derating factor of 3.43 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

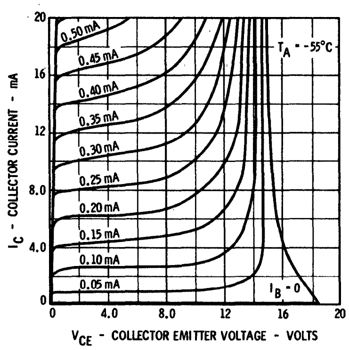
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

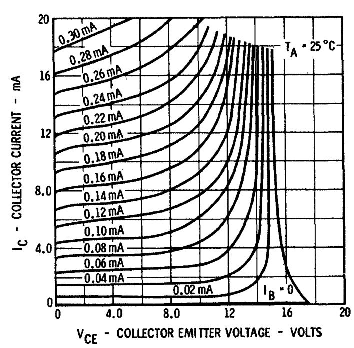
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

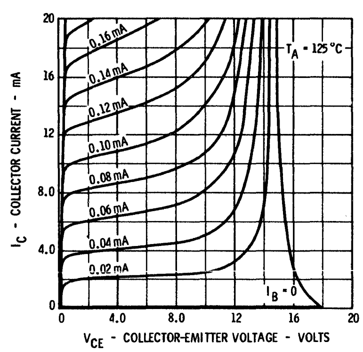
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	**10**	**33**			$I_C = 300$ mA	$V_{CE} = 0.5$ V
V_{BE} (sat)	Base Saturation Voltage		**0.72**	**0.78**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE} (sat)	Base Saturation Voltage		**0.85**	**1.1**	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE} (sat)	Base Saturation Voltage		**1.1**	**1.3**	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{BE} (sat)	Base Saturation Voltage		**1.4**	**2.1**	Volts	$I_C = 1000$ mA	$I_B = 100$ mA
V_{CE} (sat)	Collector Saturation Voltage		**0.17**	**0.25**	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE} (sat)(+125°C)	Collector Saturation Voltage		**0.3**	**0.5**	Volts	$I_C = 300$ mA	$I_B = 30$ mA
I_{CES}	Collector Reverse Current			**100**	μA	$V_{CE} = 10$ V	$V_{EB} = 0$
C_{TE}	Emitter Transition Capacitance		**15**	**25**	pf	$V_{EB} = 0.5$ V	$I_C = 0$
C_{ob}	Output Capacitance		**6.0**	**15**	pf	$V_{CB} = 5.0$ V	$I_E = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	**25**			Volts	$I_C = 0.5$ mA	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**12**			Volts	$I_C = 30$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	**4.0**			Volts	$I_E = 0.1$ mA	$I_C = 0$

TYPICAL COLLECTOR CHARACTERISTICS*

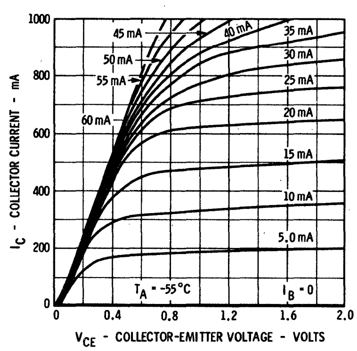
ACTIVE REGION

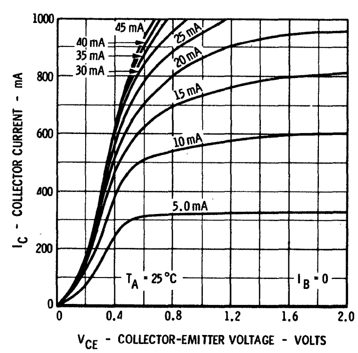


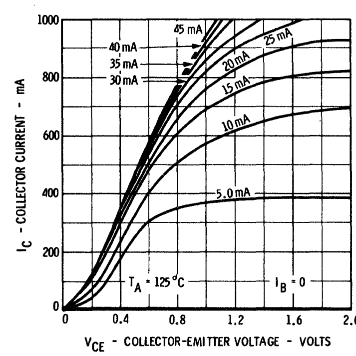




SATURATION REGION



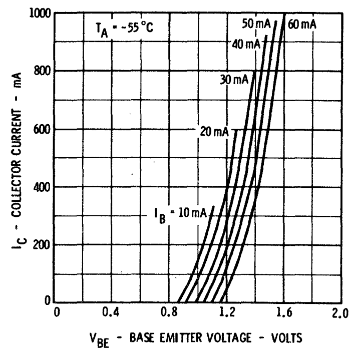


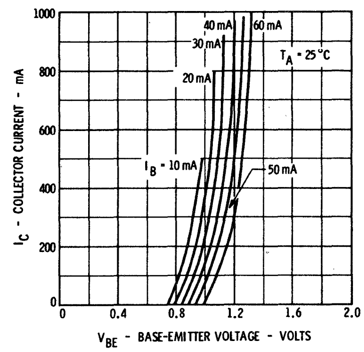


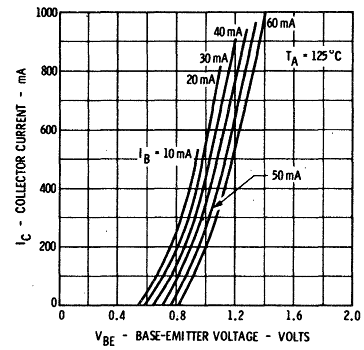
* Single family characteristics on Transistor Curve Tracer.

TYPICAL BASE CHARACTERISTICS*

SATURATION REGION

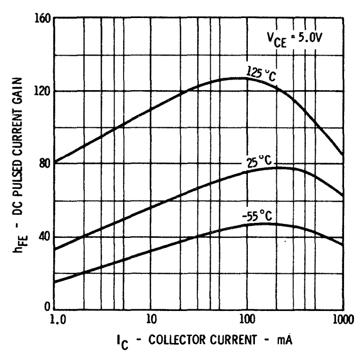




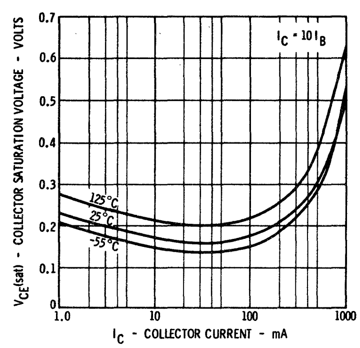


TYPICAL ELECTRICAL CHARACTERISTICS

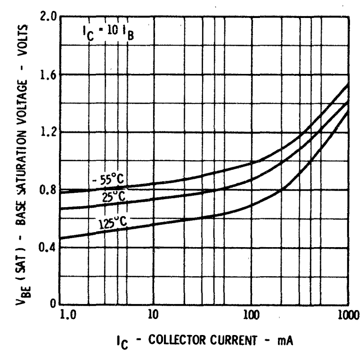
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



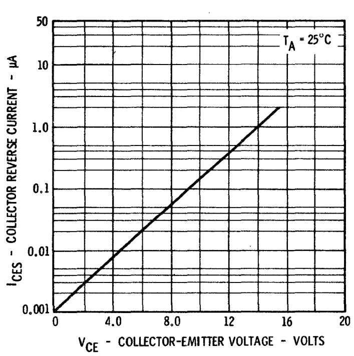
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRRENT



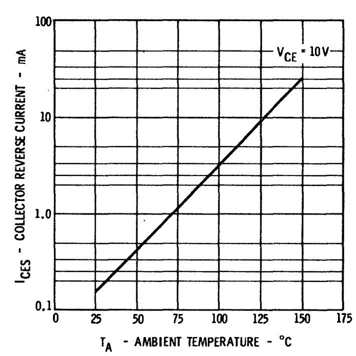
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



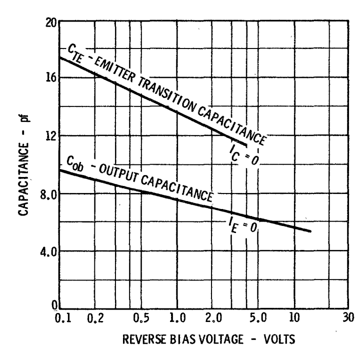
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



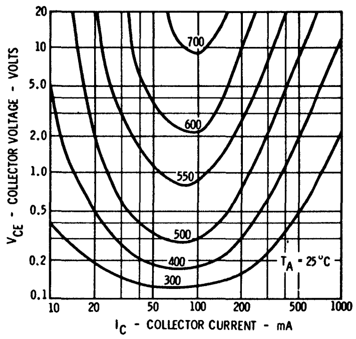
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



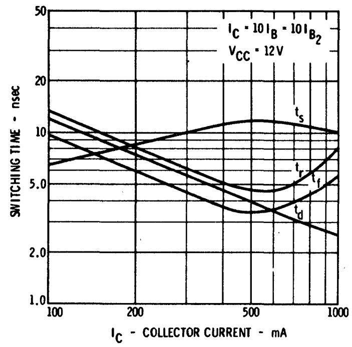
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

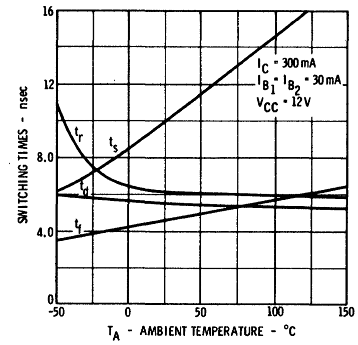
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



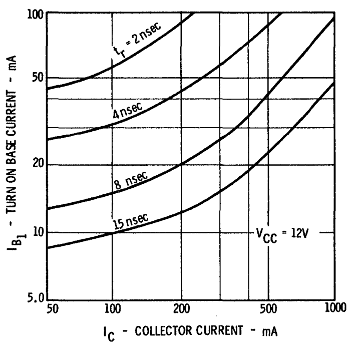
SWITCHING TIMES VERSUS COLLECTOR CURRENT



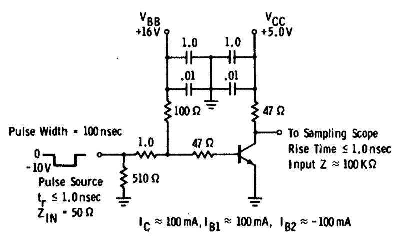
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



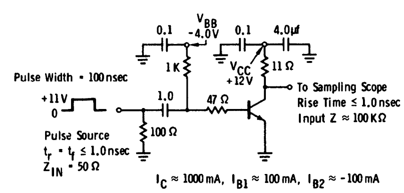
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



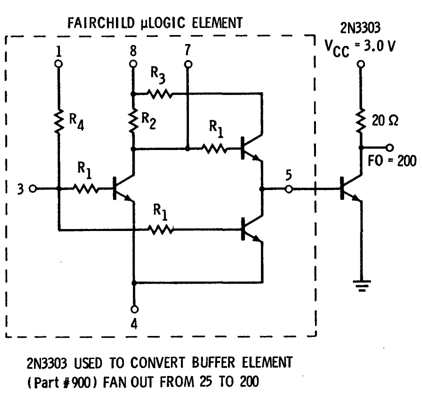
CHARGE STORAGE TIME MEASUREMENT CIRCUIT



t_{ON} — t_{OFF} MEASUREMENT CIRCUIT

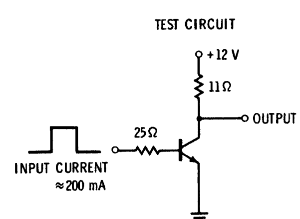


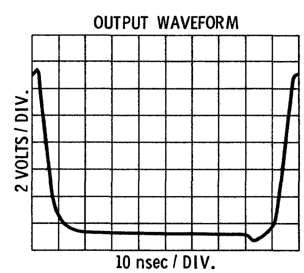
IMPROVING FAN-OUT CAPABILITY



2N3303 USED TO CONVERT BUFFER ELEMENT (Part #900) FAN OUT FROM 25 TO 200

HIGH SPEED 1 AMPERE PULSE SOURCE





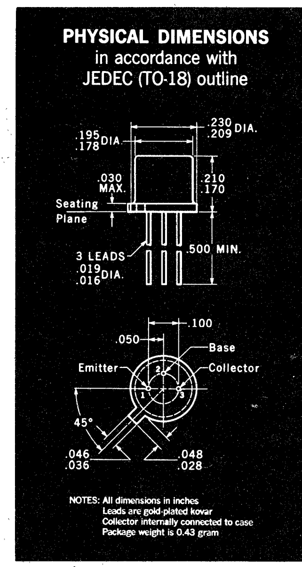
2N3304

PNP HIGH-SPEED SWITCH

SILICON PLANAR EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE USE 2N4207 SERIES

The **2N3304** is a very high speed PNP silicon epitaxial PLANAR device intended primarily for use in high speed logic application. A 500 mc minimum f_T and a 30 nsec maximum τ_s make it an ideal alternative to germanium devices for applications requiring the greater margin of reliability afforded by its silicon PLANAR construction.



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	**−65°C** to **+200°C**
Operating Junction Temperature	**200°C** Maximum
Lead Temperature (Soldering, 60 sec time limit)	**300°C** Maximum

Maximum Power Dissipation

Total Dissipation at 100°C Case Temperature [Notes 2 and 3]	**0.5** Watt
at 25°C Ambient Temperature [Notes 2 and 3]	**0.3** Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	**−6.0** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**−6.0** Volts
V_{EBO}	Emitter to Base Voltage	**−4.0** Volts

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
τ_s	Charge Storage Time [Note 6]		**22**	**30**	nsec	$I_C \approx 10$ mA $I_{B1} \approx 10$ mA $I_{B2} \approx -10$ mA
t_{on}	Turn On Time [Note 6]		**27**	**60**	nsec	$I_C \approx 10$ mA $I_{B1} \approx 0.5$ mA
t_{off}	Turn Off Time [Note 6]		**34**	**60**	nsec	$I_C \approx 10$ mA $I_{B1} \approx 0.5$ mA $I_{B2} \approx -0.5$ mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	**5.0**	**7.0**			$I_C = 10$ mA $V_{CE} = -5.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**30**	**63**	**120**		$I_C = 10$ mA $V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**20**	**50**			$I_C = 50$ mA $V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain [Note 5]	**15**	**60**			$I_C = 1.0$ mA $V_{CE} = -0.5$ V
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.05**	**−0.15**	Volts	$I_C = 1.0$ mA $I_B = 0.1$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.07**	**−0.16**	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
V_{CE} **(sat)**	Collector Saturation Voltage		**−0.2**	**−0.5**	Volts	$I_C = 50$ mA $I_B = 5.0$ mA

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 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 200°C/watt (derating factor of 5.0 mW/°C); junction-to-ambient thermal resistance of 583°C/watt (derating factor of 1.72 mW/°C).
(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.
(6) See switching circuit for exact values 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

FAIRCHILD TRANSISTOR 2N3304

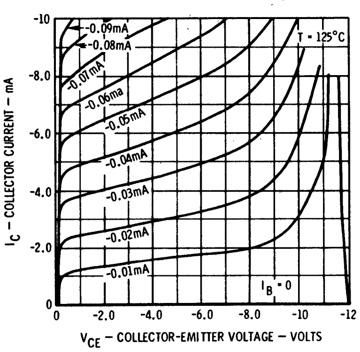
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

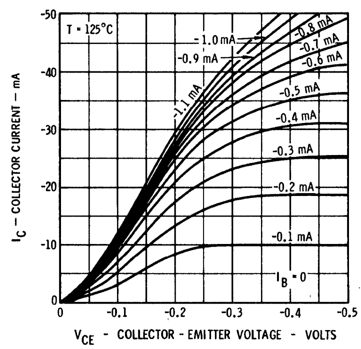
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	**12**	**33**			I_C = 10 mA	V_{CE} = −0.3 V
V_{BE} (sat)	Base Saturation Voltage	**−0.7**	**−0.76**	**−0.8**	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{BE} (sat)	Base Saturation Voltage	**−0.8**	**−0.88**	**−1.0**	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage		**−1.1**	**−1.5**	Volts	I_C = 50 mA	I_B = 5.0 mA
V_{CE} (sat)(125°C)	Collector Saturation Voltage		**−0.09**	**−0.23**	Volts	I_C = 10 mA	I_B = 1.0 mA
I_{CES}	Collector Reverse Current		**0.003**	**10**	nA	V_{CE} = −3.0 V	V_{EB} = 0
I_{CES} (125°C)	Collector Reverse Current		**0.001**	**10**	μA	V_{CE} = −3.0 V	V_{EB} = 0
C_{ob}	Output Capacitance		**1.9**	**3.5**	pf	V_{CB} = −5.0 V	I_E = 0
C_{TE}	Emitter Transition Capacitance		**1.8**	**3.5**	pf	V_{EB} = −0.5 V	I_E = 0
BV_{CBO}	Collector to Base Breakdown Voltage	**−6.0**			Volts	I_C = 100 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	**−6.0**			Volts	I_C = 100 μA	I_B = 0
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	**−6.0**			Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	**−4.0**			Volts	I_E = 100 μA	I_C = 0

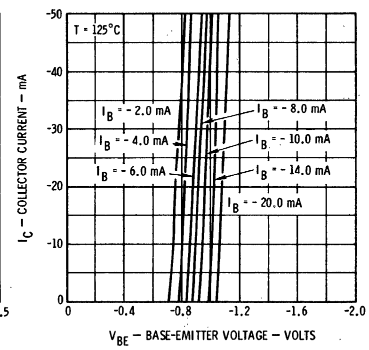
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

ACTIVE REGION

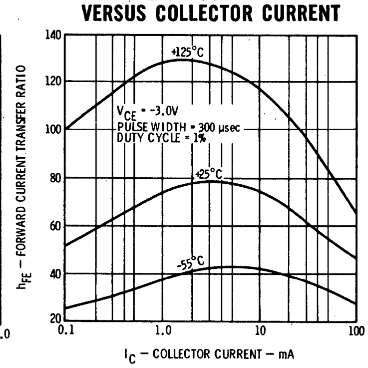
SATURATION REGION

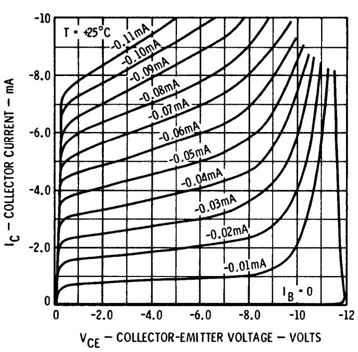


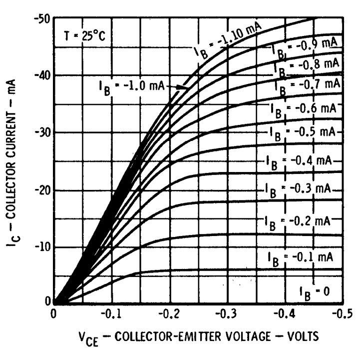


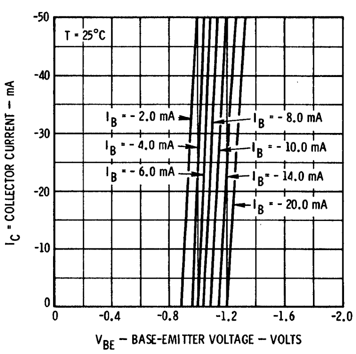


PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

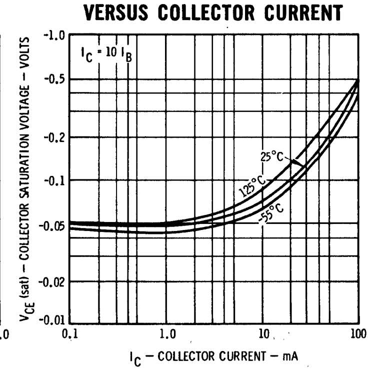


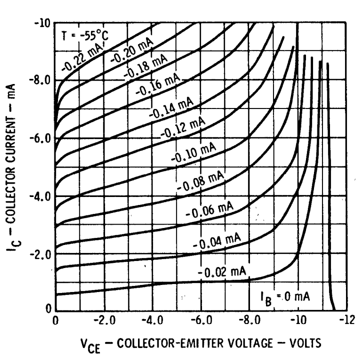


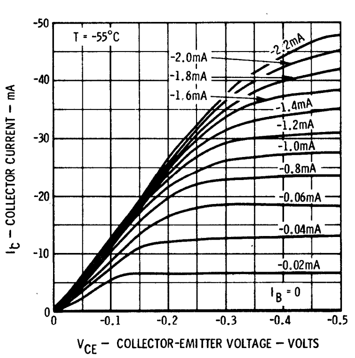


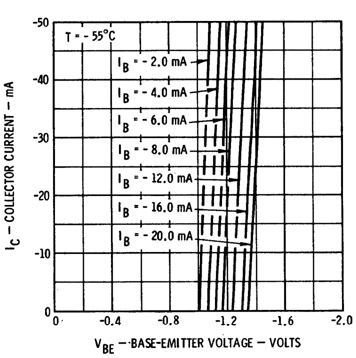


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

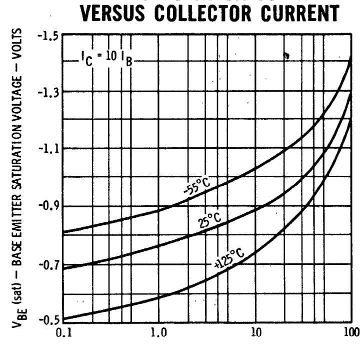




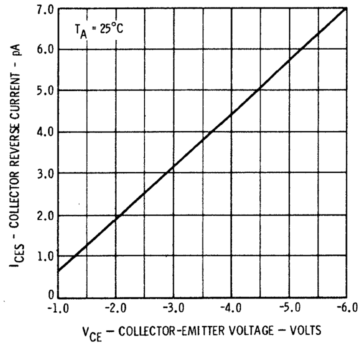




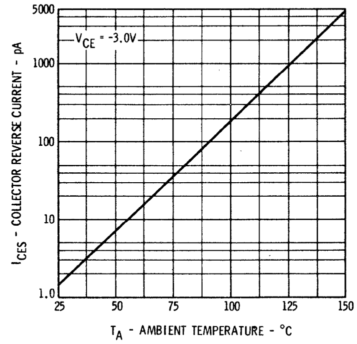
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



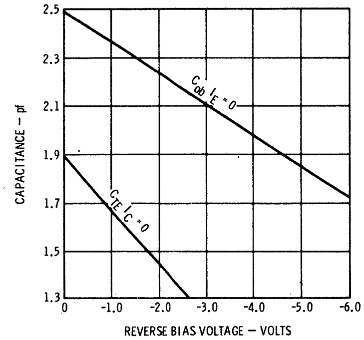
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



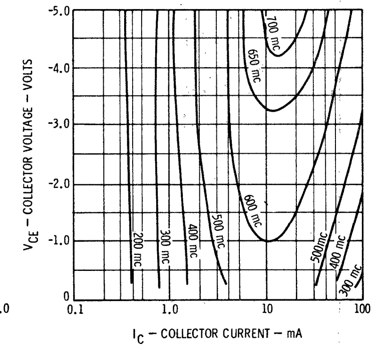
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



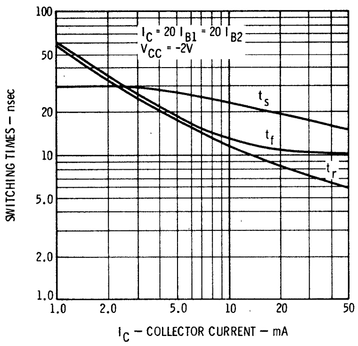
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



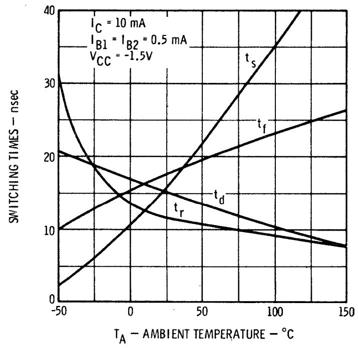
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



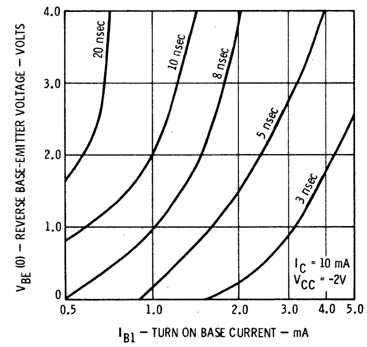
SWITCHING TIMES VERSUS COLLECTOR CURRENT



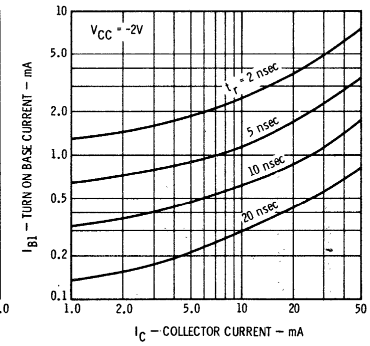
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



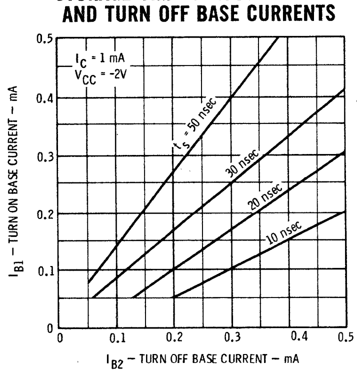
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



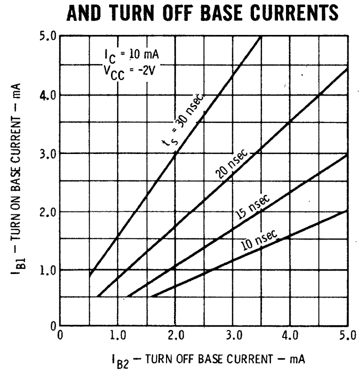
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



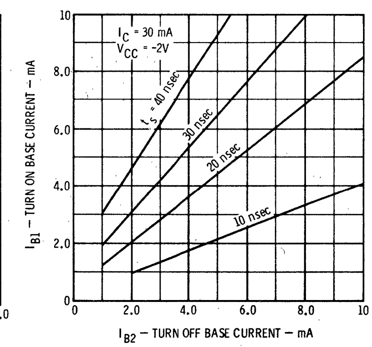
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



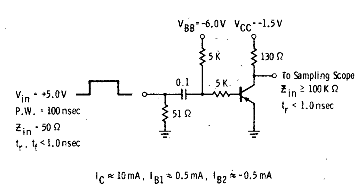
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



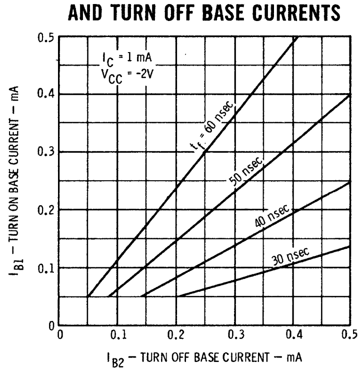
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



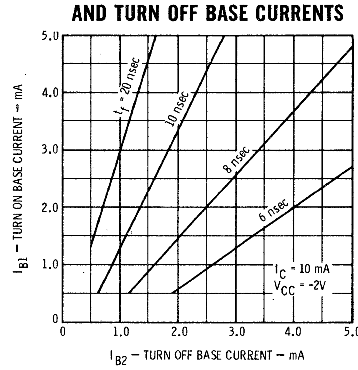
TURN ON AND TURN OFF TEST CIRCUIT



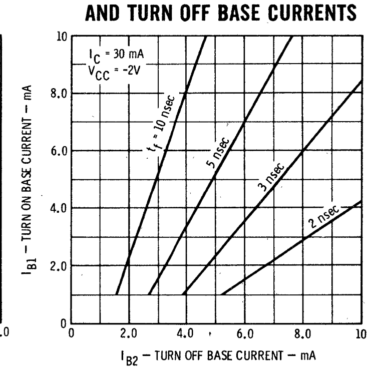
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



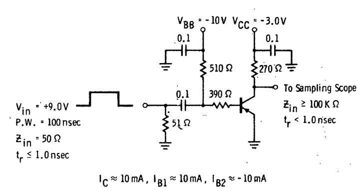
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

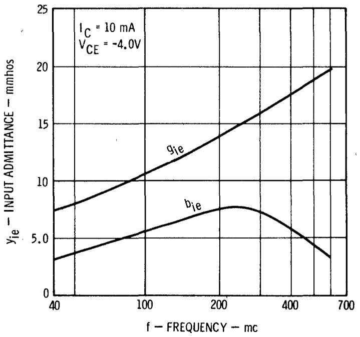


CHARGE STORAGE TIME TEST CIRCUIT

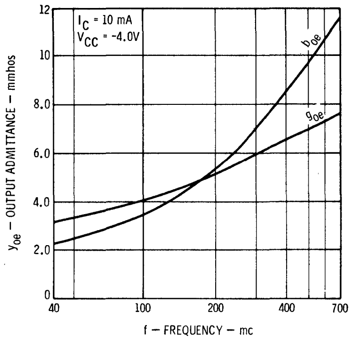


TYPICAL COMMON EMITTER "Y" PARAMETERS

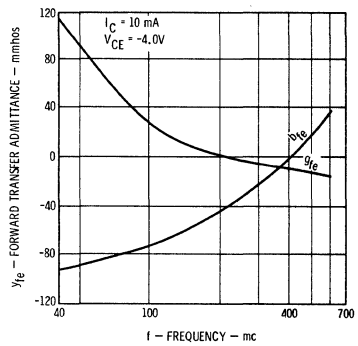
INPUT ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



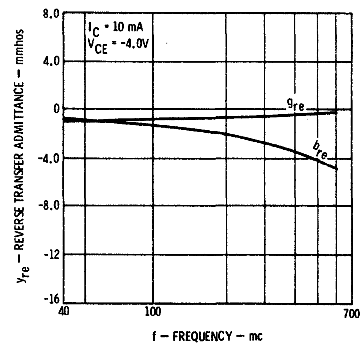
OUTPUT ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



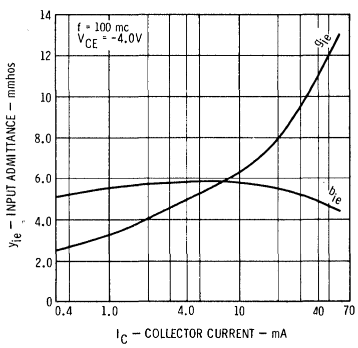
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



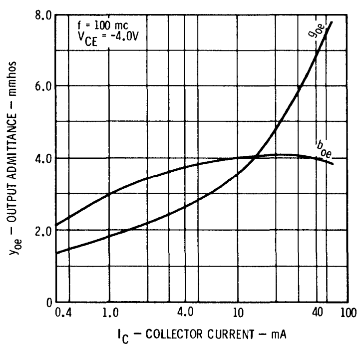
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



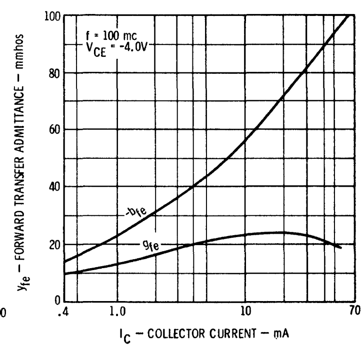
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



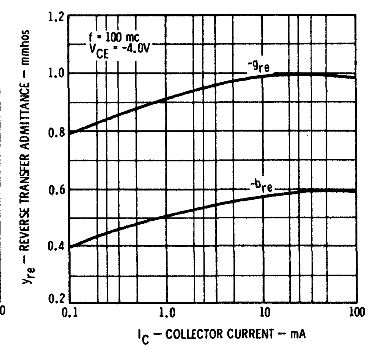
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



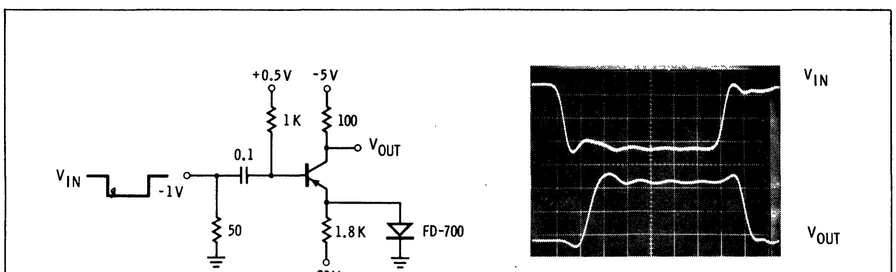
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT

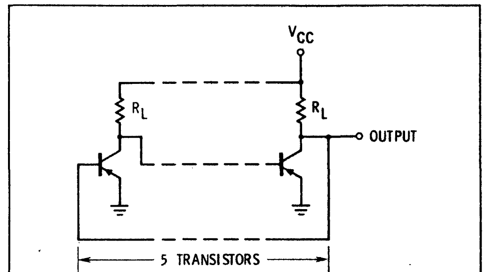


NON SATURATED SWITCHING PERFORMANCE



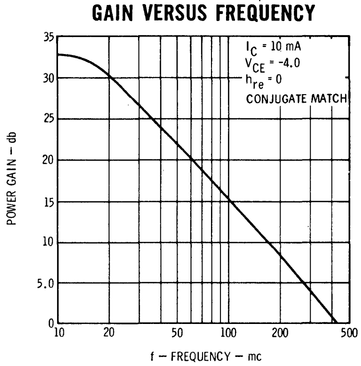
2 nsec / division

FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY

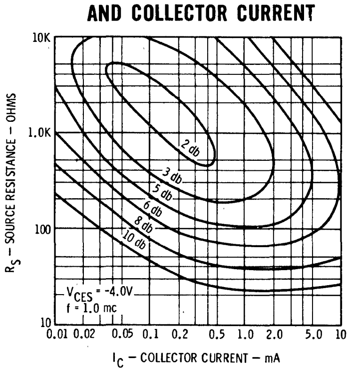


$$t_{pd} = \frac{1}{10 f_{osc}}$$

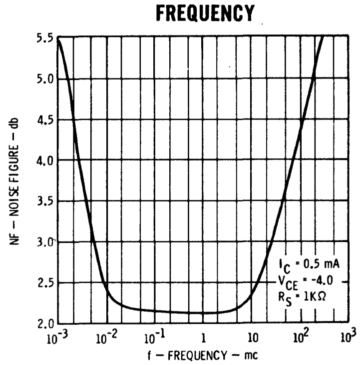
IDEALIZED SMALL SIGNAL POWER GAIN VERSUS FREQUENCY



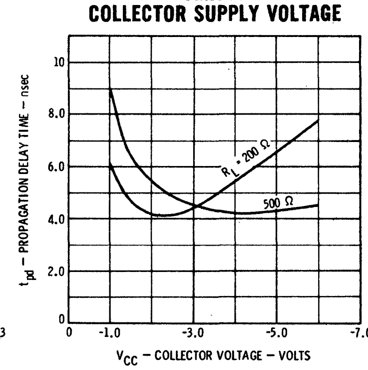
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



NOISE FIGURE VERSUS FREQUENCY



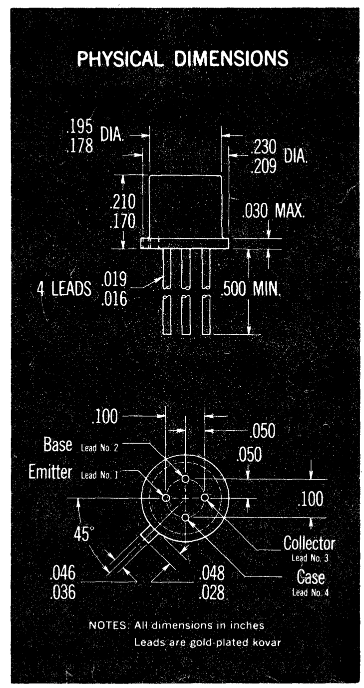
PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



2N3337 • 2N3338 • 2N3339

NPN RF-IF-AGC AMPLIFIERS

DIFFUSED SILICON PLANAR*TRANSISTORS



GENERAL DESCRIPTION — The 2N3337, 2N3338, and 2N3339 are NPN silicon PLANAR transistors designed specifically for RF-IF-AGC applications. They feature high power gain, low noise, and excellent forward AGC characteristics.

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction 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 & 3)	0.5 Watt
at 25°C Ambient Temperature (Notes 2 & 3)	0.3 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	40 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	40 Volts
V_{EBO}	Emitter to Base Voltage	4.0 Volts

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

Symbol	Characteristics		2N3337 2N3338 Min.	2N3337 2N3338 Max.	2N3339 Min.	2N3339 Max.	Units	Test Conditions	
G_{Pe_1}	Small-Signal Power Gain (f = 60 MHz)	(Note 7)	24				dB	I_C = 4.0 mA	V_{CE} = 10 V
G_{Pe_2}	Small-Signal Power Gain (f = 60 MHz)	(Note 7)	-30				dB	See Note 5	
G_{Pe_1}	Small-Signal Power Gain (f = 200 MHz)	(Note 8)			15		dB	I_C = 4.0 mA	V_{CE} = 10 V
G_{Pe_2}	Small-Signal Power Gain (f = 200 MHz)	(Note 8)			-30		dB	See Note 6	
NF	Noise Figure (f = 60MHz) 2N3338 only	(Note 7)		5.5			dB	I_C = 4.0 mA	V_{CE} = 10 V
NF	Noise Figure (f = 200 MHz)	(Note 8)				5.5	dB	I_C = 4.0 mA	V_{CE} = 10 V

Additional Electrical Characteristics on page 2

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 350°C/Watt (derating factor of 2.86 mW/°C); junction-to-ambient thermal resistance of 583°C/Watt (derating factor of 1.72 mW/°C).
(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.
(5) G_{Pe_2} is $\leq G_{Pe_1}$ -30 dB when I_C is between 8.0 and 12 mA in the 60 MHz circuit on page 4. $V_{CE} = (12 - \frac{I_C}{2})$.
(6) G_{Pe_2} is $\leq G_{Pe_1}$ - 30 dB when I_C is between 10 and 14 mA in the 200 MHz circuit on page 4. $V_{CE} = (12 - \frac{I_C}{2})$.
(7) Bandwidth = 10 MHz Source resistance (as seen by transistor) = 200Ω.
(8) Bandwidth = 8.0 MHz Source resistance (as seen by transistor) = 100Ω.
(9) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

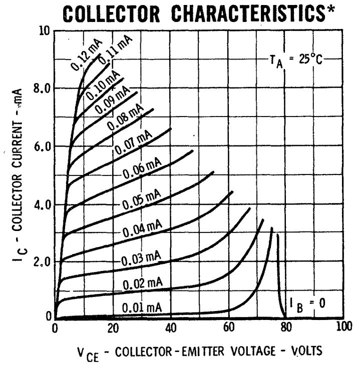
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

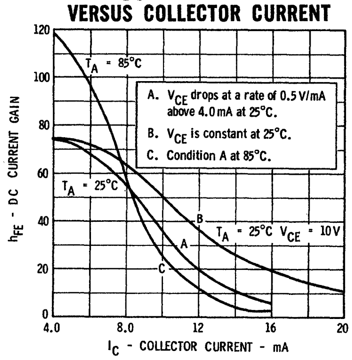
Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	30			I_C = 4.0 mA	V_{CE} = 10 V
I_{CBO}	Collector Cutoff Current		25	nA	I_E = 0	V_{CB} = 20 V
I_{CBO}(125°C)	Collector Cutoff Current		5.0	μA	I_E = 0	V_{CB} = 20 V
C_{ob}	Output Capacitance		1.6	pf	I_E = 0	V_{CB} = 10 V
h_{fe}	High Frequency Current Gain (f = 100 mc)	4.0			I_C = 4.0 mA	V_{CE} = 10 V
BV_{CBO}	Collector to Base Breakdown Voltage	40		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 9)	40		Volts	I_C = 3.0 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0		Volts	I_E = 100 μA	I_C = 0

TYPICAL ELECTRICAL CHARACTERISTICS

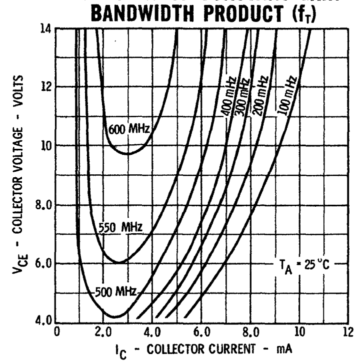
COLLECTOR CHARACTERISTICS*



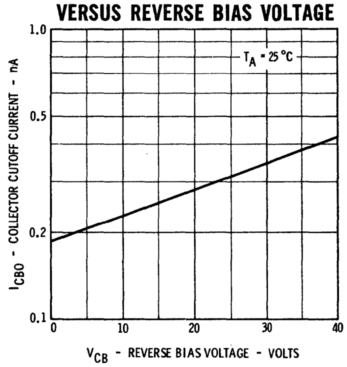
DC CURRENT GAIN VERSUS COLLECTOR CURRENT



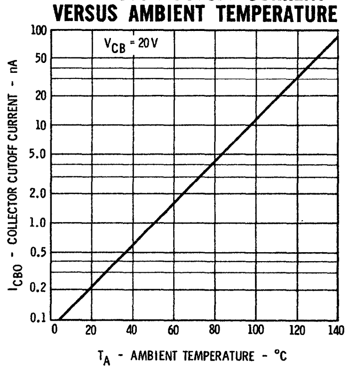
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



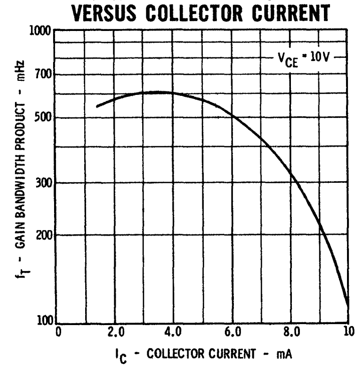
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



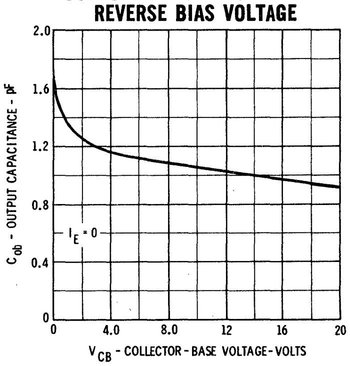
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



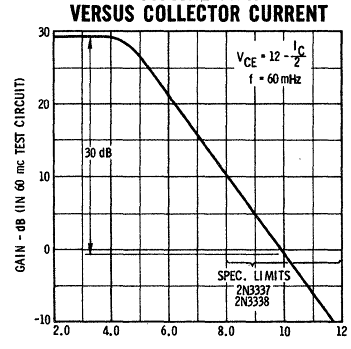
GAIN-BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



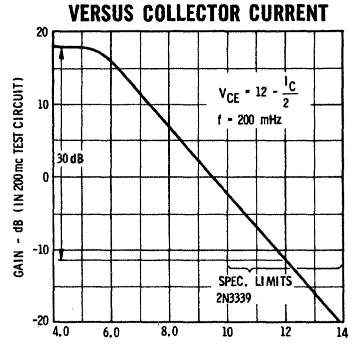
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



TYPICAL GAIN VERSUS COLLECTOR CURRENT



TYPICAL GAIN VERSUS COLLECTOR CURRENT



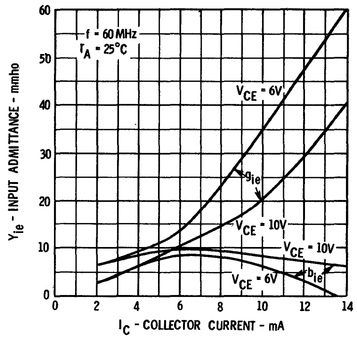
* Single family characteristics on Transistor Curve Tracer

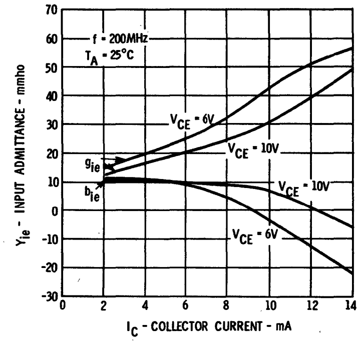
TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

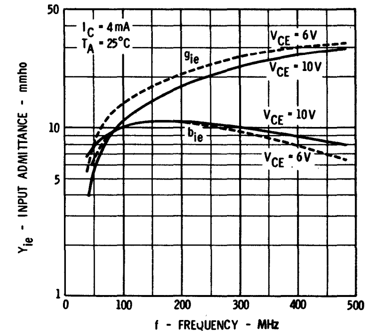
	60 MHz	200 MHz	vs. FREQUENCY
	vs. COLLECTOR CURRENT	vs. COLLECTOR CURRENT	

y_{ie}

Input Admittance
(output short circuit)

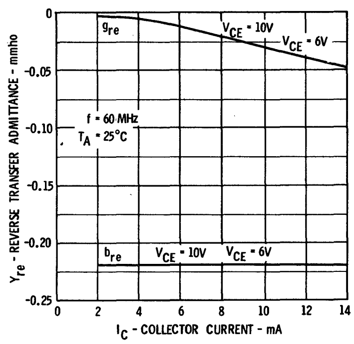


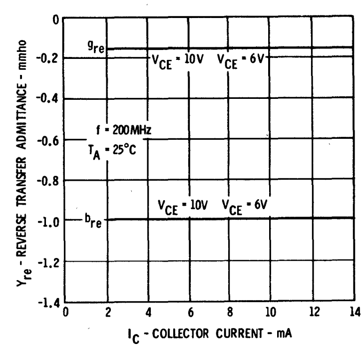


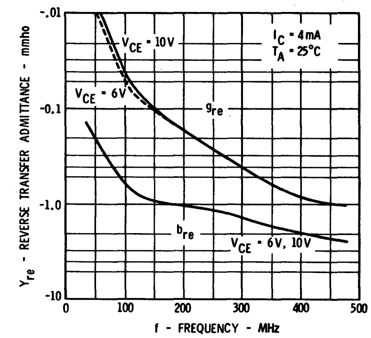


y_{re}

Reverse
Transfer Admittance
(input short circuit)

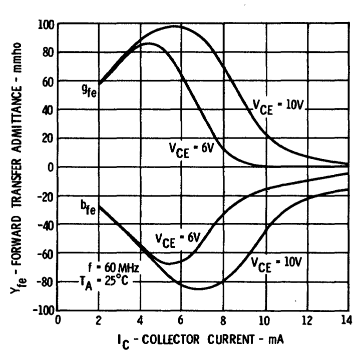


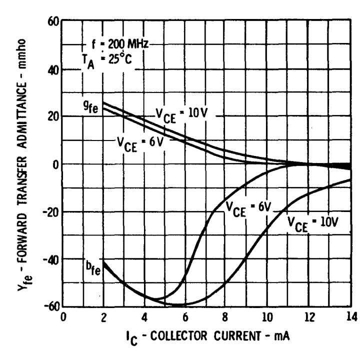


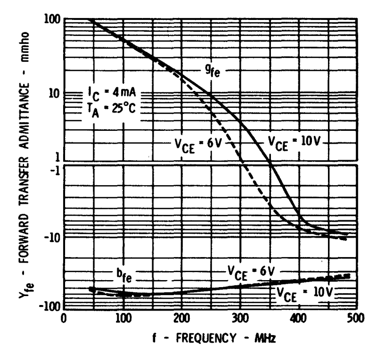


y_{fe}

Forward
Transfer Admittance
(output short circuit)

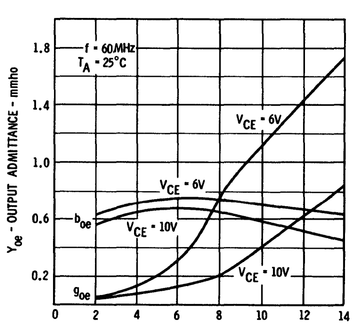


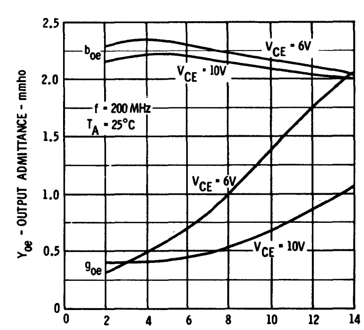


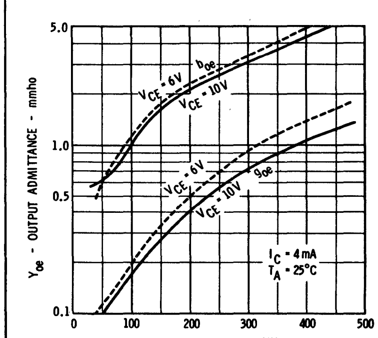


y_{oe}

Output Admittance
(input short circuit)

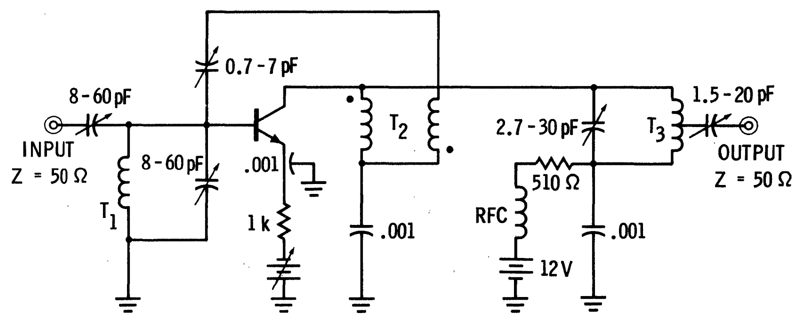






2N3337 - 2N3338

60MHz AGC TEST CIRCUIT



T_1 8 turns #16 tinned copper wire 1/4 inch I.D. x 1/2 inch long.

T_2 7 turns #32 Bifilar wire wound on toroid, I.D. = .120 inch, O.D. = .230 inch, .060 thick.

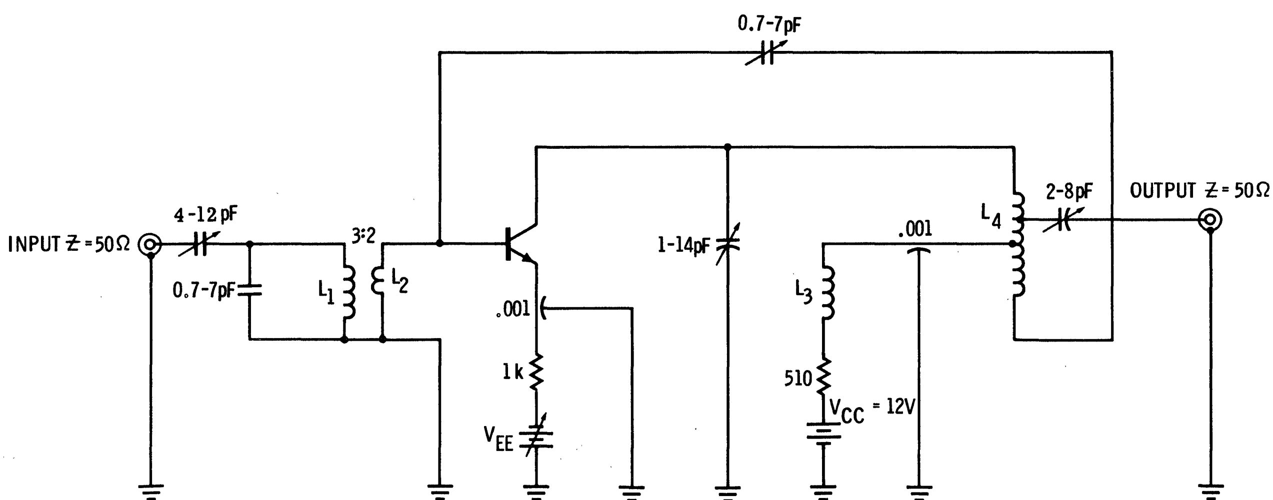
$\frac{1}{\mu_0 Q}$ = .00017 at 50 MHz μ_0 = 40 at 1 MHz

T_3 8 1/2 turns #26 enameled wire, center-tapped, wound on toroid, I.D. = .187 inch, O.D. = .375 inch, .125 thick.

$\frac{1}{\mu_0 Q}$ = .00042 at 150 MHz μ_0 = 16 at 1 MHz

2N3339

200MHz AGC TEST CIRCUIT



L_1 - 3 turns #18 enameled wire on 1/4" ceramic core.

L_2 - 2 turns #18 enameled wire interwound at cold end with L_1.

L_3 - RFC

L_4 - 7 turns 0.076 diameter silver tubing space wound (3/8" I.D., no core), output tap at 2 turns from collector end, ground tap at 4 turns from collector end.

FAIRCHILD SEMICONDUCTOR
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2N3426

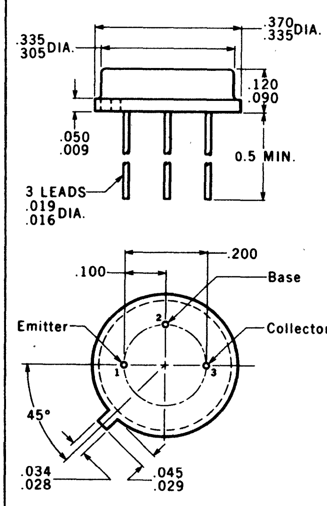
NPN HIGH-SPEED, HIGH CURRENT, SWITCH

SILICON PLANAR* EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION

The 2N3426 is a silicon PLANAR epitaxial transistor with very high speed switching capability at high currents. A maximum V_{CE}(sat) of 0.7 V at one ampere and minimum f_T of 450 MHz qualify it especially for use as a thin film memory driver.

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Collector internally connected to case
Leads are gold-plated kovar
Package weight is 0.98 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		-65°C to +200°C
Operating Junction 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)		3.0 Watts
at 25°C Ambient Temperature (Notes 2 and 3)		0.6 Watt
Maximum Voltages and Current		
V_{CBO}	Collector to Base Voltage	25 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	12 Volts
V_{EBO}	Emitter to Base Voltage	4.0 Volts
I_C	Collector Current	1.0 Amp

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic		Min.	Typ.	Max.	Units	Test Conditions
t_{on}	Turn On Time	(Note 6)		10	15	ns	$I_C \approx 1000$ mA $I_{B1} \approx 100$ mA
t_{off}	Turn Off Time	(Note 6)		15	25	ns	$I_C \approx 1000$ mA, $I_{B1} \approx 100$ mA, $I_{B2} \approx -100$ mA
τ_s	Charge Storage Time	(Note 6)			15	ns	$I_C \approx 100$ mA, $I_{B1} \approx 100$ mA, $I_{B2} \approx -100$ mA
h_{fe}	High Frequency Current Gain	(f = 100MHz)	4.5	6.5			I_C = 100 mA V_{CE} = 5.0 V
V_{CE}(sat)	Collector Saturation Voltage	(Note 5)		0.18	0.23	Volts	I_C = 100 mA I_B = 10 mA
V_{CE}(sat)	Collector Saturation Voltage	(Note 5)		0.24	0.33	Volts	I_C = 300 mA I_B = 30 mA
V_{CE}(sat)	Collector Saturation Voltage	(Notes 5 & 7)		0.51	0.7	Volts	I_C = 1000 mA I_B = 100 mA
h_{FE}	DC Pulse Current Gain	(Note 5)	30	60	120		I_C = 300 mA V_{CE} = 0.5 V
C_{obo}	Output Capacitance				25	pF	V_{CB} = 0 I_E = 0
h_{fe}	High Frequency Current Gain	(f = 100MHz)	2.0				I_C = 500 mA V_{CB} = 0

Additional Electrical Characteristics on page 2.

*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 58.3°C/Watt (derating factor of 17.2 mW/°C); junction-to-ambient thermal resistance of 291.6°C/Watt (derating factor of 3.43 mW/°C).

(4) 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.

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

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

(7) This limit applies for a measurement made 1/4" from the bottom of the case.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

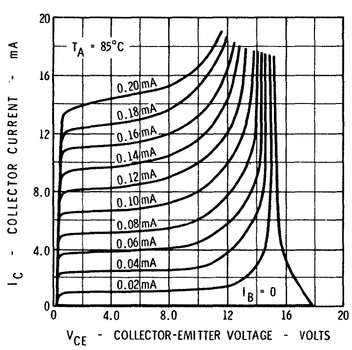
FAIRCHILD TRANSISTOR 2N3426

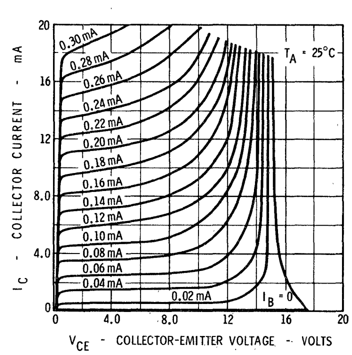
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
V_{CE}(sat)	Collector Saturation Voltage		0.17	0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat) (85°C)	Collector Saturation Voltage (Note 5)		0.25	0.5	Volts	I_C = 300 mA	I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage		0.68	0.78	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.84	1.1	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.0	1.3	Volts	I_C = 300 mA	I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)	0.9	1.36	2.1	Volts	I_C = 1000 mA	I_B = 100 mA
I_{CES}	Collector Reverse Current		1.5	100	μA	V_{CE} = 15 V	V_{EB} = 0
C_{obo}	Output Capacitance		6.2	15	pF	I_E = 0	V_{CB} = 5.0 V
C_{ibo}	Input Capacitance		14.8	25	pF	I_C = 0	V_{EB} = 0.5 V
BV_{CBO}	Collector to Base Breakdown Voltage	25			Volts	I_C = 500 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	12			Volts	I_C = 30 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0			Volts	I_E = 100 μA	I_C = 0
h_{FE}	DC Pulse Current Gain (Note 5)	30	50			I_C = 100 mA	V_{CE} = 0.5 V
h_{FE}	DC Pulse Current Gain (Note 5)	20	45			I_C = 10 mA	V_{CE} = 0.5 V

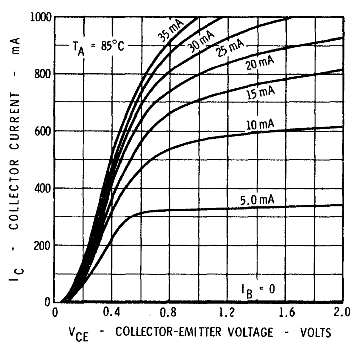
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

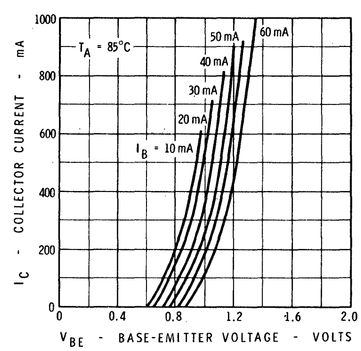
ACTIVE REGION

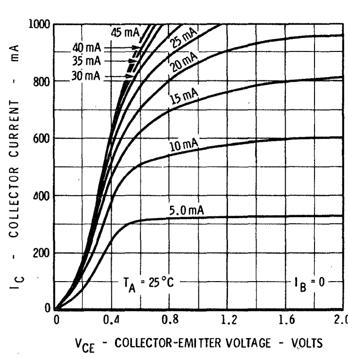


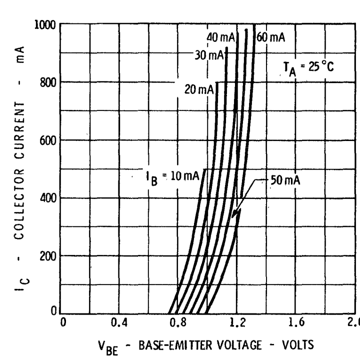


SATURATION REGION



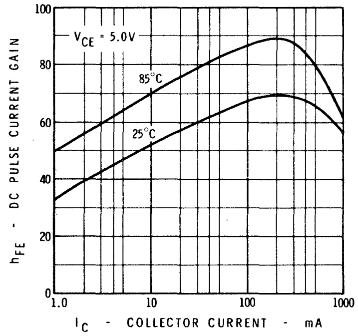




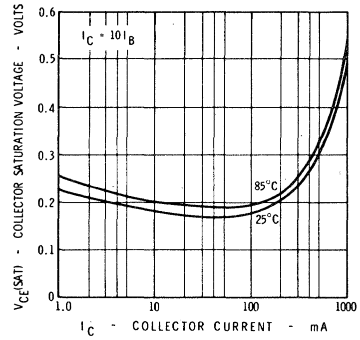


TYPICAL ELECTRICAL CHARACTERISTICS

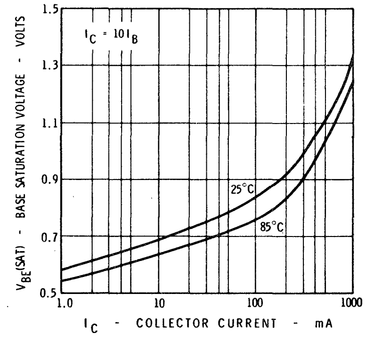
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



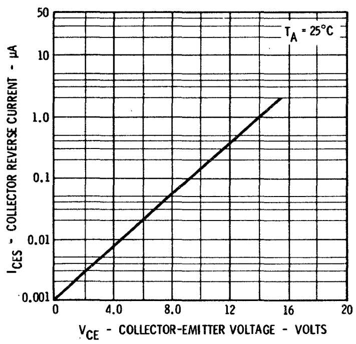
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



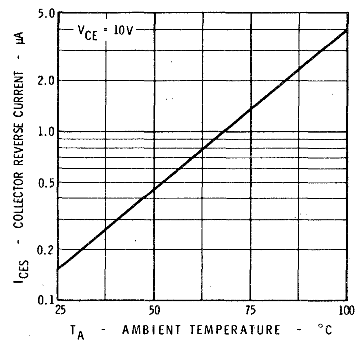
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



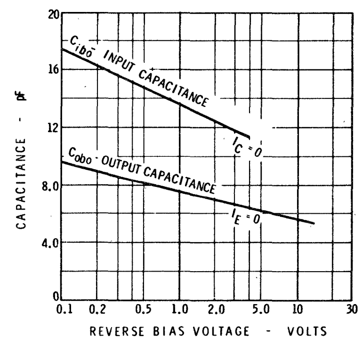
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



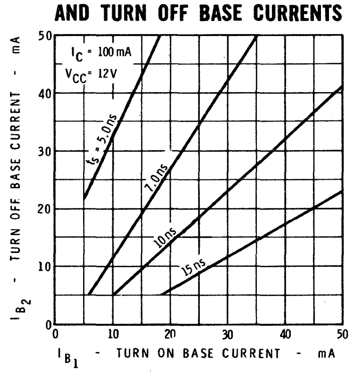
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



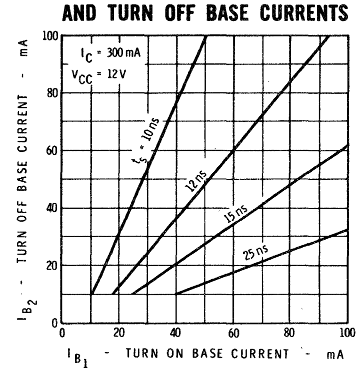
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



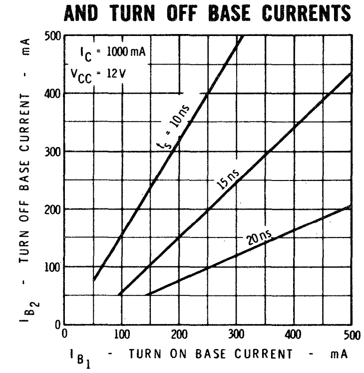
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



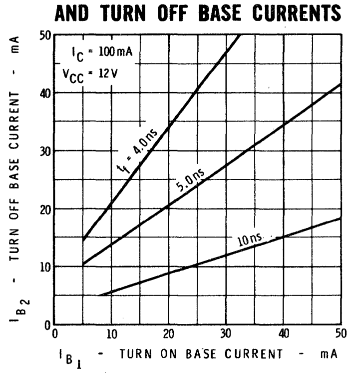
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



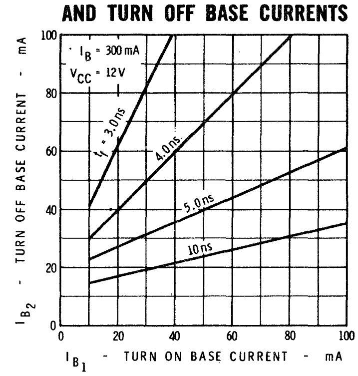
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



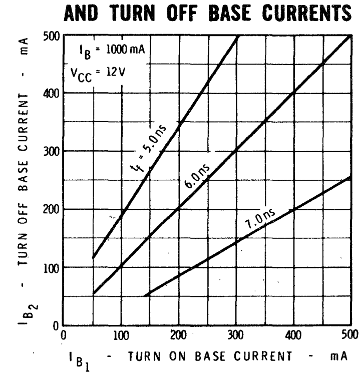
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

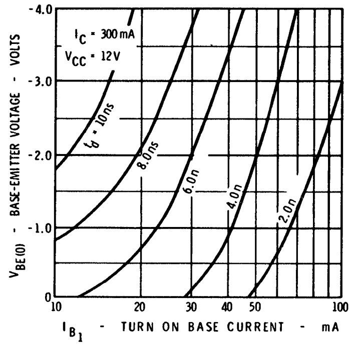


FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

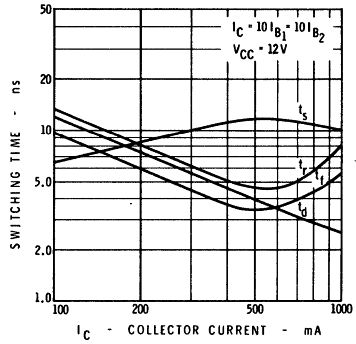


TYPICAL ELECTRICAL CHARACTERISTICS

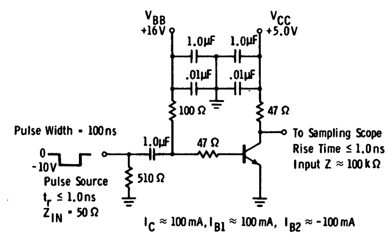
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



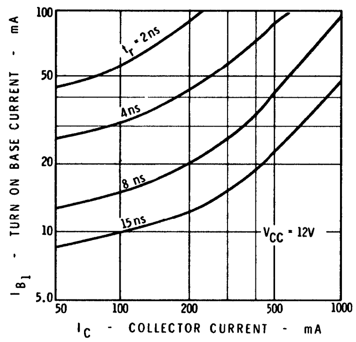
SWITCHING TIMES VERSUS COLLECTOR CURRENT



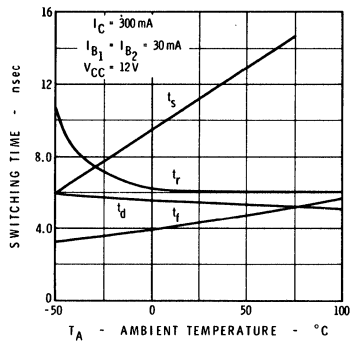
CHARGE STORAGE TIME TEST CIRCUIT



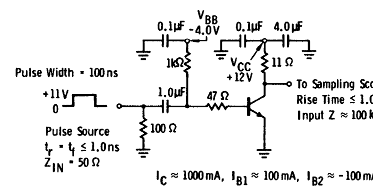
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



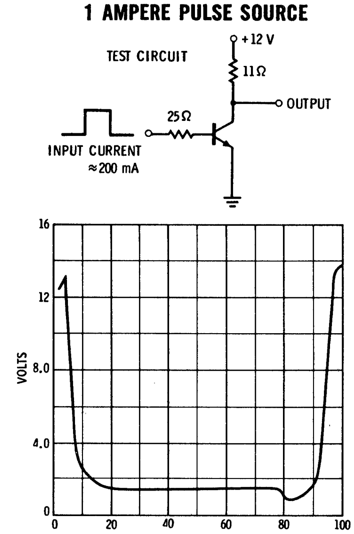
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



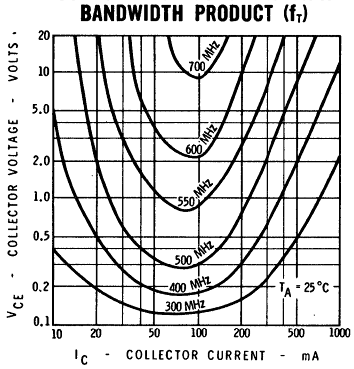
TURN ON AND TURN OFF TEST CIRCUIT



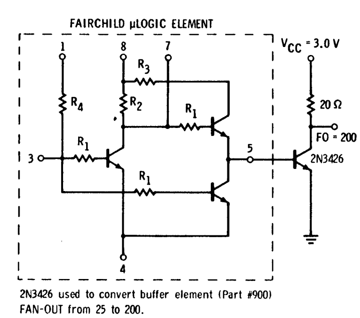
HIGH SPEED 1 AMPERE PULSE SOURCE



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



IMPROVING FAN-OUT CAPABILITY



2N3426 used to convert buffer element (Part #900) FAN-OUT from 25 to 200.

FAIRCHILD SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N3467 · 2N3468

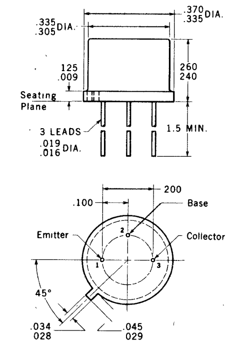
PNP HIGH-SPEED SATURATED SWITCHES

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N5022 • 2N5023

GENERAL DESCRIPTION — The 2N3467 and 2N3468 are low power, silicon PNP triode transistors designed primarily for high speed saturated switching and for core driving applications.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		−65°C to +200°C
Operating Junction Temperature		+200°C
Lead Temperature (soldering, 10 second time limit)		+230°C
Maximum Power Dissipation (Notes 2 and 3)		
Total Dissipation at 25°C Ambient Temperature		1.0 Watt
at 25°C Case Temperature		5.0 Watts
Maximum Voltages and Current	2N3467	2N3468
V_{CBO} Collector to Base Voltage	−40 Volts	−50 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	−40 Volts	−50 Volts
V_{EBO} Emitter to Base Voltage	−5.0 Volts	−5.0 Volts
I_C Collector Current	1.0 Amp	1.0 Amp

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

SYMBOL	CHARACTERISTIC	2N3467 Min.	2N3467 Max.	2N3468 Min.	2N3468 Max.	UNITS	TEST CONDITIONS
t_d	Turn On Delay Time (Figure 1)		10		10	ns	$I_C = 500$ mA $I_{B1} = 50$mA
t_r	Rise Time (Figure 1)		30		30	ns	$I_C = 500$ mA $I_{B1} = 50$mA
t_s	Storage Time (Figure 2)		60		60	ns	$I_C = 500$ mA $I_{B1} = I_{B2} = 50$ mA
t_f	Fall Time (Figure 2)		30		30	ns	$I_C = 500$ mA $I_{B1} = I_{B2} = 50$ mA
C_{ob}	Output Capacitance (f = 100 kHz)		25		25	pF	$I_E = 0$ $V_{CB} = -10$ V
C_{ib}	Input Capacitance (f = 100 kHz)		100		100	pF	$I_C = 0$ $V_{OB} = -0.5$ V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	1.75		1.5			$I_C = 50$ mA $V_{CE} = 10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	−40		−50		Volts	$I_C = 10\ \mu A$ $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0		−5.0		Volts	$I_E = 10\ \mu A$ $I_C = 0$
BV_{CEO}	Collector to Emitter Breakdown Voltage (Note 5)	−40		−50		Volts	$I_C = 10$ mA $I_B = 0$
h_{FE}	DC Pulse Current Gain (Note 5)	40		25			$I_C = 150$ mA $V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	25	75		$I_C = 500$ mA $V_{CE} = -1.0$ V
h_{FE}	DC Pulse Current Gain (Note 5)	40		20			$I_C = 1.0$ A $V_{CE} = -5.0$ V
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.30		−0.35	Volt	$I_C = 150$ mA $I_B = 15$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.50		−0.60	Volt	$I_C = 500$ mA $I_B = 50$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−1.0		−1.2	Volts	$I_C = 1.0$ A $I_B = 100$ mA

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 35°C/Watt (derating factor of 28.6 mW/°C); junction to ambient thermal resistance of 175°C/Watt (derating factor of 5.71 mW/°C).
(4) This rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publicaion APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

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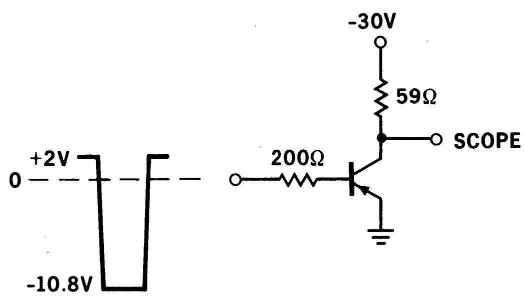
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N3467 Min.	2N3467 Max.	2N3468 Min.	2N3468 Max.	UNITS	TEST CONDITIONS
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)		−1.0		−1.0	Volt	$I_C = 150$ mA $I_B = 15$ mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)	−0.8	−1.2	−0.8	−1.2	Volts	$I_C = 500$ mA $I_B = 50$ mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)		−1.6		−1.6	Volts	$I_C = 1.0$ A $I_B = 100$ mA
I_{CBO}	Collector Cutoff Current		100		100	nA	$V_{CB} = -30$ V $I_E = 0$
$I_{CBO(100°C)}$	Collector Cutoff Current		15		15	μA	$V_{CB} = -30$ V $I_E = 0$
I_{CEX}	Collector Cutoff Current		100		100	nA	$V_{CB} = -30$ V $V_{OB} = -3.0$ V
I_{BL}	Base Cutoff Current		120		120	nA	$V_{CB} = -30$ V $V_{OB} = -3.0$ V
Q_T	Total Control Charge (Figure 3)		6.0		6.0	nC	$I_C = 500$ mA $I_B = 50$ mA

FIGURE 1

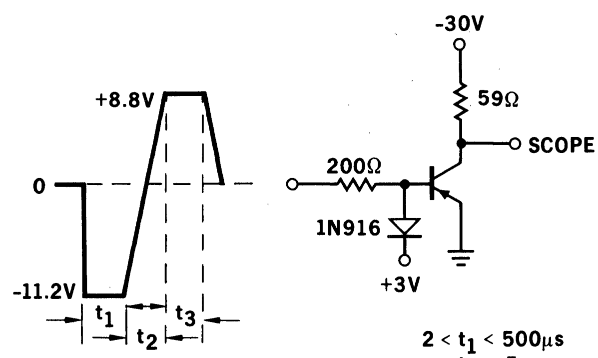
TURN-ON EQUIVALENT TEST CIRCUIT



PW = 200ns
RISE TIME ≤ 2ns
DUTY CYCLE = 2%

FIGURE 2

TURN-OFF EQUIVALENT TEST CIRCUIT

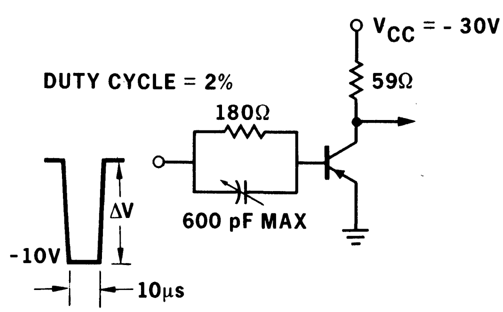


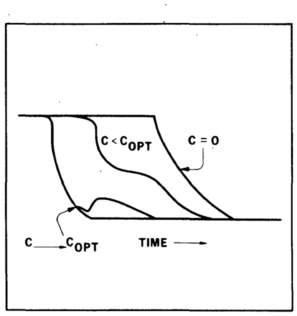
2 < t_1 < 500μs
t_2 < 5ns
t_3 > 1 μs

DUTY CYCLE = 2%

FIGURE 3

Q_T TEST CIRCUIT





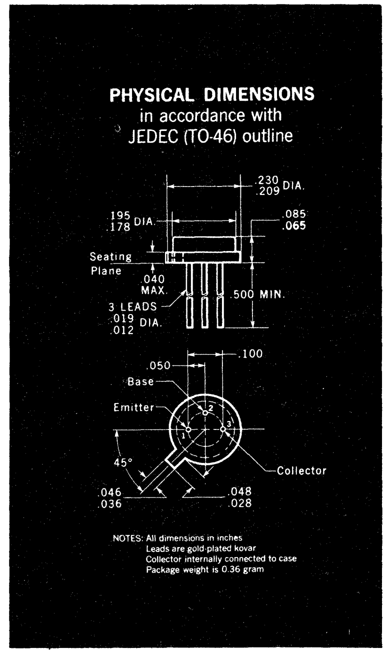
2N3485 · 2N3486 · 2N3485A · 2N3486A

PNP HIGH-SPEED SWITCHES AND CORE DRIVERS

SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3502 THROUGH 2N3505

GENERAL DESCRIPTION – These PNP Silicon Planar Epitaxial Transistors are designed primarily for high-speed saturated switching and core driver applications.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum

Maximum Power Dissipation

		2N3485 2N3486 2N3485A 2N3486A
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	2.0 Watts
at 25°C Free Air Temperature	(Notes 2 and 3)	0.4 Watt

Maximum Voltages and Current

			2N3485 2N3486	2N3485A 2N3486A
V_{CBO}	Collector to Base Voltage		-60 Volts	-60 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-40 Volts	-60 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts	-5.0 Volts
I_C	Collector Current	(Note 2)	600 mA	600 mA

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

Symbol	Characteristic	2N3485 Min.	2N3485 Max.	2N3485A Min.	2N3485A Max.	2N3486 Min.	2N3486 Max.	2N3486A Min.	2N3486A Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	40	120	100	300	100	300		I_C = 150 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	35		40		75		100			I_C = 10 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	25		40		50		100			I_C = 1.0 mA	V_{CE} = -10 V
h_{FE}	DC Current Gain	20		40		35		75			I_C = 0.1 mA	V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20		40		30		50			I_C = 500 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20		20		50		50			I_C = 150 mA	V_{CE} = -1.0 V
$V_{CE}(sat)$	Collector Saturation Voltage (pulsed, see Note 5)		-0.4		-0.4		-0.4		-0.4	Volts	I_C = 150 mA	I_B = 15 mA
$V_{CE}(sat)$	Collector Saturation Voltage (pulsed, see Note 5)		-1.6		-1.6		-1.6		-1.6	Volts	I_C = 500 mA	I_B = 50 mA
$V_{BE}(sat)$	Base Saturation Voltage (pulsed, see Note 1)		-1.3		-1.3		-1.3		-1.3	Volts	I_C = 150 mA	I_B = 15 mA
$V_{BE}(sat)$	Base Saturation Voltage (pulsed, see Note 1)		-2.6		-2.6		-2.6		-2.6	Volts	I_C = 500 mA	I_B = 50 mA
t_d	Turn-on Delay Time (see Fig. 1)		10		10		10		10	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_r	Rise Time (see Fig. 1)		40		40		40		40	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_s	Storage Time (see Fig. 2)		80		80		80		80	nsec	I_{CS} = 150 mA, I_{B1} = I_{B2}	= 15 mA
t_f	Fall Time (see Fig. 2)		30		30		30		30	nsec	I_{CS} = 150 mA, I_{B1} = I_{B2}	= 15 mA

Additional Electrical Characteristics on page 2

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

Symbol	Characteristic	2N3485 Min.	2N3485 Max.	2N3485A Min.	2N3485A Max.	2N3486 Min.	2N3486 Max.	2N3486A Min.	2N3486A Max.	Units	Test Conditions	
h_{fe}	High Frequency Current Gain (f = 100 Mc)	2.0		2.0		2.0		2.0			I_C = 50 mA	V_{CE} = -20 V
I_{CBO}	Collector Cutoff Current		20		10		20		10	nA	I_E = 0	V_{CB} = -50 V
I_{CBO}(150°C)	Collector Cutoff Current		20		10		20		10	μA	I_E = 0	V_{CB} = -50 V
I_{CEX}	Collector Reverse Current		50		50		50		50	nA	V_{CE} = -30 V	V_{BE} = +0.5 V
I_B	Base Current		50		50		50		50	nA	V_{CE} = -30 V	V_{BE} = +0.5 V
C_{obo}	Open Circuit Output Capacitance (f = 100 Kc)		8.0		8.0		8.0		8.0	pf	I_E = 0	V_{CB} = -10 V
C_{ibo}	Open Circuit Input Capacitance (f = 100 Kc)		30		30		30		30	pf	I_C = 0	V_{EB} = -2.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	-60		-60		-60		-60		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-40		-60		-40		-60		Volts	I_C = 10 mA (pulsed)	I_C = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0		-5.0		-5.0		-5.0		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 87.5°C/Watt (derating factor of 11.4 mW/°C); junction-to-ambient thermal resistance of 438°C/Watt (derating factor of 2.28 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(5) Pulse Conditions: length ≤ 300 μsec; duty cycle ≤ 2%.

FIGURE 1

TEST CIRCUIT FOR DETERMINING DELAY TIME AND RISE TIME

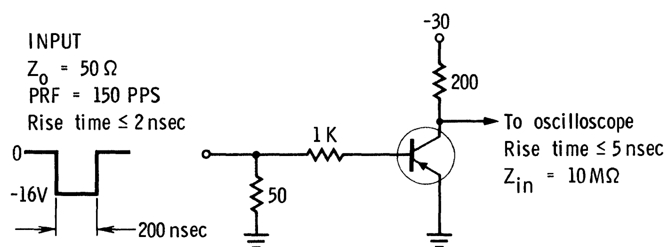
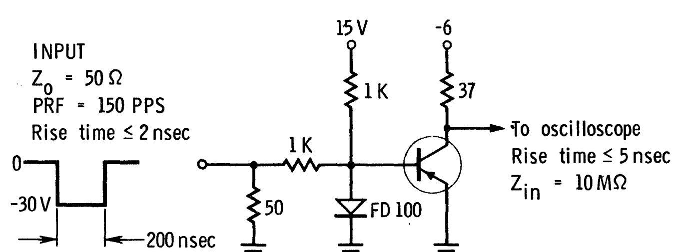


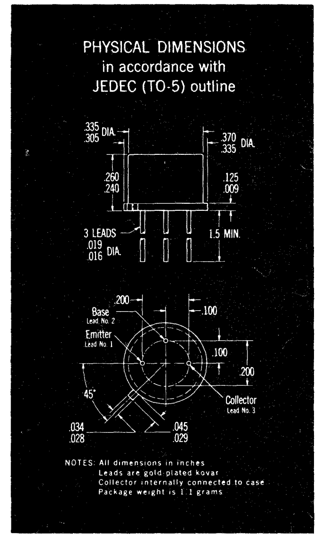
FIGURE 2

TEST CIRCUIT FOR DETERMINING STORAGE TIME AND FALL TIME

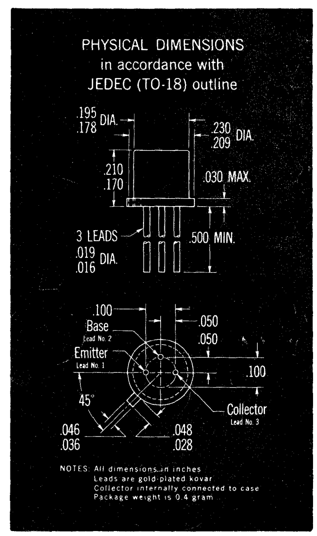


2N3502 • 2N3503 • 2N3504 • 2N3505
PNP HIGH CURRENT SWITCHES
DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

These PNP silicon PLANAR epitaxial transistors are designed for digital and analog applications at current levels up to 500 milliamperes. Their high beta, high f_T at high current, high LV_{CEO}, and low noise figure make them ideal for use as line drivers, memory applications and low-noise amplifiers.



2N3502 • 2N3503



2N3504 • 2N3505

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	-65°C to +200°C	
Operating Junction Temperature	200°C Maximum	

Maximum Power Dissipation	2N3502 2N3503	2N3504 2N3505
Total Dissipation at 25°C Case Temperature (Notes 2 & 3)	3.0 Watts	1.3 Watts
at 25°C Free Air Temperature (Notes 2 & 3)	0.7 Watt	0.4 Watt

Maximum Voltages and Current		2N3503 2N3505	2N3502 2N3504
V_{CBO}	Collector to Base Voltage	-60 Volts	-45 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	-60 Volts	-45 Volts
V_{EBO}	Emitter to Base Voltage	-5.0 Volts	-5.0 Volts
I_C	Collector Current (Note 2)	600 mA	600 mA

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

		2N3503 2N3505			2N3502 2N3504				
Symbol	Characteristic	Min.	Typ.	Max.	Min.	Typ.	Max.	Units	Conditions
h_{FE}	DC Current Gain	80	120		80	120			I_C = 10 μA, V_{CE} = -10 V
h_{FE}	DC Current Gain	120			120				I_C = 100 μA, V_{CE} = -10 V
h_{FE}	DC Current Gain	135	200		135	200			I_C = 1.0 mA, V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain (Note 5)	140	270		140	270			I_C = 10 mA, V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain (Note 5)	100	150	300	100	150	300		I_C = 150 mA, V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50	70		50	70			I_C = 500 mA, V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain	115	160	300	115	160	300		I_C = 50 mA, V_{CE} = -1.0 V
$V_{BE}(sat)$	Base Saturation Voltage (Pulsed, see Note 1)		-0.9	-1.0		-0.9	-1.0	Volts	I_C = 50 mA, I_B = 2.5 mA
$V_{BE}(sat)$	Base Saturation Voltage (Pulsed, see Note 1)		-1.0	-1.3		-1.0	-1.3	Volts	I_C = 150 mA, I_B = 15 mA
$V_{CE}(sat)$	Collector Saturation Voltage (Pulsed, see Note 1)		-0.08	-0.25		-0.08	-0.25	Volts	I_C = 50 mA, I_B = 2.5 mA
$V_{CE}(sat)$	Collector Saturation Voltage (Pulsed, see Note 1)		-0.18	-0.4		-0.18	-0.4	Volts	I_C = 150 mA, I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 100 mc)	2.0	2.50		2.0	2.50			I_C = 50 mA, V_{CE} = -20 V
$V_{CEO}(sust)$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-60			-45			Volts	I_C = 10 mA (pulsed), I_B = 0
t_{on}	Turn On Time (Note 6)		20	40		20	40	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA
t_{off}	Turn Off Time (Note 6)		40	100		40	100	nsec	$I_C \approx$ 300 mA, $I_{B1} \approx$ 30 mA, $I_{B2} \approx$ -30 mA

Electrical Characteristics Continued on Page 2.

(See notes on back page)

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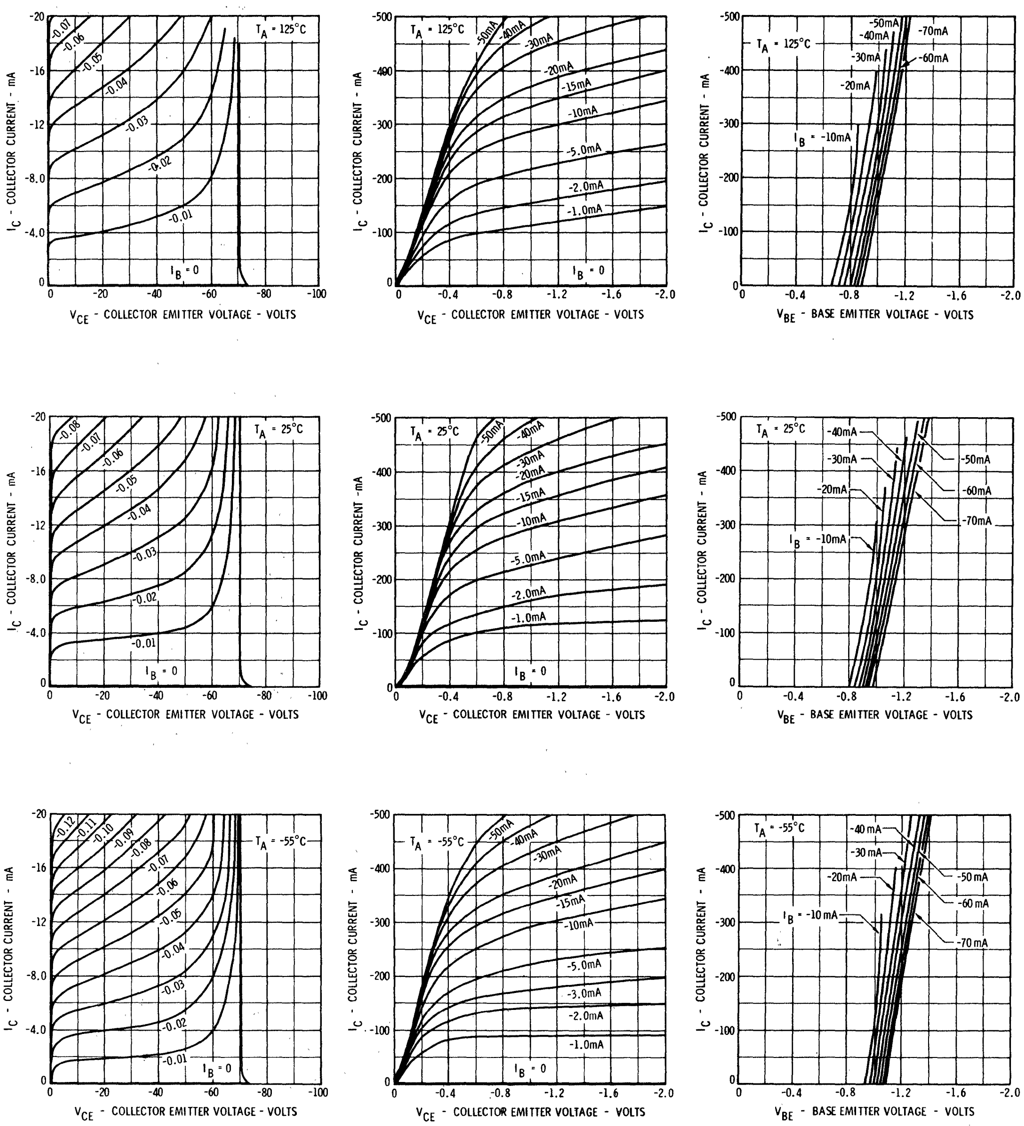
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

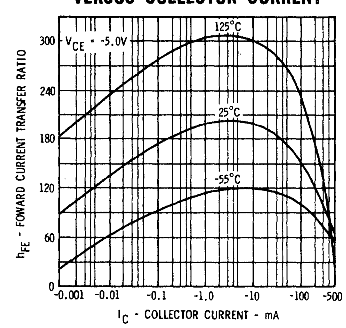
Symbol	Characteristic	2N3503 2N3505 Min.	Typ.	Max.	2N3502 2N3504 Min.	Typ.	Max.	Units	Conditions
h_{FE}(-55°C)	DC Pulse Current Gain	50	100		50	100			I_C = 50 mA V_{CE} = -1.0 V
I_{CES}	Collector Reverse Current		0.07	10				nA	V_{CE} = -50 V V_{BE} = 0
I_{CES}	Collector Reverse Current					0.05	10	nA	V_{CE} = -30 V V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-60			-45			Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0			-5.0			Volts	I_E = 10 μA I_C = 0
C_{ob}	Output Capacitance		4.5	8.0		4.5	8.0	pf	I_E = 0 V_{CB} = -10 V
C_{TE}	Emitter Transition Capacitance		15	25		15	25	pf	I_C = 0 V_{EB} = -0.5 V
NF	Noise Figure (Note 7)		1.0	4.0		1.0	4.0	db	I_C = 30 μA V_{CE} = -5.0 V
I_{CBO}(+150)	Collector Cutoff Current			10				μA	V_{CB} = -50 V I_E = 0
I_{CBO}(+150)	Collector Cutoff Current						10	μA	V_{CB} = -30 V I_E = 0
V_{CE}(sat)	Collector-Saturation Voltage (Pulsed, see Note 5)		-0.5	-1.6		-0.5	-1.6	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Base-Emitter Saturation Voltage (Pulsed, see Note 5)			-2.0			-2.0	Volts	I_C = 500 mA I_B = 50 mA

TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

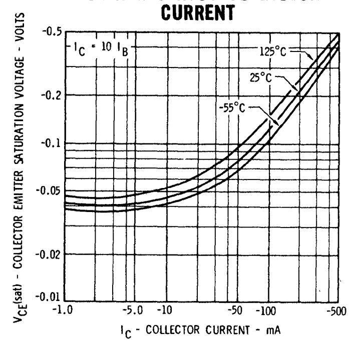
ACTIVE REGION | SATURATION REGION



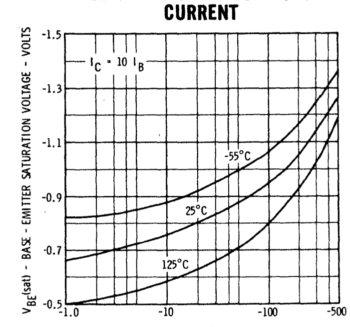
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



PULSED COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



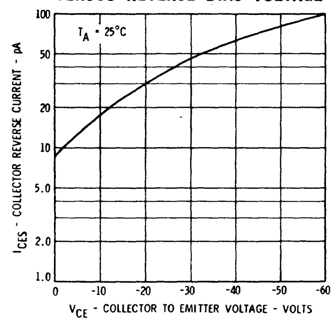
PULSED BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



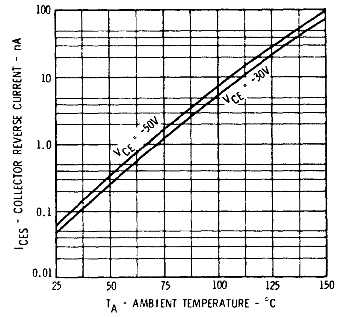
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

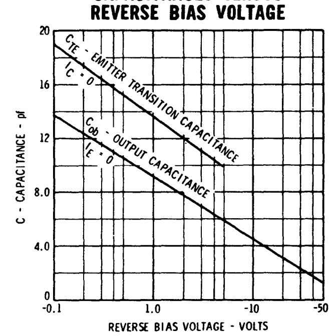
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



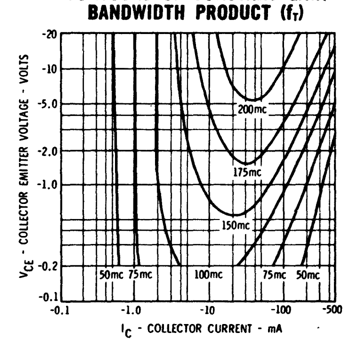
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



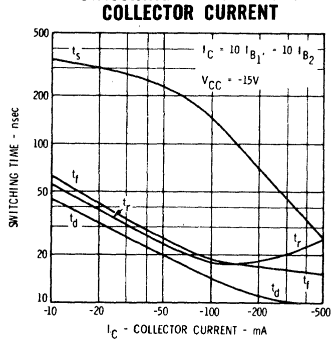
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



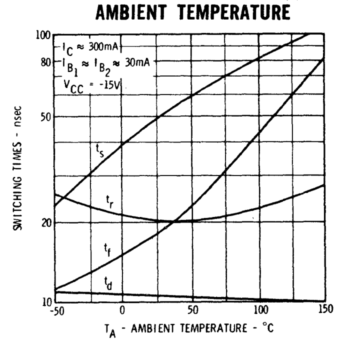
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



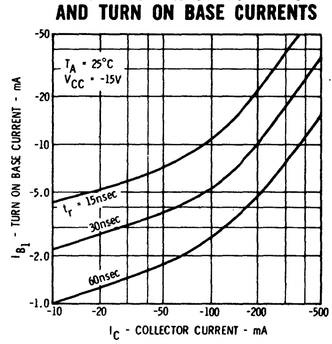
SWITCHING TIMES VERSUS COLLECTOR CURRENT



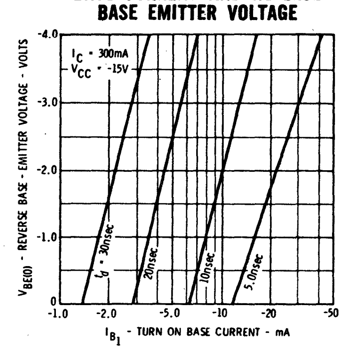
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



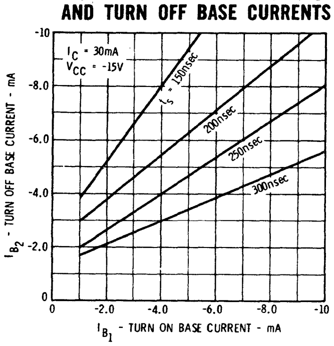
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



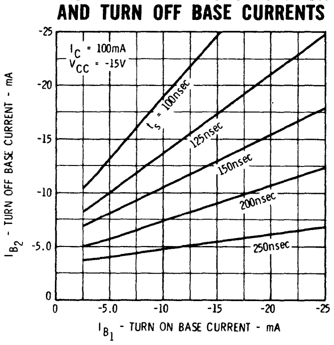
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



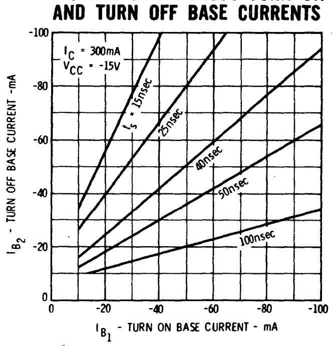
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



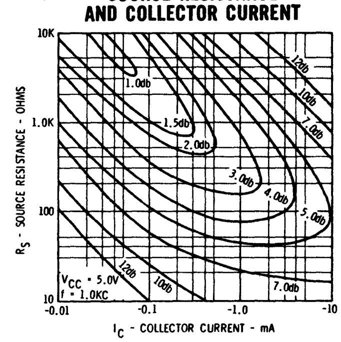
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



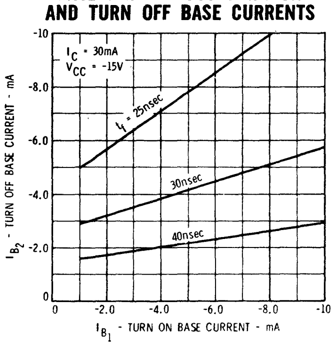
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



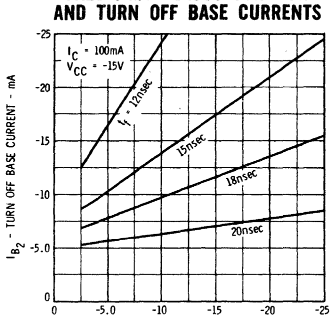
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



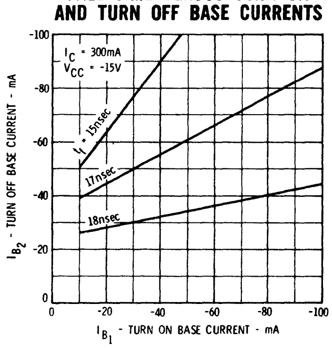
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



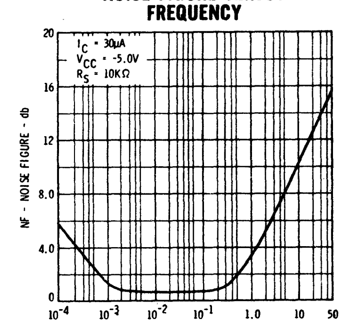
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



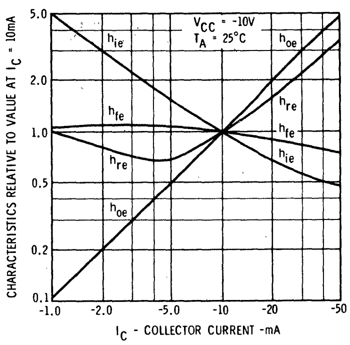
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

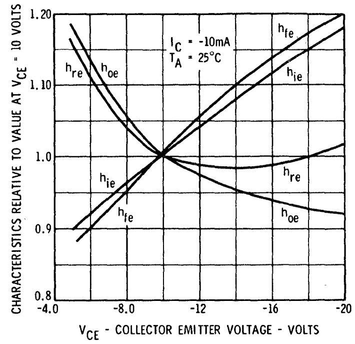


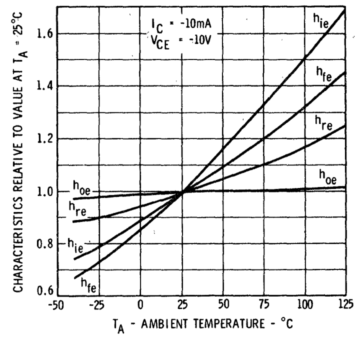
NOISE FIGURE VERSUS FREQUENCY



SMALL SIGNAL CHARACTERISTICS



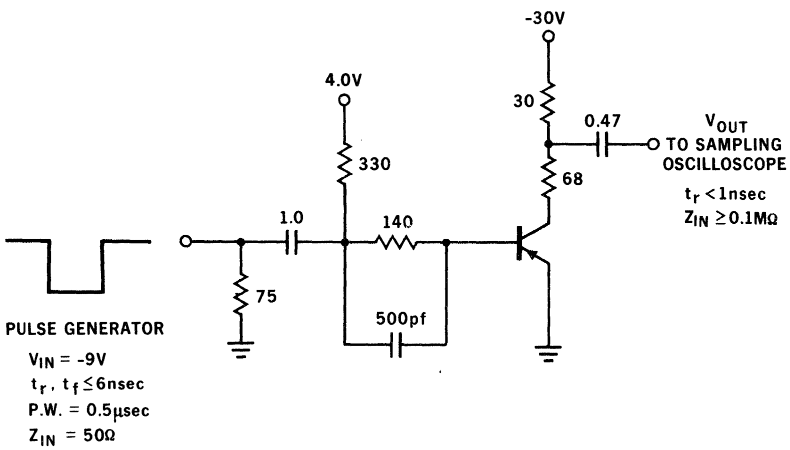




(f = 1kc)

Symbol	Characteristics	Min.	Typ.	Max.	Units	Test Conditions	
h_{ie}	Input Resistance		1050	2300	Ohms	I_C = 10 mA	V_{CE} = -10 V
h_{oe}	Output Conductance		110	800	μmhos	I_C = 10 mA	V_{CE} = -10 V
h_{re}	Voltage Feedback Ratio		240	1500	$x10^{-6}$	I_C = 10 mA	V_{CE} = -10 V
h_{fe}	Small Signal Current Gain	135	200	420		I_C = 10 mA	V_{CE} = -10 V

T_{ON} and T_{OFF} TEST CIRCUIT



NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor 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 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N3502 and 2N3503, and 146°C/Watt (derating factor of 6.85 mW/°C) for the 2N3504 and 2N3505; junction-to-ambient thermal resistance of 250°C/Watt (derating factor of 4.0 mW/°C) for the 2N3502 and 2N3503, and 438°C/Watt (derating factor of 2.28 mW/°C) for the 2N3504 and 2N3505.

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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

(7) f = 1.0 Kc; R_S = 10 KΩ.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

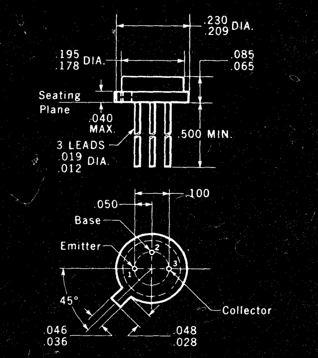
2N3647 • 2N3648

NPN HIGH — SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3647 and 2N3648 are NPN diffused silicon Planar epitaxial transistors designed primarily for high speed saturated switching and memory applications.

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 (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 10 sec time limit)	240°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	2.0 Watts
at 25°C Ambient Temperature	0.4 Watts

Maximum Voltages and Current

		2N3647	2N3648
V_{CBO}	Collector to Base Voltage	40 Volts	40 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	10 Volts	15 Volts
V_{EBO}	Emitter to Base Voltage	6 Volts	6 Volts
I_C	Collector Current	500 mA	500 mA

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

Symbol	Characteristic	2N3647 Min.	2N3647 Max.	2N3648 Min.	2N3648 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	25	150	30	120		I_C = 150 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	20		25			I_C = 10 mA V_{CE} = 1.0 V
h_{FE}	DC Current Gain	12		15			I_C = 1.0 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	15					I_C = 300 mA V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)			12			I_C = 500 mA V_{CE} = 1.0 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)			12			I_C = 150 mA V_{CE} = 1.0 V
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.25		0.25	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.4		0.4	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.6			Volts	I_C = 300 mA I_B = 30 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)				0.8	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		0.8		0.8	Volts	I_C = 10 mA I_B = 1.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	0.8	1.0	0.8	1.0	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		1.15			Volts	I_C = 300 mA I_B = 30 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)				1.5	Volts	I_C = 500 mA I_B = 50 mA

\dditional Electrical Characteristics on page 2 **(See notes on back page)**

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

Symbol	Characteristic	2N3647 Min.	2N3647 Max.	2N3648 Min.	2N3648 Max.	Units	Test Conditions	
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.5		4.5			I_C = 15 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance		4.0		4.0	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance		8.0		8.0	pf	I_C = 0	V_{EB} = 0.5 V
I_{CEX}	Collector Reverse Current		25		25	nA	V_{CE} = 10 V	V_{EB} = 1.0 V
I_{CEX}(150°C)	Collector Reverse Current		50		50	μA	V_{CE} = 10 V	V_{EB} = 1.0 V
I_{BL}	Base Current		25		25	nA	V_{CE} = 10 V	V_{EB} = 1.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	40		40		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	10		15		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		6.0		Volts	I_C = 0	I_E = 10 μA
t_d	Turn-On Delay Time (see Fig. 1)		10		8.0	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_r	Rise Time (see Fig. 1)		12		10	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_{on}	Turn-On Time (see Fig. 1)		20		16	nsec	I_{CS} = 150 mA	I_{B1} = 15 mA
t_s	Storage Time (see Fig. 2)		16		12	nsec	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA	
t_f	Fall Time (see Fig. 2)		12		8.0	nsec	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA	
t_{off}	Turn-Off Time (see Fig. 2)		25		18	nsec	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA	
Q_T	Total Control Charge		0.3		0.3	ncoul	I_C = 150 mA	I_{B1} = 15 mA
h_{fe}	Small Signal Current Gain (f = 1 kHz)	20	150	20	150		I_C = 1.0 mA	V_{CE} = 10 V
h_{re}	Voltage Feedback Ratio (f = 1 kHz)		25		25	$x10^{-4}$	I_C = 1.0 mA	V_{CE} = 10 V
h_{ie}	Input Impedance (f = 1 kHz)	0.6	4.5	0.6	4.5	KΩ	I_C = 1.0 mA	V_{CE} = 10 V
h_{oe}	Output Admittance (f = 1 kHz)	10	100	10	100	μmho	I_C = 1.0 mA	V_{CE} = 10 V

SWITCHING TIME EQUIVALENT TEST CIRCUITS

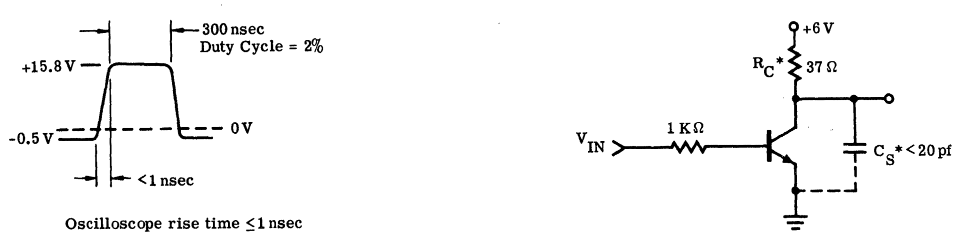


FIGURE 1 DELAY AND RISE TIME

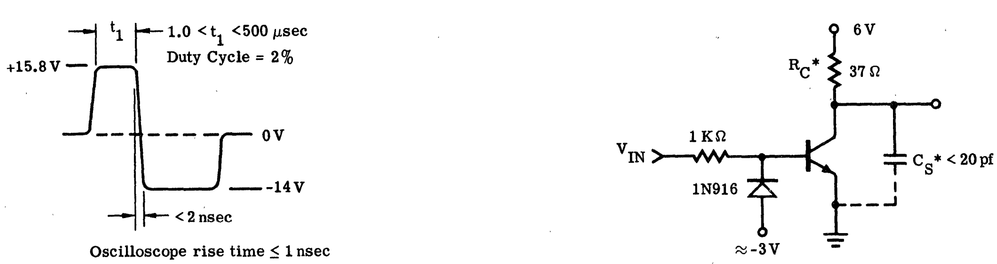


FIGURE 2 STORAGE AND FALL TIME

*C_S is total shunt capacitance of oscilloscope and test fixture.
*R_C includes oscilloscope resistance.

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 87.5°C/watt (derating factor of 11.43 mW/°C); junction to ambient thermal resistance of 437°C/watt (derating factor of 2.29 mW/°C).

(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

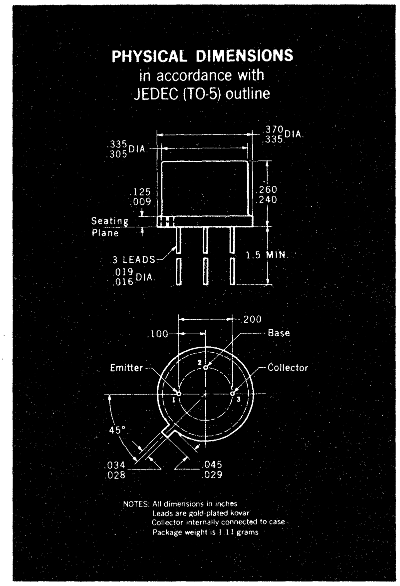
(5) Pulse Conditions: length = 300 μsec; duty cycle ≤2%.

2N3665 • 2N3666

NPN GENERAL PURPOSE AMPLIFIER AND SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3665 and 2N3666 are NPN Diffused Silicon Planar Epitaxial Transistors designed primarily for general purpose amplifier and switching applications. They feature high voltage, low output capacity and a useful beta over a wide current range.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 10 sec. time limit)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	5.0 Watts

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		120 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	80 Volts
V_{EBO}	Emitter to Base Voltage		10 Volts
I_C	Collector Current		1.0 Amp

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

Symbol	Characteristic	2N3665 Min.	2N3665 Max.	2N3666 Min.	2N3666 Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	40	120	100	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	30		70			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	25		50			I_C = 500 mA V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	16		40			I_C = 150 mA V_{CE} = 10 V
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.8		1.8	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.2		1.2	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		1.2		1.2	Volts	I_C = 500 mA I_B = 50 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.5		0.5	Volts	I_C = 150 mA I_B = 15 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0		3.0			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Open Circuit Output Capacitance		12		12	pf	I_E = 0 V_{CB} = 10 V
C_{ibo}	Open Circuit Input Capacitance		60		60	pf	I_C = 0 V_{EB} = 0.5 V

Additional Electrical Characteristics on page 2

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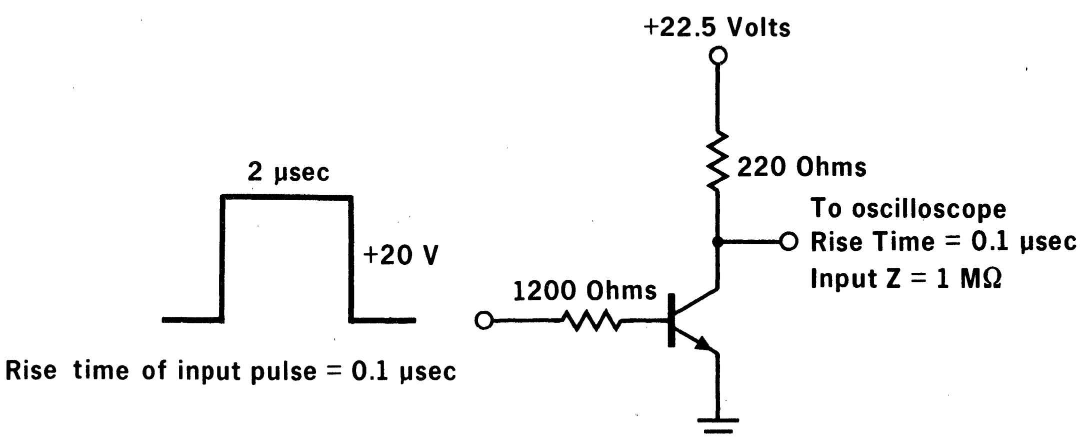
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Characteristic	2N3665 Min.	2N3665 Max.	2N3666 Min.	2N3666 Max.	Units	Test Conditions	
I_{CEX}	Collector Reverse Current		50		50	nA	V_{CE} = 80 V	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		50		50	nA	V_{CB} = 60 V	I_E = 0
I_{CBO}(150°C)	Collector Cutoff Current		50		50	μA	V_{CB} = 60 V	I_E = 0
I_{BEX}	Base Reverse Current		50		50	nA	V_{CE} = 80 V	V_{EB} = 0.5 V
I_{EBO}	Emitter Cutoff Current		50		50	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	120		120		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	80		80		Volts	I_C = 10 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	10		10		Volts	I_C = 0	I_E = 100 μA
BV_{CER}	Collector to Emitter Breakdown Voltage (Notes 4 and 5)	90		90		Volts	I_C = 10 mA	R_{BE} = 10 Ω
$t_{on} + t_{off}$	Total Switching Time		4.0		5.0	μsec	(See Fig. 1)	

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 35°C/watt (derating factor of 28.6 mW/°C).
(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

SWITCHING CIRCUIT

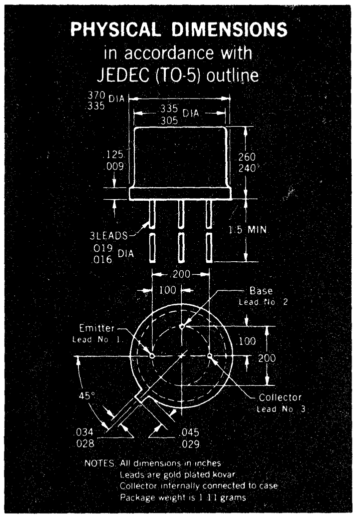


2N3671 • 2N3672 • 2N3673

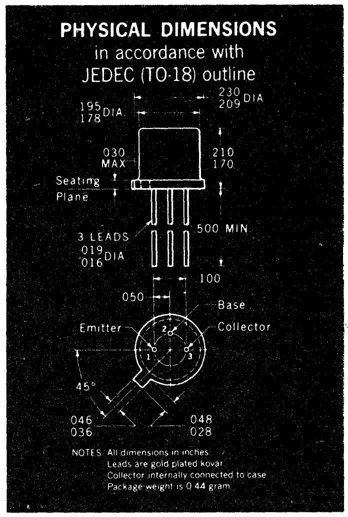
PNP HIGH-SPEED SWITCHES AND CORE DRIVERS

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

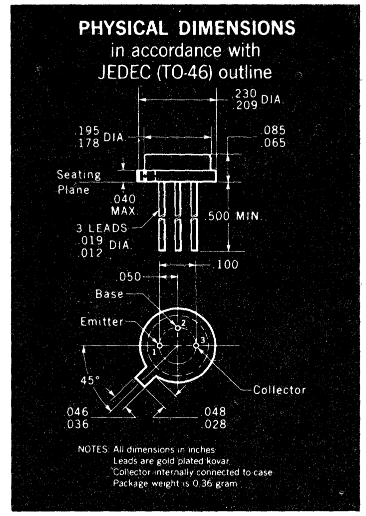
FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3502 • 2N3503



2N3671



2N3672



2N3673

GENERAL DESCRIPTION - The 2N3671, 2N3672 and 2N3673 are PNP silicon Planar epitaxial transistors designed primarily for high-speed saturated switching, line drivers and memory applications.

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum

Maximum Power Dissipation (Notes 2 and 3)	2N3671	2N3672	2N3673
Total Dissipation at 25°C Case Temperature	3.0 Watts	1.8 Watts	3.0 Watts
at 25°C Ambient Temperature	0.6 Watt	0.4 Watt	0.35 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		-60 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-50 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts
I_C	Collector Current	(Note 2)	600 mA

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

Symbol	Characteristic		Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain	(Note 5)	75	225		I_C = 150 mA V_{CE} = -10 V
h_{FE}	DC Current Gain		75			I_C = 1.0 mA V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	75			I_C = 10 mA V_{CE} = -10 V
h_{FE}	DC Current Gain		55			I_C = 0.1 mA V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	40			I_C = 500 mA V_{CE} = -10 V
h_{FE}	DC Pulse Current Gain	(Note 5)	20			I_C = 150 mA V_{CE} = -0.6 V

Additional Electrical Characteristics on page 2

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

Symbol	Characteristic		Min.	Max.	Units	Test Conditions
V_{CE}(sat)	Pulsed Collector Saturation Voltage	(Note 5)		-0.4	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage	(Note 5)		-1.6	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage	(Note 5)		-1.3	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage	(Note 5)		-2.6	Volts	I_C = 500 mA I_B = 50 mA
t_d	Turn-On Delay Time	(See Figure 1)		10	ns	I_{CS} = 150 mA I_{B1} = 15 mA
t_r	Rise Time	(See Figure 1)		40	ns	I_{CS} = 150 mA I_{B1} = 15 mA
t_s	Storage Time	(See Figure 2)		80	ns	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA
t_f	Fall Time	(See Figure 2)		30	ns	I_{CS} = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA
t_{on}	Turn On Time	(See Figure 1)		45	ns	I_{CS} = 150 mA I_{B1} = 15 mA
t_{off}	Turn Off Time	(See Figure 2)		100	ns	I_{CS} = 150 mA I_{B1} = 15 mA I_{B2} = -15 mA
h_{fe}	High Frequency Current	(f = 100 MHz)	2.0			I_C = 50 mA V_{CE} = -20 V
I_{CBO}	Collector Cutoff Current			10	nA	I_E = 0 V_{CB} = -50 V
I_{CBO}(150°C)	Collector Cutoff Current			10	μA	I_E = 0 V_{CB} = -50 V
I_{CEX}	Collector Reverse Current			50	nA	V_{CE} = -30 V V_{BE} = +0.5 V
I_B	Base Current			50	nA	V_{CE} = -30 V V_{BE} = +0.5 V
C_{obo}	Output Capacitance			9.0	pF	I_E = 0 V_{CB} = -10 V
C_{ibo}	Input Capacitance			30	pF	I_C = 0 V_{EB} = -2.0 V
BV_{CBO}	Collector to Base Breakdown Voltage		-60		Volts	I_C = 10 μA I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)		-50		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 μA

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 58.3°C/watt (derating factor of 17.2 mW/°C); junction to ambient thermal resistance of 292°C/watt (derating factor of 3.43 mW/°C) for the 2N3671. Junction to case thermal resistance of 97.3°C/watt (derating factor of 10.3 mW/°C) junction to ambient thermal resistance of 437°C/watt (derating factor of 2.28 mW/°C for the 2N3672. Junction to case thermal resistance of 58.3°C/watt (derating factor of 17.2 mW/°C); junction to ambient thermal resistance of 500°C/watt (derating factor of 2.0 mW/°C).

(4) Rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

FIGURE 1

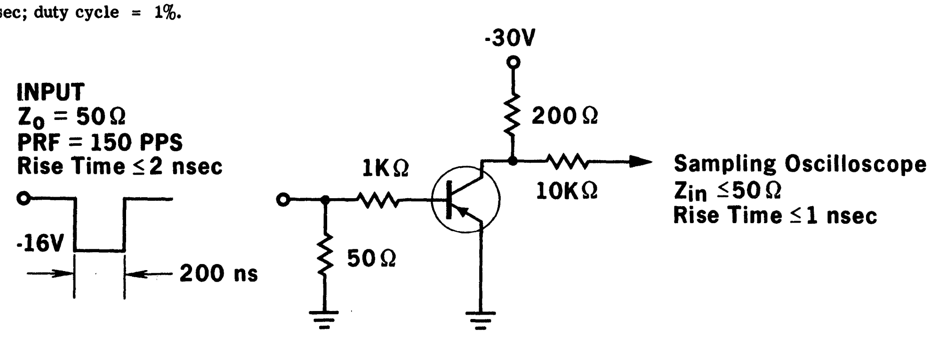
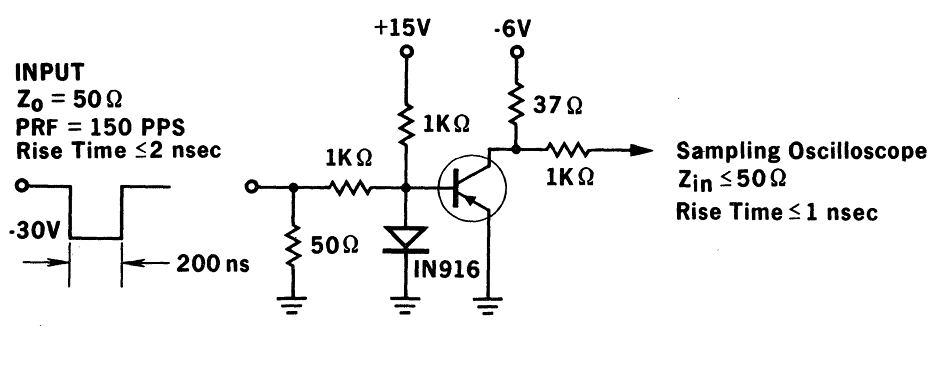


FIGURE 2



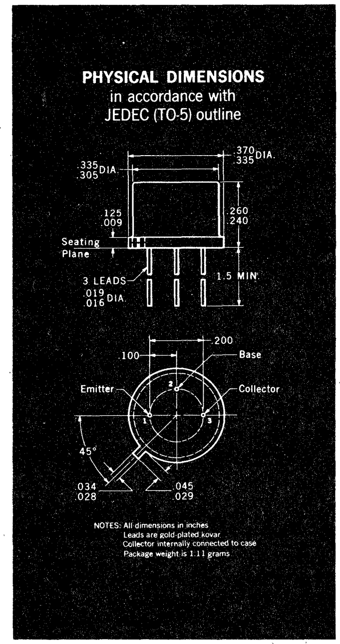
2N3678

NPN HIGH SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3300

GENERAL DESCRIPTION - The 2N3678 NPN silicon Planar epitaxial transistor is designed for high current switching applications at levels to 800 milliamperes. It has excellent power dissipation capability, low saturation voltage at high current levels, and low leakage current at elevated temperature. These characteristics allow stable operation over a wide temperature range.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		-65°C to +200°C
Operating Junction Temperature		+200°C Maximum
Lead Temperature (Soldering, 60 sec. time limit)		+230°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	4.0 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.8 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		75 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	55 Volts
V_{EBO}	Emitter to Base Voltage		6.0 Volts
I_C	Collector Current		800 mA

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	40	120		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	35			I_C = 10 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	25			I_C = 1.0 mA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	25			I_C = 500 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	20			I_C = 100 μA V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	20			I_C = 150 mA V_{CE} = 1.0 V
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.4	Volts	I_C = 150 mA I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		1.0	Volts	I_C = 500 mA I_B = 50 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	0.6	1.2	Volts	I_C = 150 mA I_B = 15 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		2.0	Volts	I_C = 500 mA I_B = 50 mA
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0 V_{CB} = 60 V
I_{CBO}(150°C)	Collector Cutoff Current		10	μA	I_E = 0 V_{CB} = 60 V

Additional Electrical Characteristics on page 2

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 43.8°C/watt (derating factor of 22.8 mW/°C); junction to ambient thermal resistance of 218.7°C/watt (derating factor of 4.57 mW/°C).
4) 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.
5) Pulse Conditions: length $\leq$ 300 μsec; duty cycle $\leq$ 1%.

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
I_{CEX}	Collector Reverse Current		10	nA	V_{CE} = 60 V	V_{EB} = 3.0 V
I_{BL}	Base Current		20	nA	V_{CE} = 60 V	V_{EB} = 3.0 V
I_{EBO}	Emitter Cutoff Current		10	nA	I_C = 0	V_{EB} = 3.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	75		Volts	I_C = 10 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	55		Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	I_E = 10 μA	I_C = 0
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5			I_C = 20 mA	V_{CE} = 20 V
C_{obo}	Open Circuit Output Capacitance		8.0	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Open Circuit Input Capacitance		30	pf	I_C = 0	V_{EB} = 2.0 V
t_d	Delay Time (see Fig. 1)		15	nsec	V_{CC} = 30 V, I_{B1} = 15 mA	I_{CS} = 150 mA
t_r	Rise Time (see Fig. 1)		25	nsec	V_{CC} = 30 V, I_{B1} = 15 mA	I_{CS} = 150 mA
t_s	Storage Time (see Fig. 2)		190	nsec	V_{CC} = 6.0 V, I_{B1} = 15 mA	I_{CS} = 150 mA, I_{B2} = -15 mA
t_f	Fall Time (see Fig. 2)		60	nsec	V_{CC} = 6.0 V, I_{B1} = 15 mA	I_{CS} = 150 mA, I_{B2} = -15 mA
$t_{on} + t_{off}$	Total Switching Time (see Fig. 3)		18	nsec	V_{CC} = 30 V	R_L = 60 Ω

FIGURE 1. Saturated turn-on switching-time test circuit

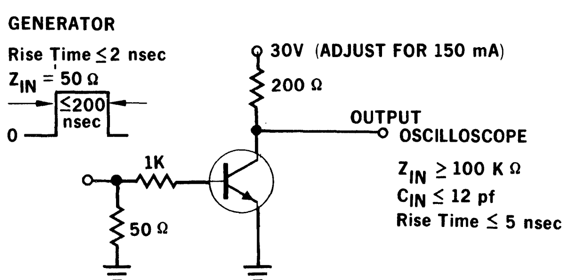


FIGURE 2. Saturated turn-off switching-time test circuit

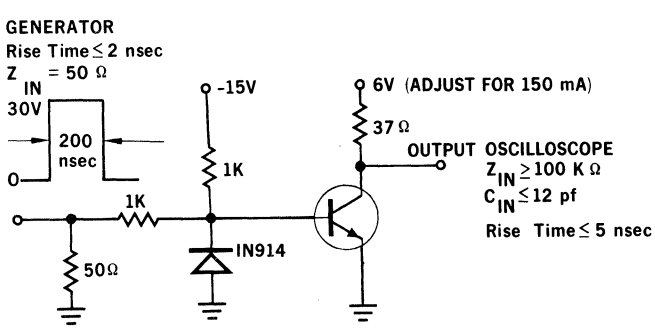
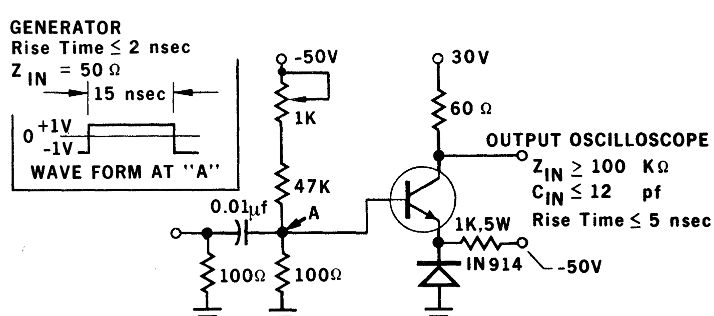


FIGURE 3. Non-saturated switching-time test circuit

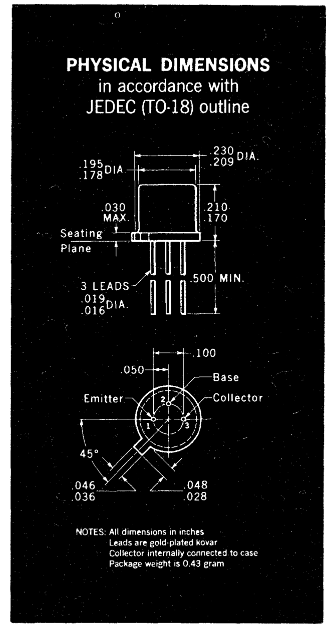


2N3700 • 2N3701

NPN HIGH FREQUENCY IF-RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3700 and 2N3701 are NPN diffused silicon Planar epitaxial transistors designed primarily for high frequency applications in IF-RF amplifier circuits. The Planar structure provides low saturation voltage at high collector currents and low leakage current over a wide range of temperature and bias conditions. Useful frequency range: DC to 100 MHz.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	200°C Maximum
Lead Temperature (Soldering, 60 sec. time limit)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.8 Watts
at 100°C Case Temperature	1.0 Watt
at 25°C Ambient Temperature	0.5 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		140 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	80 Volts
V_{EBO}	Emitter to Base Voltage		7.0 Volts
I_C	Collector Current		1.0 Amp.

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

Symbol	Characteristic	2N3700 Min.	2N3700 Max.	2N3701 Min.	2N3701 Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	100	300	40	120		I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	90		40	120		I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50		30	100		I_C = 0.1 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50		30	100		I_C = 500 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	15		15			I_C = 1.0 A	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	40					I_C = 150 mA	V_{CE} = 10 V
V_{BE}(sat)	Pulsed Base Saturation Voltage		1.1		1.1	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.2		0.2	Volts	I_C = 150 mA	I_B = 15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.5		0.5	Volts	I_C = 500 mA	I_B = 50 mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	5.0	10	4.0	10		I_C = 50 mA	V_{CE} = 10 V
h_{fe}	Small Signal Current Gain (f = 1 KHz)	80	400	30	200		I_C = 1.0 mA	V_{CE} = 5.0 V
C_{obo}	Output Capacitance		12		12	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance		60		60	pf	I_C = 0	V_{EB} = 0.5 V

Additional Electrical Characteristics on page 2
Notes on page 2

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

Symbol	Characteristic	2N3700 Min.	2N3700 Max.	2N3701 Min.	2N3701 Max.	Units	Test Conditions	
$r_b'C_c$	Collector-Base Time Constant (f = 4 MHz)	25	400	25	400	psec	I_C = 10 mA	V_{CB} = 10 V
I_{CBO}	Collector Cutoff Current		10		10	nA	I_E = 0	V_{CB} = 90 V
I_{CBO}(150°C)	Collector Cutoff Current		10		10	μA	I_E = 0	V_{CB} = 90 V
I_{EBO}	Emitter Cutoff Current		10		10	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	140		140		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	80		80		Volts	I_C = 30 mA	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	7.0		7.0		Volts	I_C = 0	I_E = 100 μA
NF	Noise Figure		4.0			db	I_C = 100 μA	V_{CE} = 10 V
							f = 1 KHz	R_G = 1 KΩ

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 97°C/watt (derating factor of 10.3 mW/°C); junction to ambient thermal resistance of 350°C/watt (derating factor of 2.85 mW/°C).

(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

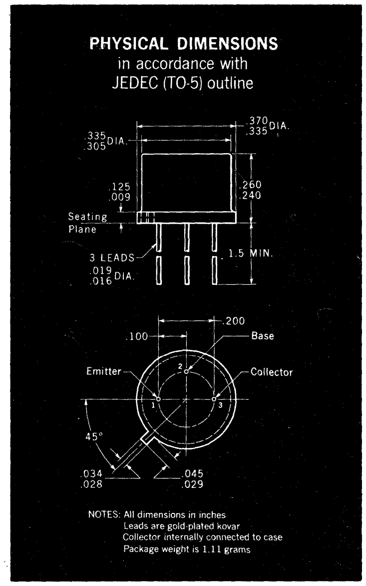
(5) Pulse Conditions: length = 300 μsec; duty cycle $\leq$ 1%.

2N3722 • 2N3723

NPN HIGH-VOLTAGE, HIGH-CURRENT SWITCHES

SILICON PLANAR EPITAXIAL TRANSISTORS

- **HIGH BREAKDOWN -- 80 VOLT LV_{CEO}**
- **HIGH FREQUENCY -- f_T = 300 MHz Min.**
- **FAST HIGH CURRENT SWITCHING**
- **LOW V_{CE} (sat) -- 0.75V Max. @ 500 mA**
- **LOW OUTPUT CAPACITANCE -- 9.0 pF**



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction 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)	4.0 Watts
at 25°C Ambient Temperature (Notes 2 and 3)	0.8 Watt

Maximum Voltages and Current

		2N3722	2N3723
V_{CBO}	Collector to Base Voltage	80 Volts	100 Volts
V_{CES}	Collector to Emitter Voltage	80 Volts	100 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	60 Volts	80 Volts
V_{EBO}	Emitter to Base Voltage	6.0 Volts	6.0 Volts
	Maximum Collector Current (Note 5)	1.0 Amp	1.0 Amp

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

Symbol	†FACT Subgroup	Characteristic	2N3722 Min.	Typ.	Max.	2N3723 Min.	Typ.	Max.	Units	Test Conditions	
V_{CEO} (sust)	Ia	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	60			80			Volts	I_C = 10 mA (pulsed)	I_B = 0
*V_{CE} (sat)	Ia	Collector Saturation Voltage (pulsed, see Note 5)		0.35	0.5		0.45	0.75	Volts	I_C = 500 mA	I_B = 50 mA
V_{CE} (sat)	Ib	Collector Saturation Voltage (pulsed, see Note 5)		0.25	0.37		0.30	0.44	Volts	I_C = 300 mA	I_B = 30 mA
t_{on}	IV	Turn-on Time (Note 6)		20	50		25	70	nsec	$I_C \approx$ 500 mA	$I_{B1} \approx$ 50 mA
t_{off}	IV	Turn-off Time (Note 6)		63	100		70	130	nsec	$I_C \approx$ 500 mA,	$I_{B1} \approx$ 50 mA, $I_{B2} \approx$ −50 mA
h_{fe}	IV	High Frequency Current Gain (f = 100 Mc)	3.0	4.0		3.0	4.0			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	IV	Common-Base, Open-Circuit Output Capacitance		5.5	10		5.0	9.0	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	IV	Common-Base, Open-Circuit Input Capacitance		50	65		50	65	pf	I_C = 0	V_{BE} = −0.5 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

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lotes on page 4

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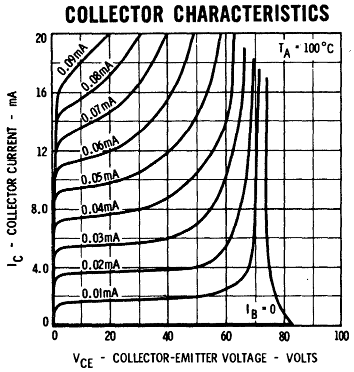
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	†FACT Subgroup	Characteristic	2N3722 Min.	2N3722 Typ.	2N3722 Max.	2N3723 Min.	2N3723 Typ.	2N3723 Max.	Units	Test Conditions	
$^*h_{FE}$	Ia	DC Pulse Current Gain (Note 5)	40	70	150	**40**	**70**	**150**		I_C = 100 mA	V_{CE} = 1.0 V
h_{FE}	Ib	DC Pulse Current Gain (Note 5)	25	45		25	45			I_C = 10 mA	V_{CE} = 1.0 V
h_{FE}	Ib	DC Pulse Current Gain (Note 5)	20	35		**15**	**30**			I_C = 300 mA	V_{CE} = 2.0 V
h_{FE}	Ib	DC Pulse Current Gain (Note 5)	15	30						I_C = 500 mA	V_{CE} = 2.0 V
h_{FE}	Ib	DC Pulse Current Gain (Note 5)				15	30			I_C = 500 mA	V_{CE} = 3.0 V
h_{FE}	Ib	DC Pulse Current Gain (Note 5)	12	25		12	25			I_C = 800 mA	V_{CE} = 5.0 V
h_{FE} (−55°C)	IV	DC Pulse Current Gain (Note 5)	15	30		15	30			I_C = 100 mA	V_{CE} = 1.0 V
V_{CE} (sat)	II	Collector Saturation Voltage (Note 5)		0.15	0.22		0.22	0.28	Volts	I_C = 100 mA	I_B = 10 mA
V_{CE} (sat)	II	Collector Saturation Voltage (Note 5)		0.16	0.25		0.16	0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE} (sat)	II	Collector Saturation Voltage (Note 5)		0.6	2.0				Volts	I_C = 800 mA	I_B = 80 mA
V_{BE} (sat)	IIa	Base Saturation Voltage (Note 5)		0.62	0.75		0.62	0.75	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE} (sat)	IIa	Base Saturation Voltage (Note 5)		0.73	0.85		0.73	0.85	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE} (sat)	IIa	Base Saturation Voltage (Note 5)		0.89	1.1		0.89	1.1	Volts	I_C = 300 mA	I_B = 30 mA
$^*V_{BE}$ (sat)	Ia	Base Saturation Voltage (Note 5)	0.86	0.91	1.2	0.86	0.91	1.2	Volts	I_C = 500 mA	I_B = 50 mA
V_{BE} (sat)	IIa	Base Saturation Voltage (Note 5)		1.0	1.5				Volts	I_C = 800 mA	I_B = 80 mA
$^*I_{CES}$	Ia	Collector Reverse Current		0.1	0.5				μA	V_{CE} = 40 V	V_{EB} = 0
$^*I_{CES}$	Ia	Collector Reverse Current					0.13	0.5	μA	V_{CE} = 50 V	V_{EB} = 0
I_{CES} (125°C)	IV	Collector Reverse Current		40	70				μA	V_{CE} = 40 V	V_{EB} = 0
I_{CES} (125°C)	IV	Collector Reverse Current					40	70	μA	V_{CE} = 50 V	V_{EB} = 0
BV_{CBO}	II	Collector to Base Breakdown Voltage	80			100			Volts	I_C = 100 μA	I_E = 0
B_{CES}	II	Collector to Emitter Breakdown Voltage	80			100			Volts	I_C = 100 μA	V_{EB} = 0
BV_{EBO}	Ia	Emitter to Base Breakdown Voltage	6.0			6.0			Volts	I_C = 0	I_E = 100 μA
h_{FE} (−55°C)	IV	DC Pulse Current Gain (Note 5)	20			**20**				I_C = 200 mA	V_{CE} = 2.0 V

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS
2N3722

COLLECTOR CHARACTERISTICS



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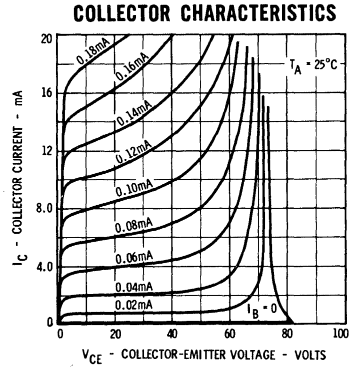

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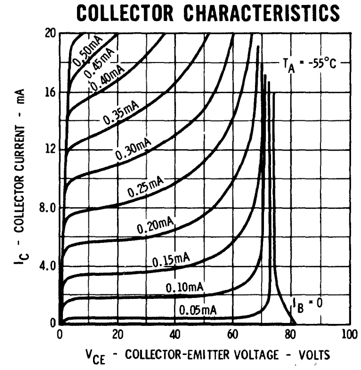
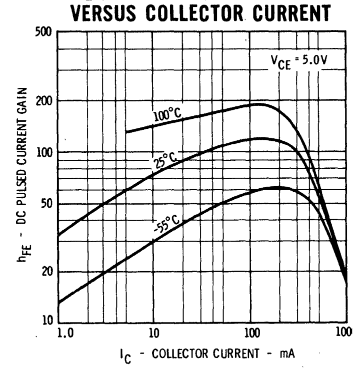


DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



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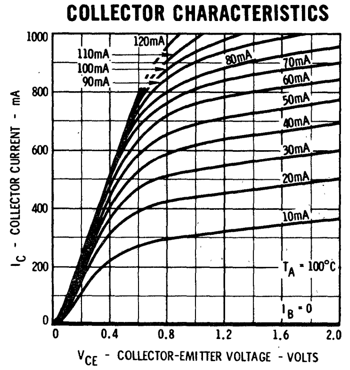

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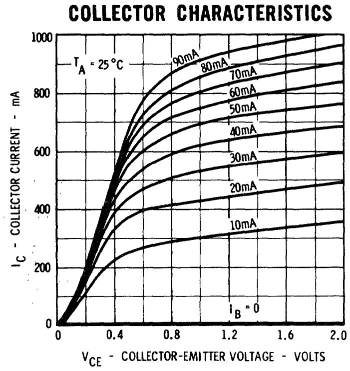

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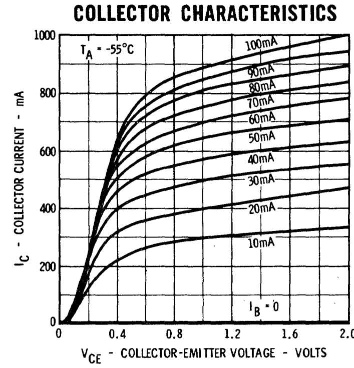
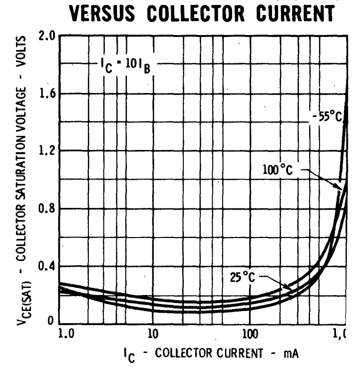


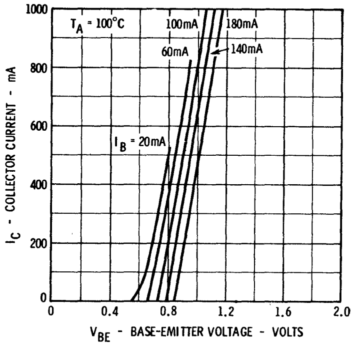
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



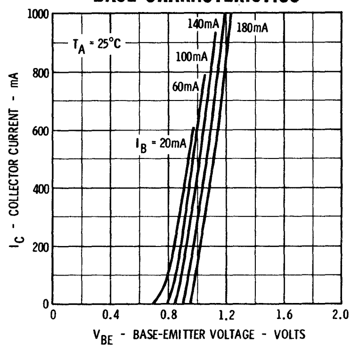
TYPICAL ELECTRICAL CHARACTERISTICS

2N3722 • 2N3723

BASE CHARACTERISTICS



BASE CHARACTERISTICS



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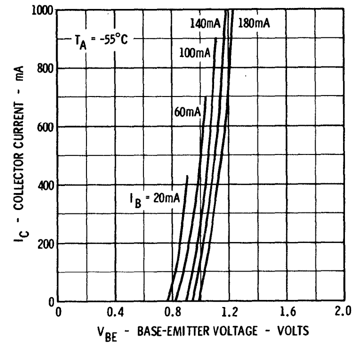
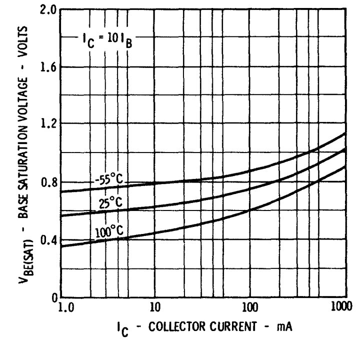
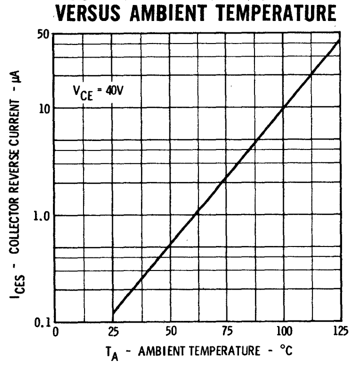


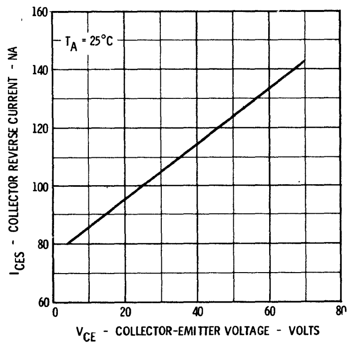
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



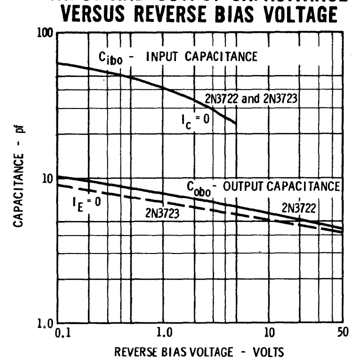
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



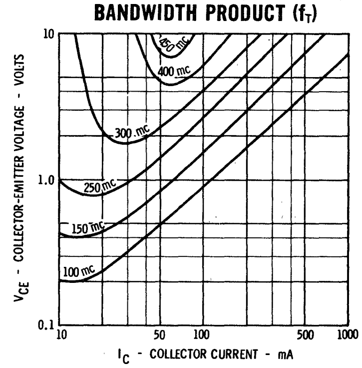
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

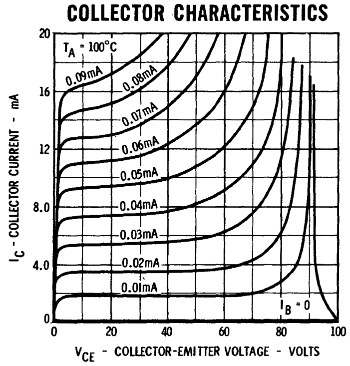


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

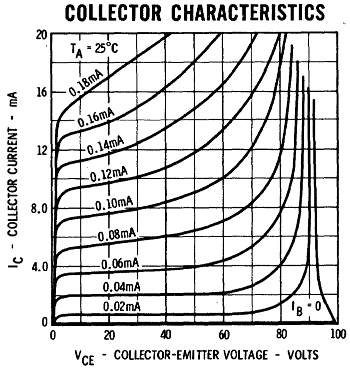


2N3723

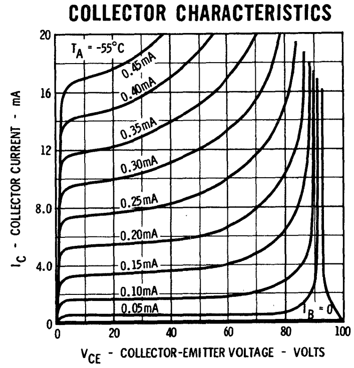
COLLECTOR CHARACTERISTICS



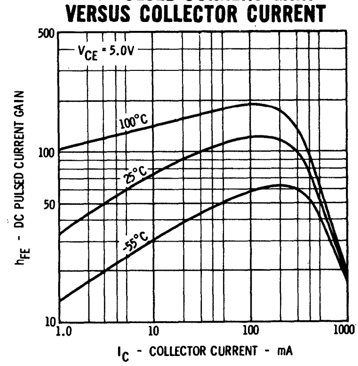
COLLECTOR CHARACTERISTICS



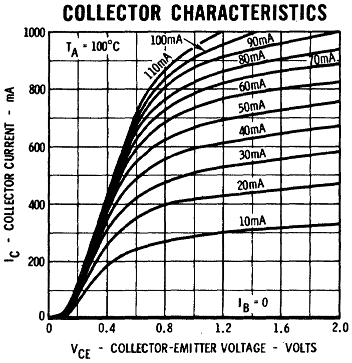
COLLECTOR CHARACTERISTICS



DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR CHARACTERISTICS



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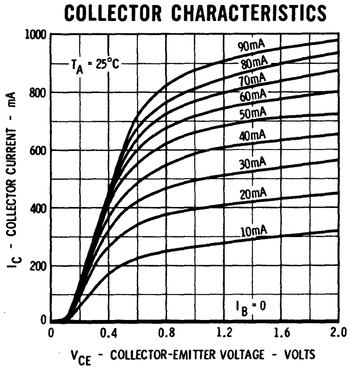

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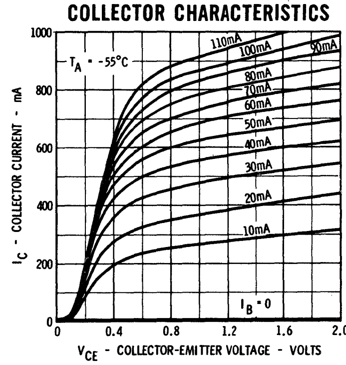
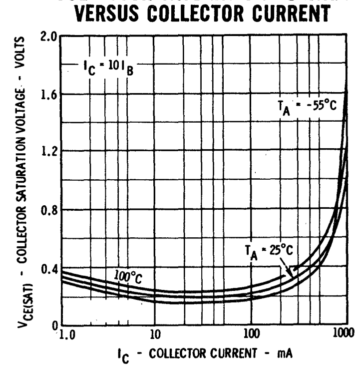


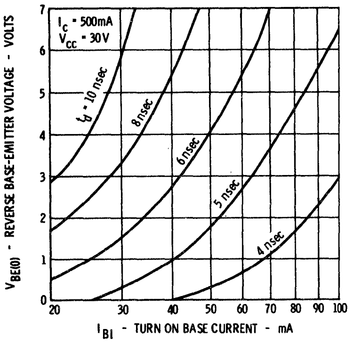
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



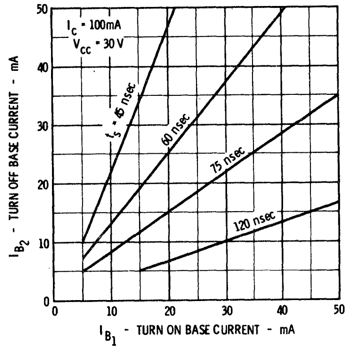
TYPICAL ELECTRICAL CHARACTERISTICS

2N3722 • 2N3723

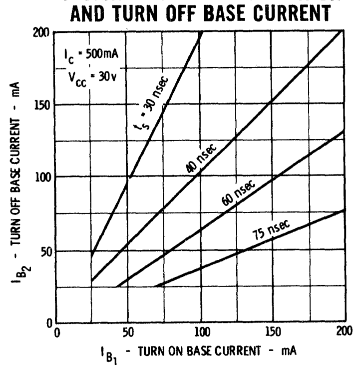
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



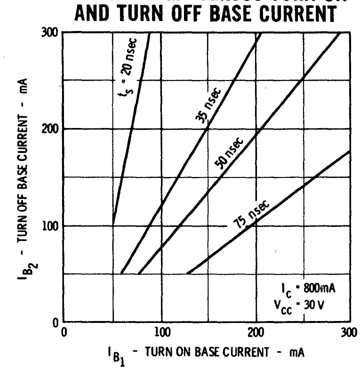
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



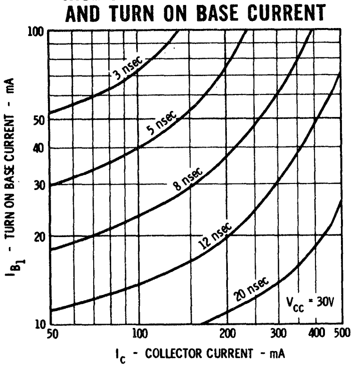
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



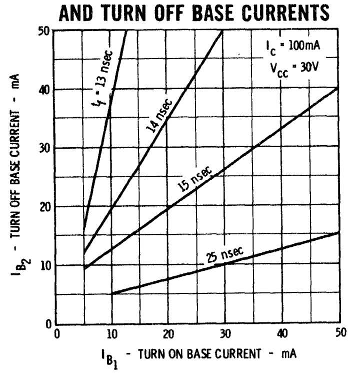
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



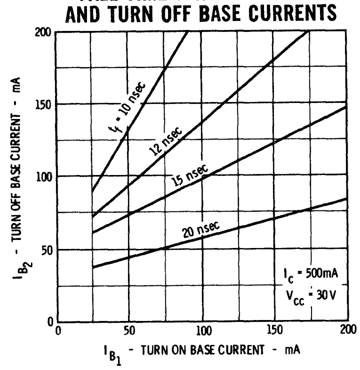
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENT



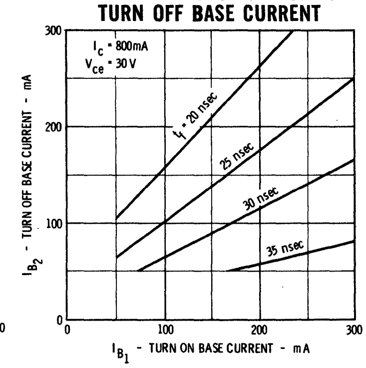
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



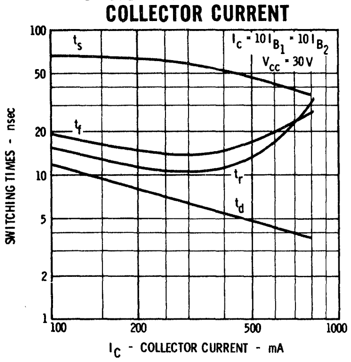
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



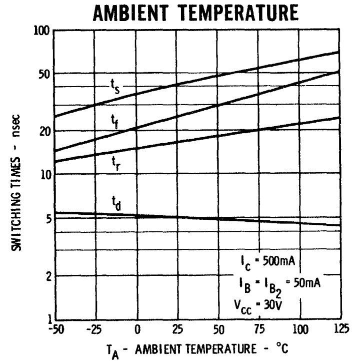
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENT



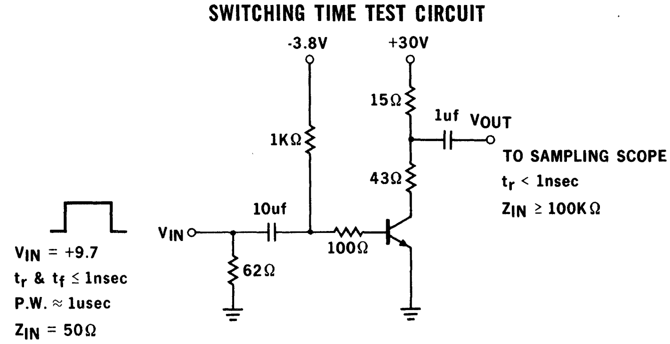
SWITCHING TIMES VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



SWITCHING TIME TEST CIRCUIT



$I_C \approx$ 500mA, $I_{B_1} \approx$ 50mA, $I_{B_2} \approx$ 50mA

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor 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 43.8°C/Watt (derating factor of 22.8 mW/°C). Junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

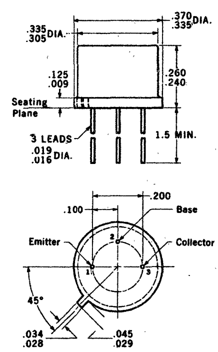
2N3724 • 2N3725 • 2N4013 • 2N4014

NPN HIGH-VOLTAGE, HIGH-CURRENT SWITCHES

SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N3724 · 2N3725 and 2N4013 · 2N4014 are High-Voltage, High-Current NPN Silicon Planar Epitaxial Transistors useful for memory applications requiring breakdown voltages up to 50 volts and operating currents to one ampere. Fast turn-on and turn-off times are assured because of the high minimum f_T (300 MHz) and tight control on storage time.

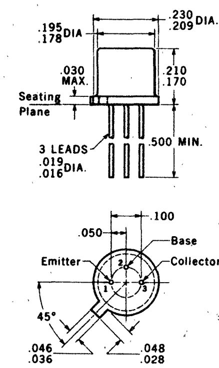
PHYSICAL DIMENSIONS in accordance with JEDEC (TO-5) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

2N3724 • 2N3725

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 0.44 gram

2N4013 • 2N4014

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 60 sec Time Limit)	+300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

	2N4013 2N4014	2N3724 2N3725
Total Dissipation at 25°C Case Temperature	1.2 Watts	3.5 Watts
at 25°C Ambient Temperature	0.36 Watt	0.8 Watt

Maximum Voltages and Current

			2N3724 2N4013	2N3725 2N4014
V_{CBO}	Collector to Base Voltage		50 Volts	80 Volts
V_{CES}	Collector to Emitter Voltage		50 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	30 Volts	50 Volts
V_{EBO}	Emitter to Base Voltage		6.0 Volts	6.0 Volts
I_C	Maximum Collector Current	(Note 5)	1.0 Amp	1.0 Amp

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

Symbol	Characteristic	2N3724 2N4013 Min.	Typ.	Max.	2N3725 2N4014 Min.	Typ.	Max.	Units	Test Conditions
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	30			50			Volts	I_C = 10 mA I_B = 0 (pulsed)
V_{CE}(sat)	Collector Saturation Voltage (pulsed, see Note 5)		0.5	0.75		0.6	0.95	Volts	I_C = 1000 mA I_B = 100 mA
V_{CE}(sat)	Collector Saturation Voltage (pulsed, see Note 5)		0.3	0.42		0.4	0.52	Volts	I_C = 500 mA I_B = 50 mA
t_{on}	Turn-on Time (Note 6)		18	35		18	35	nsec	$I_C \approx$ 500 mA $I_{B1} \approx$ 50 mA
t_{off}	Turn-off Time (Note 6)		45	60		45	60	nsec	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA, $I_{B2} \approx$ -50 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0	4.5		3.0	4.5			I_C = 50 mA V_{CE} = 10 V
C_{obo}	Common Base, Open Circuit, Output Capacitance		6.0	12		4.8	10	pF	I_E = 0 V_{CB} = 10 V
C_{ibo}	Common Base, Open Circuit, Input Capacitance		40	55		40	55	pF	I_C = 0 V_{BE} = 0.5 V

Additional Electrical Characteristics on page 2
Notes on page 4

* Planar is a patented Fairchild process.

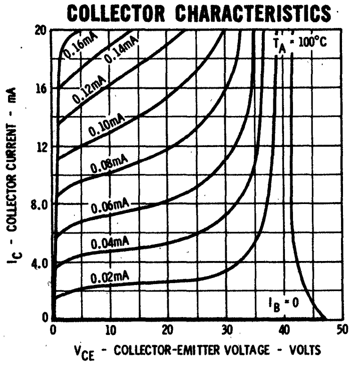
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

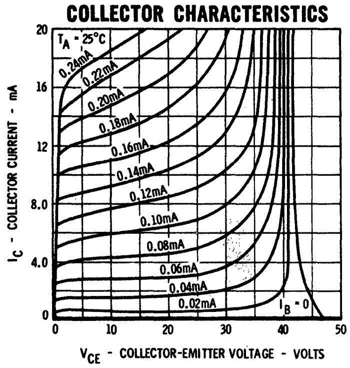
Symbol	Characteristic	2N3724 2N4013 Min.	Typ.	Max.	2N3725 2N4014 Min.	Typ.	Max.	Units	Test Conditions	
h_{FE}	DC Pulse Current Gain (Note 5)	60	90	150	60	90	150		I_C = 100 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	35	50		35	45			I_C = 500 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	40	65		40	60			I_C = 300 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	65		25	65			I_C = 1000 mA	V_{CE} = 5.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	60		30	60			I_C = 10 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	25	45		20	40			I_C = 800 mA	V_{CE} = 2.0 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	30	45		30	40			I_C = 100 mA	V_{CE} = 1.0 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	20	40		20	35			I_C = 500 mA	V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.11	0.25		0.19	0.25	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.13	0.2		0.21	0.26	Volts	I_C = 100 mA	I_B = 10 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.22	0.32		0.31	0.4	Volts	I_C = 300 mA	I_B = 30 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.4	0.65		0.5	0.8	Volts	I_C = 800 mA	I_B = 80 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.64	0.76		0.64	0.76	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.75	0.86		0.75	0.86	Volts	I_C = 100 mA	I_B = 10 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.89	1.1		0.89	1.1	Volts	I_C = 300 mA	I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)	0.9	0.95	1.2	0.9	0.95	1.2	Volts	I_C = 500 mA	I_B = 50 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.0	1.5		1.0	1.5	Volts	I_C = 800 mA	I_B = 80 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.1	1.7		1.1	1.7	Volts	I_C = 1000 mA	I_B = 100 mA
I_{CBO}	Collector Cutoff Current		0.25	1.7				μA	I_E = 0	V_{CB} = 40 V
I_{CBO}	Collector Cutoff Current					0.33	1.7	μA	I_E = 0	V_{CB} = 60 V
I_{CBO}(100°C)	Collector Cutoff Current		25	120				μA	I_E = 0	V_{CB} = 40 V
I_{CBO}(100°C)	Collector Cutoff Current					25	120	μA	I_E = 0	V_{CB} = 60 V
BV_{CBO}	Collector to Base Breakdown Voltage	50			80			Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	50			80			Volts	I_C = 10 μA	V_{BE} = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			6.0			Volts	I_C = 0	I_E = 10 μA

TYPICAL ELECTRICAL CHARACTERISTICS 2N3724 • 2N4013

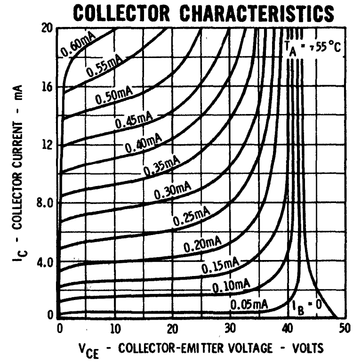
COLLECTOR CHARACTERISTICS



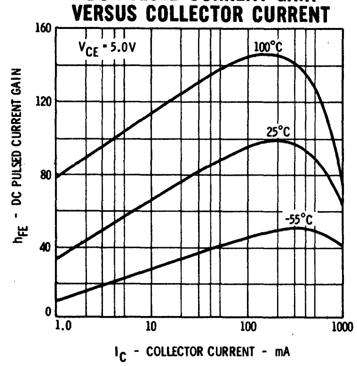
COLLECTOR CHARACTERISTICS



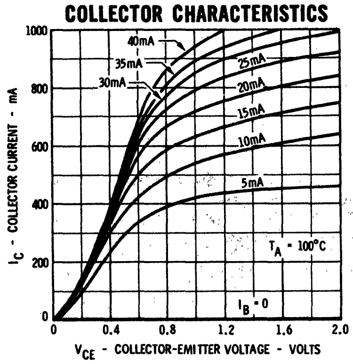
COLLECTOR CHARACTERISTICS



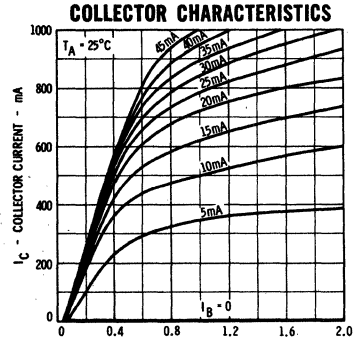
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



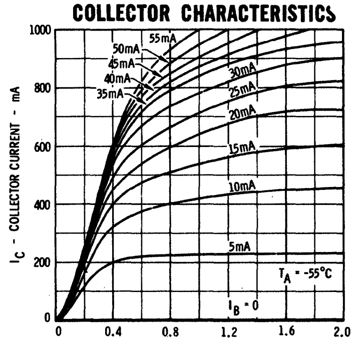
COLLECTOR CHARACTERISTICS



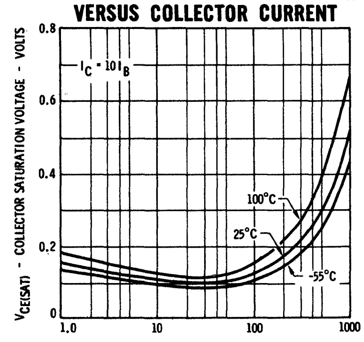
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



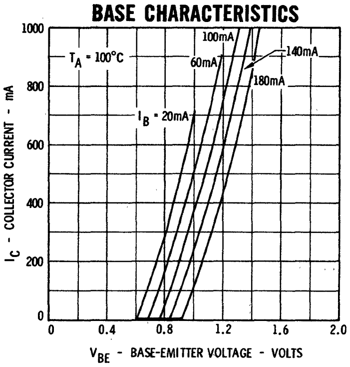
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



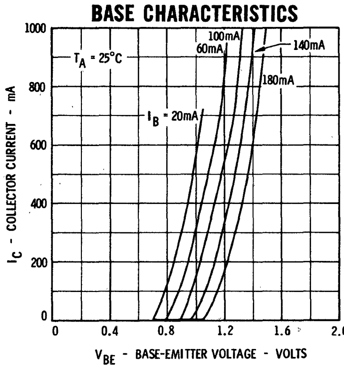
TYPICAL ELECTRICAL CHARACTERISTICS

2N3724 • 2N3725 • 2N4013 • 2N4014

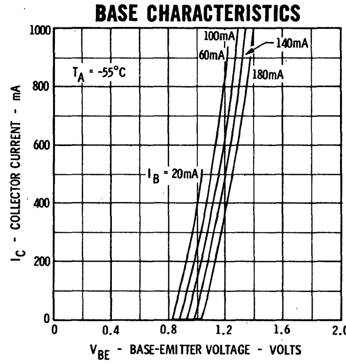
BASE CHARACTERISTICS



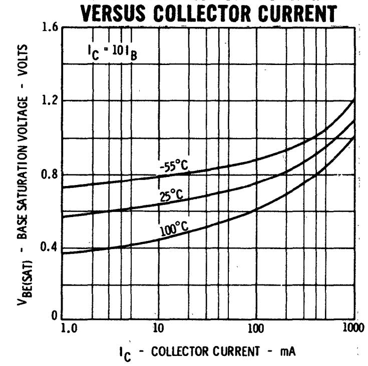
BASE CHARACTERISTICS



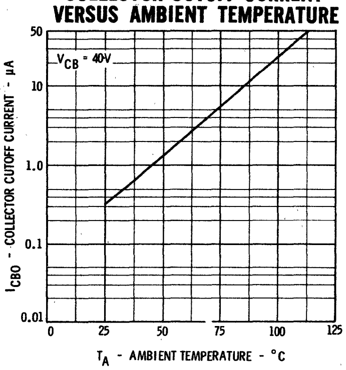
BASE CHARACTERISTICS



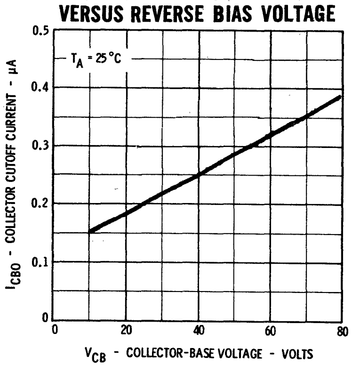
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



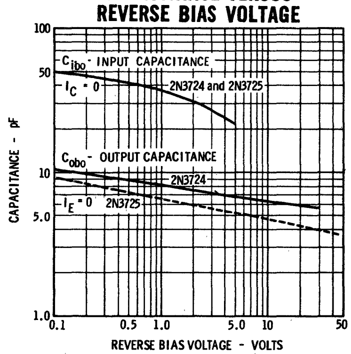
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



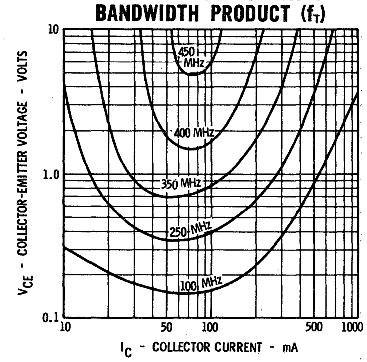
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

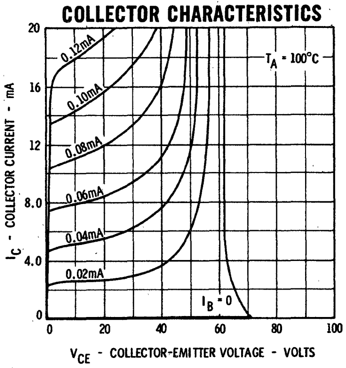


CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)

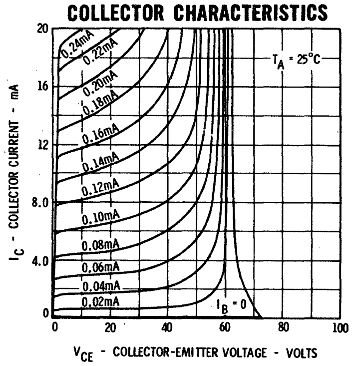


2N3725 • 2N4014

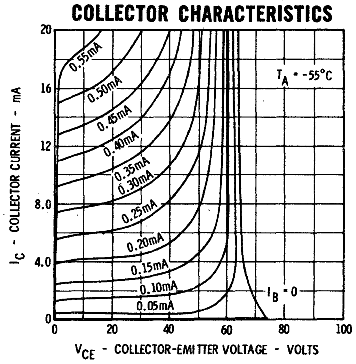
COLLECTOR CHARACTERISTICS



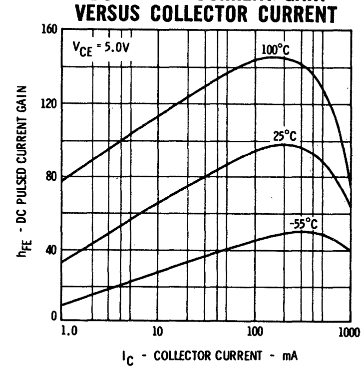
COLLECTOR CHARACTERISTICS



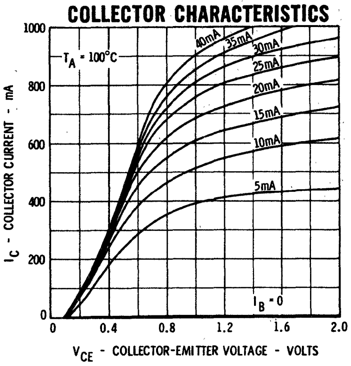
COLLECTOR CHARACTERISTICS



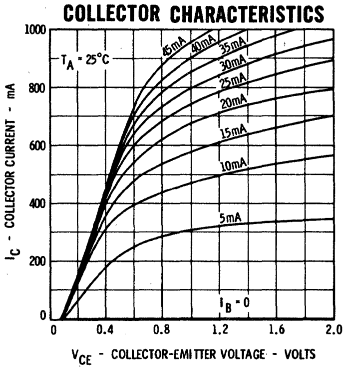
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



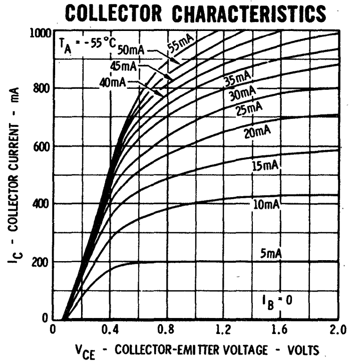
COLLECTOR CHARACTERISTICS



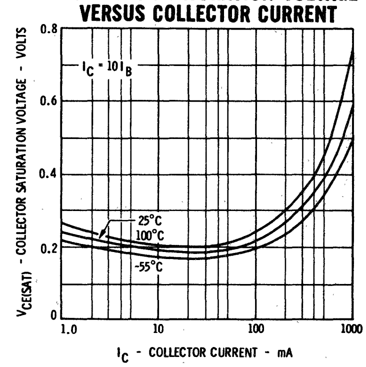
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS

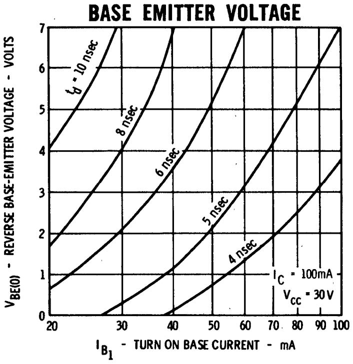


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

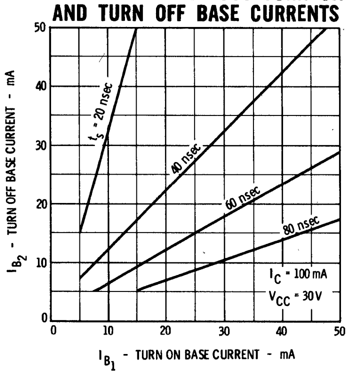


TYPICAL ELECTRICAL CHARACTERISTICS
2N3724 • 2N3725 • 2N4013 • 2N4014

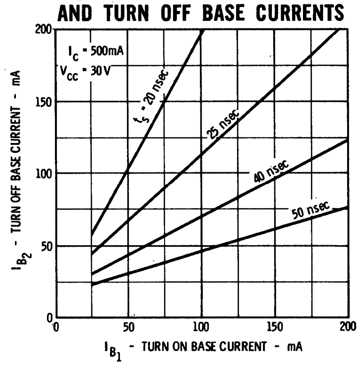
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



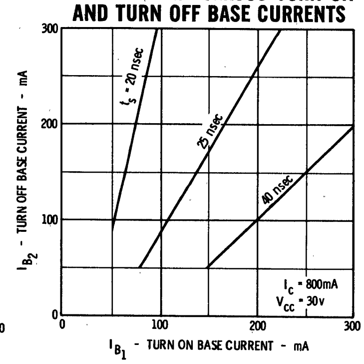
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



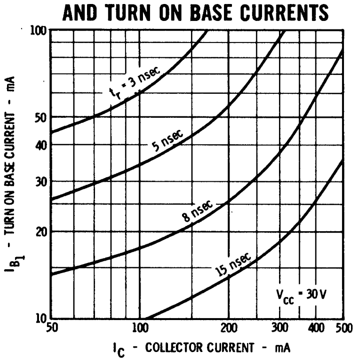
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



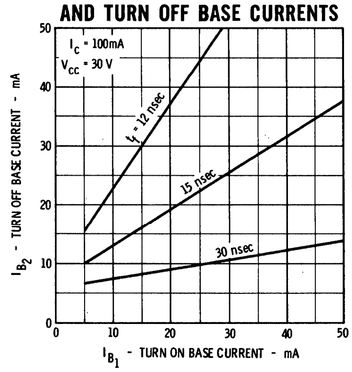
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



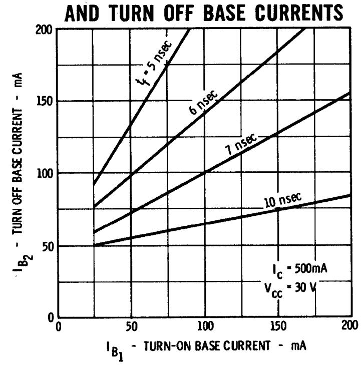
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



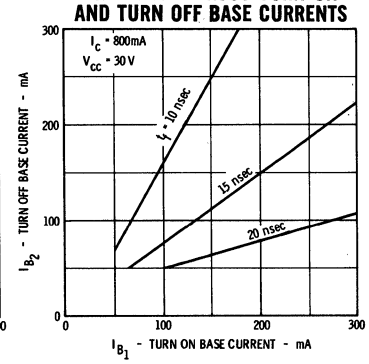
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



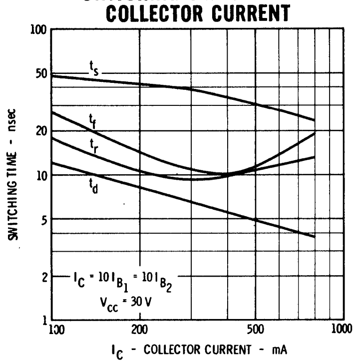
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



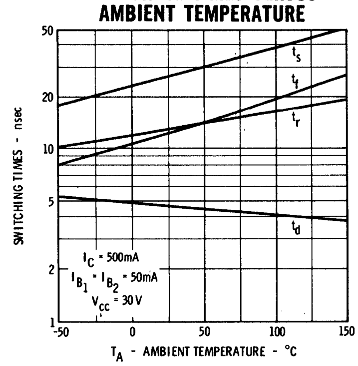
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



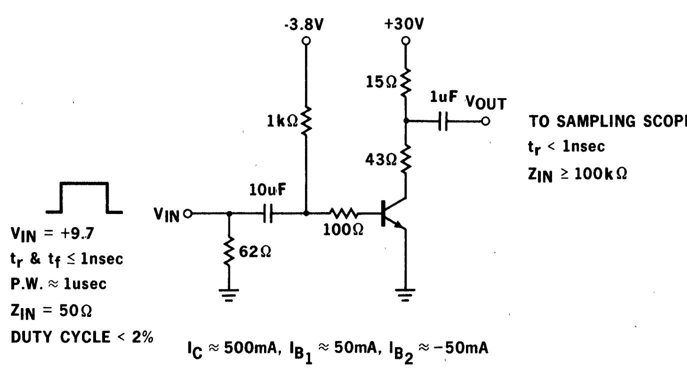
SWITCHING TIMES VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



SWITCHING TIME 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 give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 50°C/Watt (derating factor of 20 mW/°C) for the 2N3724 and 2N3725, and 146°C/Watt (derating factor of 6.85 mW/°C) for the 2N4013 and 2N4014; junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the 2N3724 and 2N3725, and 485°C/Watt (derating factor of 2.06 mW/°C) for the 2N4013 and 2N4014.

(4) Ratings refer to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

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

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

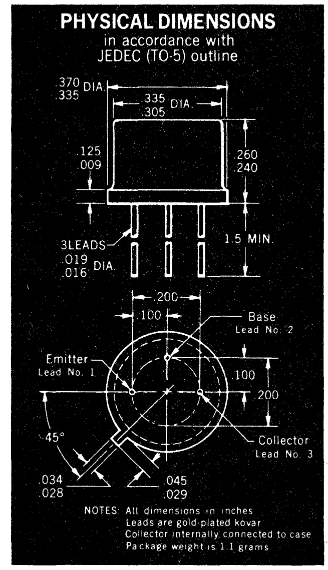
2N3734 • 2N3736

NPN HIGH VOLTAGE, HIGH CURRENT SWITCHES

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

FOR IMPROVED PERFORMANCE SEE FAIRCHILD 2N3724 • 2N3725

GENERAL DESCRIPTION - The 2N3734 and 2N3736 are High Voltage, High Current NPN Diffused Silicon Planar Epitaxial Transistors useful for memory applications requiring breakdown voltages up to 50 volts and high current capacity with Beta specified to 1.5 amperes.



2N3734

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction Temperature	+200°C Maximum
Lead Temperature (Soldering, 10 sec Time Limit)	+230°C Maximum

Maximum Power Dissipation (Notes 2 and 3)

	2N3734	2N3736
Total Dissipation at 25°C Case Temperature	4.0 Watts	2.0 Watts
at 25°C Ambient Temperature	1.0 Watt	0.5 Watt

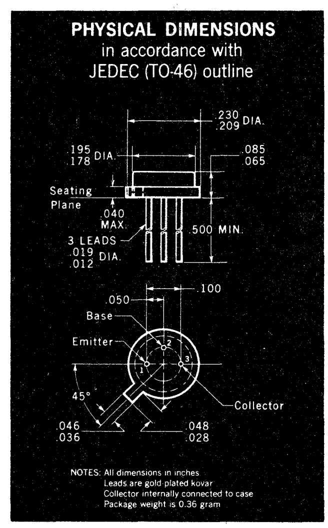
Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	50 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	30 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	1.5 Amps

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	30		Volts	I_C = 10 mA (pulsed)	I_B = 0
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.9	Volts	I_C = 1.0 A	I_B = 100 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.5	Volts	I_C = 500 mA	I_B = 50 mA
t_d	Delay Time (see Fig. 1)		8.0	nsec	I_C = 1.0 A	I_{B1} = 100 mA
t_r	Rise Time (see Fig. 1)		40	nsec	I_C = 1.0 A	I_{B1} = 100 mA
t_s	Storage Time (see Fig. 2)		30	nsec	I_C = 1.0 A I_{B2} = -100 mA	I_{B1} = 100 mA
t_f	Fall Time (see Fig. 2)		30	nsec	I_C = 1.0 A I_{B2} = -100 mA	I_{B1} = 100 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Output Capacitance		9.0	pf	I_E = 0	V_{CB} = 10 V
C_{ibo}	Input Capacitance		80	pf	I_C = 0	V_{BE} = 0.5 V

Additional Electrical Characteristics on page 2



2N3736

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 43.8°C/watt (derating factor of 22.8 mW/°C) for the 2N3734; and 87.5°C/watt (derating factor of 11.4 mW/°C) for the 2N3736, junction to ambient thermal resistance of 175°C/watt (derating factor of 5.71 mW/°C) for the 2N3734; and 350°C/watt (derating factor of 2.86 mW/°C) for the 2N3736.

(4) Ratings refer to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

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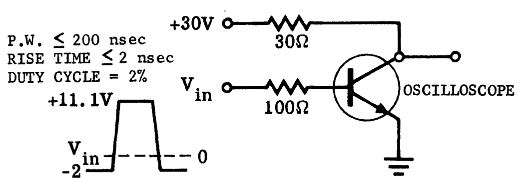
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
h_{FE}	DC Pulse Current Gain (Note 5)	40		Volts	I_C = 150 mA, V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	35		Volts	I_C = 10 mA, V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	35		Volts	I_C = 500 mA, V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	120	Volts	I_C = 1.0 A, V_{CE} = 1.5 V
h_{FE}	DC Pulse Current Gain (Note 5)	30		Volts	I_C = 1.5 A, V_{CE} = 5.0 V
$V_{CE}(sat)$	Pulsed Collector Saturation Voltage (Note 5)		0.2	Volts	I_C = 10 mA, I_B = 1.0 mA
$V_{CE}(sat)$	Pulsed Collector Saturation Voltage (Note 5)		0.3	Volts	I_C = 150 mA, I_B = 15 mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)		0.8	Volts	I_C = 10 mA, I_B = 1.0 mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)		1.0	Volts	I_C = 150 mA, I_B = 15 mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)		1.2	Volts	I_C = 500 mA, I_B = 50 mA
$V_{BE}(sat)$	Pulsed Base Saturation Voltage (Note 5)	0.9	1.4	Volts	I_C = 1.0 A, I_B = 100 mA
I_{CEX}	Collector Cutoff Current		0.2	µA	V_{CE} = 25 V, V_{EB} = 2.0 V
$I_{CEX}(100°C)$	Collector Cutoff Current		20	µA	V_{CE} = 25 V, V_{EB} = 2.0 V
I_{BL}	Base Current		0.3	µA	V_{CE} = 25 V, V_{EB} = 2.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	50		Volts	I_C = 10 µA, I_E = 0
BV_{EBO}	Emitter to Base	5.0		Volts	I_C = 0, I_E = 10 µA
Q_T	Total Control Charge		10	ncoul	I_C = 1.0 A, I_B = 100 mA, V_{CC} = 30 V

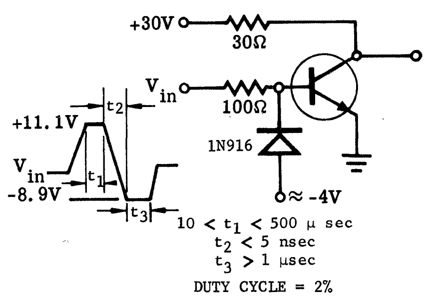
FIGURE 1



Z_{in} > 100 Kohm
C_{in} ≤ 12 pf
Rise time ≤ 5 nsec

T_{on} Circuit

FIGURE 2



Z_{in} > 100 Kohm
C_{in} ≤ 12 pf
Rise time ≤ 5 nsec

T_{off} Circuit

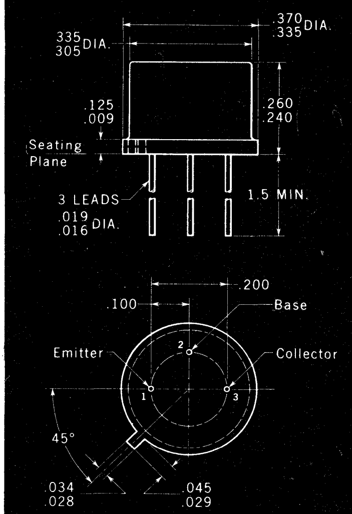
2N3923

NPN HIGH-VOLTAGE AMPLIFIER

DIFFUSED SILICON PLANAR TRANSISTOR

GENERAL DESCRIPTION - The 2N3923 is an NPN silicon PLANAR transistor designed primarily for use as a high-voltage output device where low collector base capacitance is required. The device features a maximum C_{obo} of 3.5 pf together with a minimum LV_{CEO} of 150 volts and a minimum f_T of 40 Mc. The TO-5 package permits operation to 200°C junction temperature and a power rating of 3 watts.

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.10 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 25°C Case Temperature	(Notes 2 and 3)	3.0 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.8 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		150 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	150 Volts
V_{EBO}	Emitter to Base Voltage		6.0 Volts
I_C	Collector Current		100 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)	30	100	120		I_C = 25 mA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	15	40			I_C = 25 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	15	62			I_C = 100 μA	V_{CE} = 10 V
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	150			Volts	I_C = 10 mA (pulsed)	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	150			Volts	I_C = 100 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			Volts	I_E = 100 μA	I_C = 0
V_{BE}(sat)	Base Saturation Voltage		0.77	0.9	Volts	I_C = 25 mA	I_B = 2.5 mA
V_{CE}(sat)	Collector Saturation Voltage		0.3	1.0	Volts	I_C = 25 mA	I_B = 2.5 mA

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 58°C/Watt (derating factor of 17.2 mW/°C); junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).

(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

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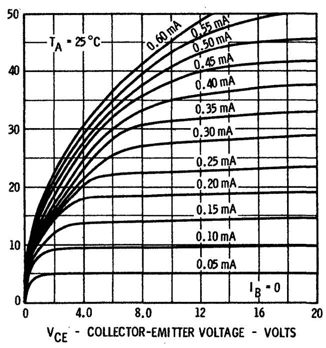
FAIRCHILD TRANSISTOR 2N3923

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

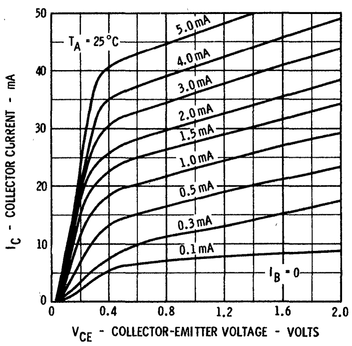
Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions	
I_{CBO}	Collector Cutoff Current		0.1	10	nA	$I_E = 0$	$V_{CB} = 100$ V
$I_{CBO}(150°C)$	Collector Cutoff Current		0.5	10	μA	$I_E = 0$	$V_{CB} = 100$ V
I_{EBO}	Emitter Cutoff Current		0.005	50	nA	$I_C = 0$	$V_{EB} = 4.0$ V
h_{fe}	High Frequency Current Gain (f = 20 Mc)	2.0	4.3			$I_C = 10$ mA	$V_{CE} = 10$ V
h_{fe}	Small Signal Current Gain (f = 1.0 Kc)	20				$I_C = 25$ mA	$V_{CE} = 10$ V
C_{obo}	Common Base Open Circuit Output Capacitance		2.6	3.5	pf	$I_E = 0$	$V_{CB} = 20$ V
C_{ibo}	Common Base Open Circuit Input Capacitance		17	25	pf	$I_C = 0$	$V_{EB} = 0.5$ V
$R_e(h_{ie})$	Real Part of Input Impedance (f = 300 Mc)			50	Ohms	$I_C = 10$ mA	$V_{CE} = 10$ V

TYPICAL ELECTRICAL CHARACTERISTICS

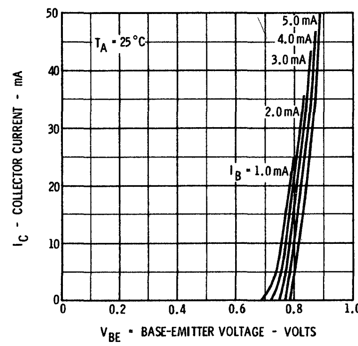
COLLECTOR CHARACTERISTICS*



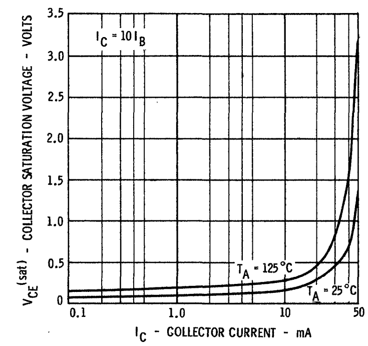
COLLECTOR CHARACTERISTICS*



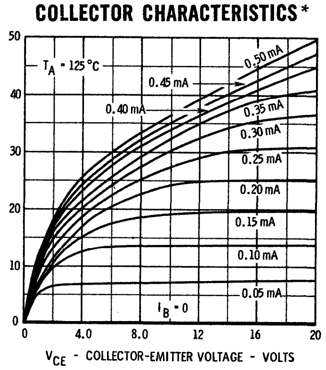
BASE CHARACTERISTICS*



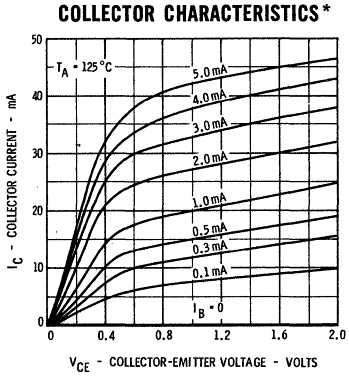
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



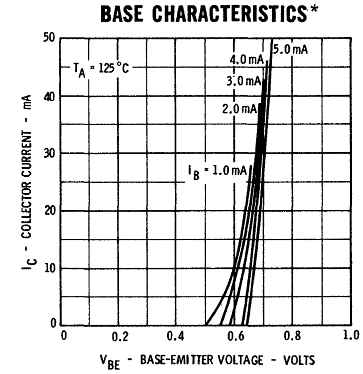
COLLECTOR CHARACTERISTICS*



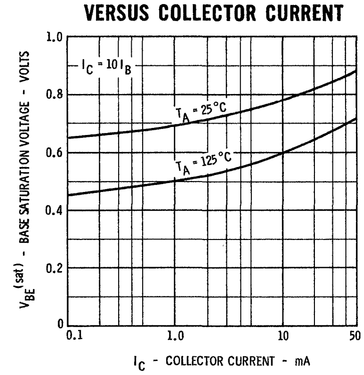
COLLECTOR CHARACTERISTICS*



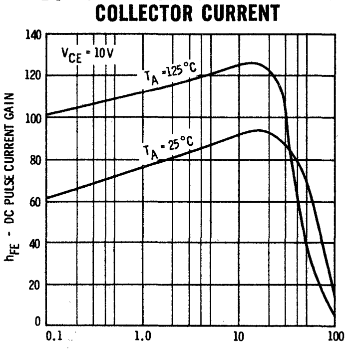
BASE CHARACTERISTICS*



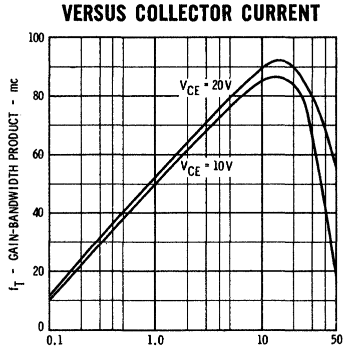
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



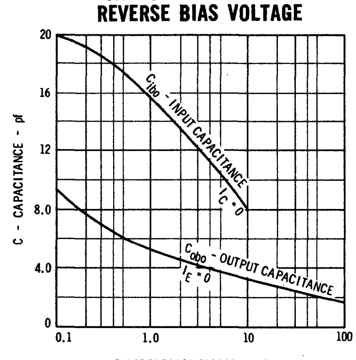
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



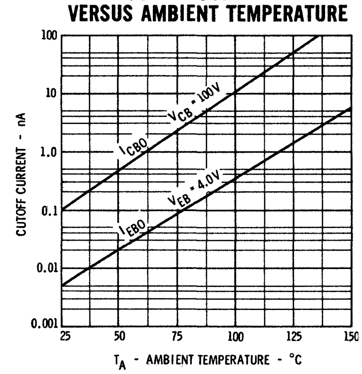
GAIN-BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COLLECTOR & EMITTER CUTOFF CURRENTS VERSUS AMBIENT TEMPERATURE



* Single family characteristics on Transistor Curve Tracer

2N3930 • 2N3931 • 2N4357 • 2N4358

PNP HIGH VOLTAGE AMPLIFIER

DIFFUSED SILICON PLANAR* II TRANSISTORS

FEATURES

- **HIGH VOLTAGE -- 240 VOLT LV_{CEO}**
- **HIGH BETA -- 80–300 @ 10 mA**
- **LOW NOISE -- 3 dB @ 1.0 kHz**
- **EXCELLENT BETA LINEARITY from 10 μA to 50 mA**

ABSOLUTE MAXIMUM RATINGS [Note 1]

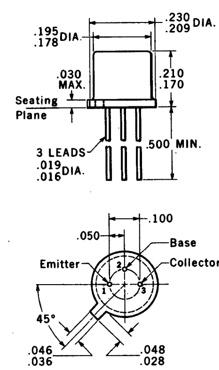
Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, 60 second time limit)	+300°C

	2N3930 2N4357	2N3931 **2N4358**
Maximum Power Dissipation [Notes 2 and 3]		
Total Dissipation at 25°C Case Temperature	1.4 Watts	2.5 Watts
at 25°C Ambient Temperature	0.4 Watt	0.7 Watt

		2N3930 2N3931	2N4357 **2N4358**
Maximum Voltages			
V_{CBO}	Collector to Base Voltage	−180 Volts	−240 Volts
V_{CEO}	Collector to Emitter to Voltage [Note 4]	−180 Volts	−240 Volts
V_{EBO}	Emitter to Base Voltage	−6.0 Volts	−6.0 Volts

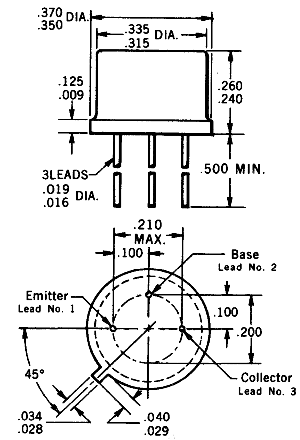
PHYSICAL DIMENSIONS in accordance with JEDEC (TO-18) outline



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

2N3930 • 2N4357

PHYSICAL DIMENSIONS in accordance with JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

2N3931 • 2N4358

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	2N3930 2N3931	−180			Volts	$I_C = 10\ \mu A$ $I_E = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	2N4357 2N4358	−240			Volts	$I_C = 10\ \mu A$ $I_E = 0$
$V_{CEO(sust)}$	Collector to Emitter Sustaining Voltage	2N3930 2N3931	−180			Volts	$I_C = 2.0$ mA $I_B = 0$
$V_{CEO(sust)}$	**Collector to Emitter Sustaining Voltage**	**2N4357 2N4358**	**−240**			**Volts**	**$I_C = 2.0$ mA $I_B = 0$**
h_{FE}	**DC Current Gain**		**60**	**110**			**$I_C = 10\ \mu A$ $V_{CE} = -10$ V**
h_{FE}	**DC Current Gain**		**80**	**170**			**$I_C = 1.0$ mA $V_{CE} = -10$ V**
h_{FE}	**DC Pulse Current Gain** [Note 5]		**80**	**200**	**300**		**$I_C = 10$ mA $V_{CE} = -10$ V**
h_{FE} (−55°C)	DC Current Gain		15	50			$I_C = 10\ \mu A$ $V_{CE} = -10$ V
h_{FE} (−55°C)	DC Current Gain		30	105			$I_C = 100\ \mu A$ $V_{CE} = -10$ V
$V_{CE(sat)}$	Collector Saturation Voltage	2N3930 2N3931		−0.1	−0.25	Volts	$I_C = 10$ mA $I_B = 1.0$ mA
$V_{CE(sat)}$	Collector Saturation Voltage	2N4357 2N4358		−0.2	−0.5	Volts	$I_C = 10$ mA $I_B = 1.0$ mA

See notes on back page

* Planar is a patented Fairchild process.

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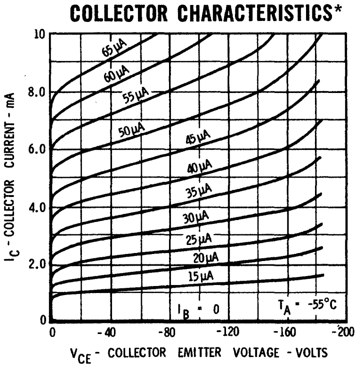
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature Unless Otherwise Noted)

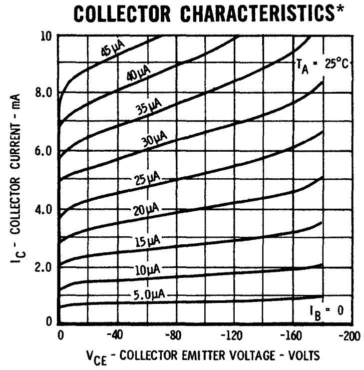
SYMBOL	CHARACTERISTIC		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
$V_{BE(sat)}$	Base Saturation Voltage			0.74	0.9	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
BV_{EBO}	Emitter to Base Breakdown Voltage		−6.0			Volts	$I_E = 10\ \mu A$	$I_C = 0$
I_{EBO}	Emitter Cutoff Current			0.2	10	nA	$I_C = 0$	$V_{EB} = -4.0$ V
I_{CBO}	Collector Reverse Current	2N3930 2N3931		0.2	10	nA	$I_E = 0$	$V_{CB} = -100$ V
I_{CBO}	Collector Reverse Current	2N4357 2N4358		0.5	20	nA	$I_E = 0$	$V_{CB} = -200$ V
I_{CBO} (150°C)	Collector Reverse Current	2N3930 2N3931		0.03	10	μA	$I_E = 0$	$V_{CB} = -100$ V
I_{CBO} (150°C)	Collector Reverse Current	2N4357 2N4358		0.07	20	μA	$I_E = 0$	$V_{CB} = -200$ V
C_{obo}	Open Circuit, Output Capacitance (f = 1.0 MHz)			5.0	7.0	pF	$I_E = 0$	$V_{CB} = -5.0$ V
C_{ibo}	Open Circuit, Input Capacitance (f = 1.0 MHz)			20	25	pF	$I_C = 0$	$V_{EB} = -0.5$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.0	3.0	8.0		$I_C = 1.0$ mA	$V_{CE} = -10$ V
NF	Narrow Band Noise Figure (f = 10 kHz)			1.0	3.0	dB	$I_C = 10\ \mu A$ $R_S = 10$ kΩ	$V_{CE} = -5.0$ V BW = 1.5 kHz
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**			**1.0**	**3.0**	**dB**	**$I_C = 10\ \mu A$ $R_S = 10$ kΩ**	**$V_{CE} = -5.0$ V BW = 150 Hz**
NF	Narrow Band Noise Figure (f = 100 Hz)			2.0	10	dB	$I_C = 10\ \mu A$ $R_S = 10$ kΩ	$V_{CE} = -5.0$ V BW = 15 Hz

TYPICAL ELECTRICAL CHARACTERISTICS

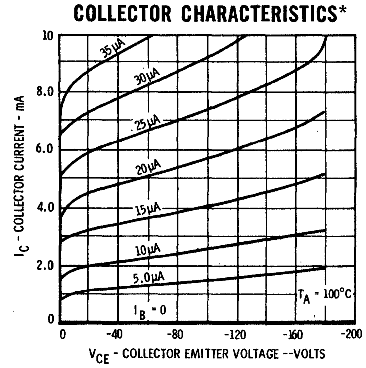
COLLECTOR CHARACTERISTICS*



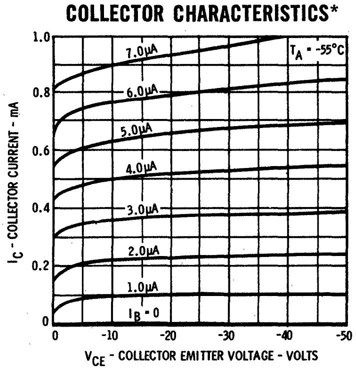
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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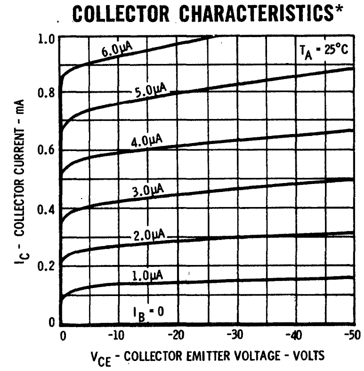
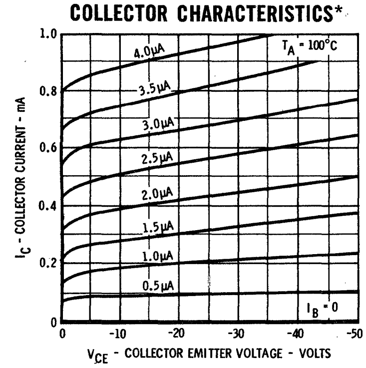


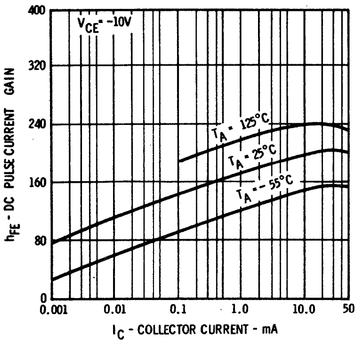
COLLECTOR CHARACTERISTICS*



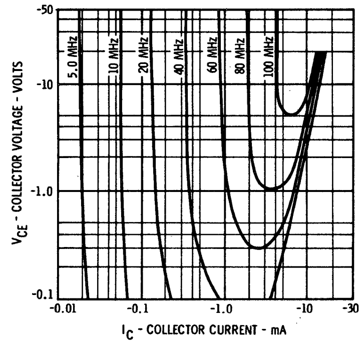
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

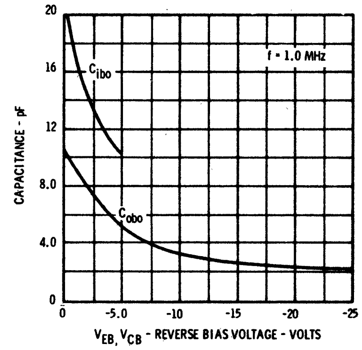
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



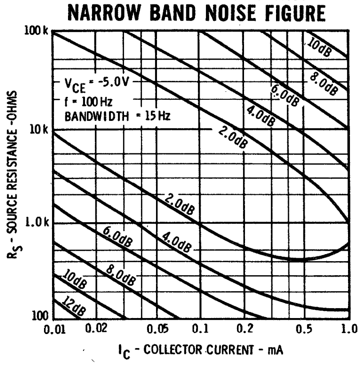
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_t)



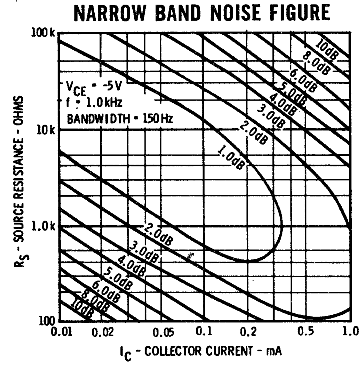
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



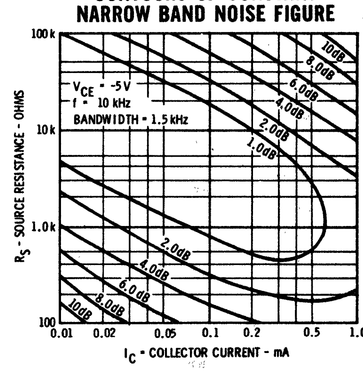
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



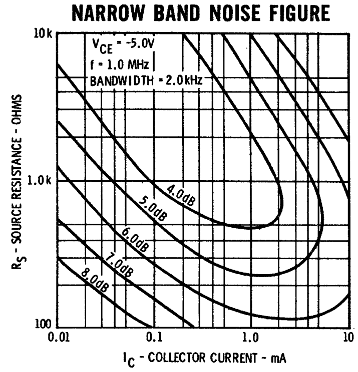
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



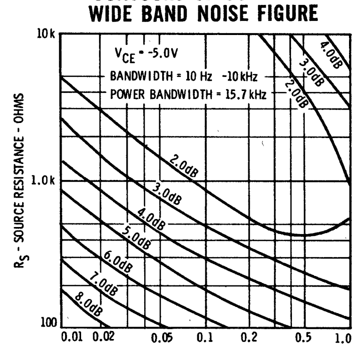
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



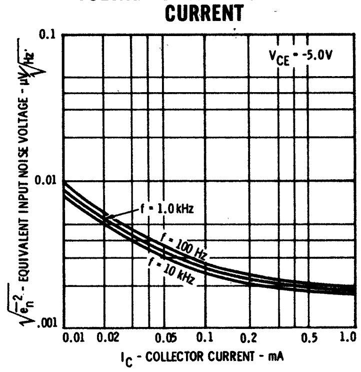
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



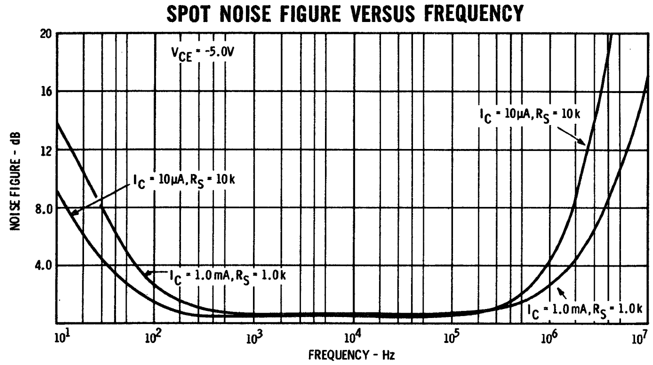
CONTOURS OF CONSTANT WIDE BAND NOISE FIGURE



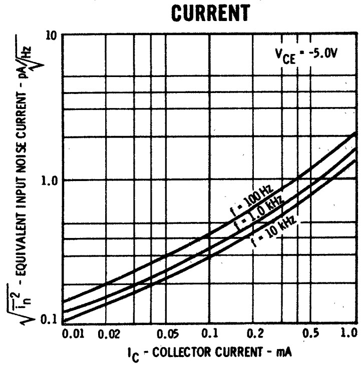
EQUIVALENT INPUT NOISE VOLTAGE VERSUS COLLECTOR CURRENT



SPOT NOISE FIGURE VERSUS FREQUENCY



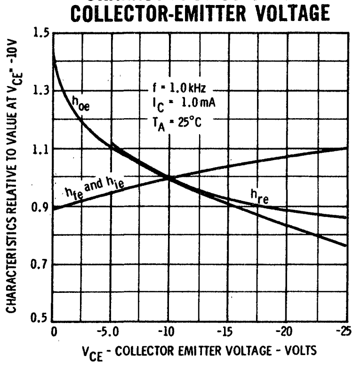
EQUIVALENT INPUT NOISE CURRENT VERSUS COLLECTOR CURRENT



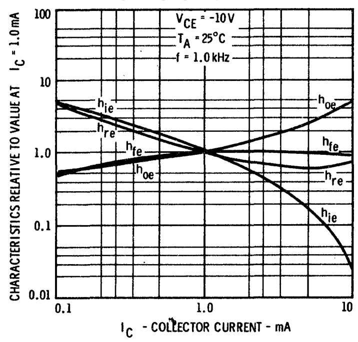
SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz, T_A = 25°C)

SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS
h_{fe}	Small Signal Current Gain	100	400		$I_C = 1.0$ mA $V_{CE} = -10$ V
h_{ie}	Input Resistance	2.5	12	kOhms	$I_C = 1.0$ mA $V_{CE} = -10$ V
h_{oe}	Output Conductance	5.0	25	μmhos	$I_C = 1.0$ mA $V_{CE} = -10$ V

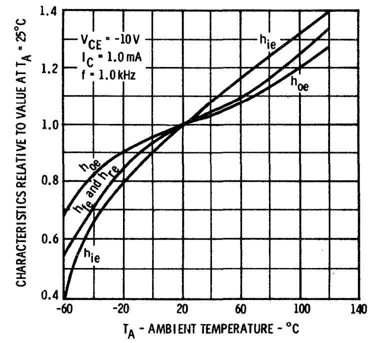
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT

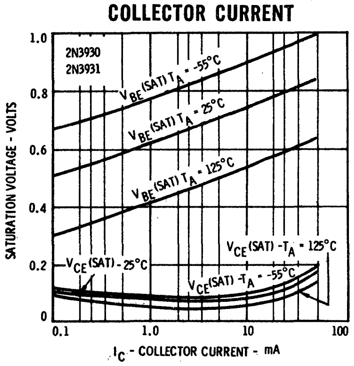


COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE

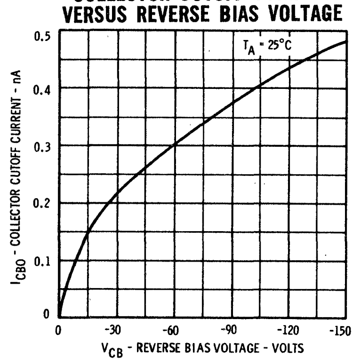


TYPICAL ELECTRICAL CHARACTERISTICS

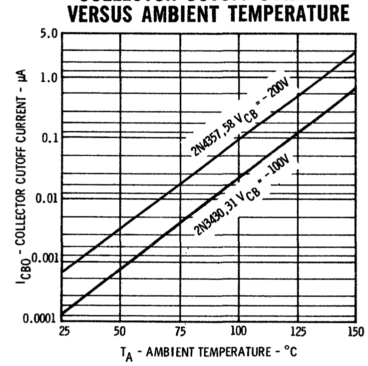
COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



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 125°C/watt (derating factor of 8.0 mW/°C); junction to ambient thermal resistance of 438°C/watt (derating factor of 2.28 mW/°C) for the 2N3920 and 2N4357; junction to case thermal resistance of 70°C/watt (derating factor of 14.3 mW/°C); junction to ambient thermal resistance of 250°C/watt (derating factor of 4.0 mW/°C) for the 2N3931 and 2N4358.
(4) 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.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

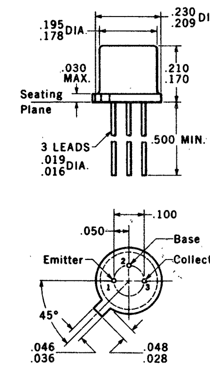
2N3962 • 2N3963 • 2N3964 • 2N3965

PNP LOW-LEVEL, LOW-NOISE TYPE

DIFFUSED SILICON PLANAR* II TRANSISTORS

- **LOW NOISE FIGURE . . . . NF = 2.0 dB (MAX) AT 1.0 kHz**
  NF = 4.0 dB (MAX) AT 100 Hz
- **HIGH CURRENT GAIN . . . . . . h_{FE} = 180 (MIN) AT 1.0 μA**
  h_{FE} = 250 - 500 AT 10 μA
  h_{FE} = 250 - 600 AT 1.0 mA
- **HIGH BREAKDOWN VOLTAGE . . . LV_{CEO} = 45, 60 AND 80 VOLTS**
- **EXCELLENT BETA LINEARITY FROM 1.0 μA TO 50 mA**

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 second time limit)	300°C

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.2 Watts
at 25°C Ambient Temperature	0.36 Watt

Maximum Voltages and Current		**2N3962 2N3965**	**2N3963**	**2N3964**
V_{CBO}	Collector to Base Voltage	−60 Volts	−80 Volts	−45 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	−60 Volts	−80 Volts	−45 Volts
V_{EBO}	Emitter to Base Voltage	−6.0 Volts	−6.0 Volts	−6.0 Volts

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

SYMBOL	CHARACTERISTICS	2N3962 • 2N3963 MIN.	TYP.	MAX.	2N3964 • 2N3965 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**	60	175		**180**	**300**			**I_C = 1.0 μA**	**V_{CE} = −5.0 V**
h_{FE}	**DC Current Gain**	100	210	300	**250**	**320**	**500**		**I_C = 10 μA**	**V_{CE} = −5.0 V**
h_{FE}	DC Current Gain	100	240		250	330			I_C = 100 μA	V_{CE} = −5.0 V
h_{FE}	**DC Current Gain**	100	260	450	**250**	**330**	**600**		**I_C = 1.0 mA**	**V_{CE} = −5.0 V**
h_{FE}	DC Pulse Current Gain (Note 5)	100	280		200	330			I_C = 10 mA	V_{CE} = −5.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	90	260		180	315			I_C = 50 mA	V_{CE} = −5.0 V
h_{FE}(−55°C)	DC Current Gain	40	90		100	160			I_C = 10 μA	V_{CE} = −5.0 V
h_{FE}(−55°C)	DC Pulse Current Gain (Note 5)	45	150		90	190			I_C = 50 mA	V_{CE} = −5.0 V
h_{FE}(+100°C)	DC Current Gain		375	600		400	800		I_C = 1.0 mA	V_{CE} = −5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	−60	2N3962 (only)		−45	2N3964 (only)		Volts	I_C = 10 μA	I_E = 0
BV_{CBO}	Collector to Base Breakdown Voltage	−80	2N3963 (only)		−60	2N3965 (only)		Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−60	2N3962 (only)		−45	2N3964 (only)		Volts	I_C = 10 μA	I_B = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−80	2N3963 (only)		−60	2N3965 (only)		Volts	I_C = 10 μA	I_B = 0
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 & 5)	**−60**	**2N3962** (only)		**−45**	**2N3964** (only)		**Volts**	**I_C = 5.0 mA** (pulsed)	**I_B = 0**
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 & 5)	**−80**	**2N3963** (only)		**−60**	**2N3965** (only)		**Volts**	**I_C = 5.0 mA** (pulsed)	**I_B = 0**
BV_{EBO}	Emitter to Base Breakdown Voltage	−6.0			−6.0			Volts	I_C = 0	I_E = 10 μA
NF	Wideband Noise Figure (f = 10 Hz to 10 kHz)		1.0	3.0		0.7	2.0	dB	I_C = 20 μA R_S = 10 kΩ	V_{CE} = −5.0 V BW = 15.7 kHz
NF	Narrowband Noise Figure (f = 10 kHz)		0.8	3.0		0.5	2.0	dB	I_C = 20 μA R_S = 10 kΩ	V_{CE} = −5.0 V BW = 1.5 kHz
NF	**Narrowband Noise Figure (f = 1.0 kHz)**		0.8	3.0		**0.5**	**2.0**	**dB**	**I_C = 20 μA** **R_S = 10 kΩ**	**V_{CE} = −5.0 V** **BW = 150 Hz**
NF	**Narrowband Noise Figure (f = 100 Hz)**		3.0	10		**1.8**	**4.0**	**dB**	**I_C = 20 μA** **R_S = 10 kΩ**	**V_{CE} = −5.0 V** **BW = 15 Hz**
NF	Narrowband Noise Figure (f = 10 Hz)					3.5	8.0	dB	I_C = 20 μA R_S = 10 kΩ	V_{CE} = −5.0 V BW = 2.0 Hz

Additional Electrical Characteristics on page 2.
Notes on page 2.

*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)

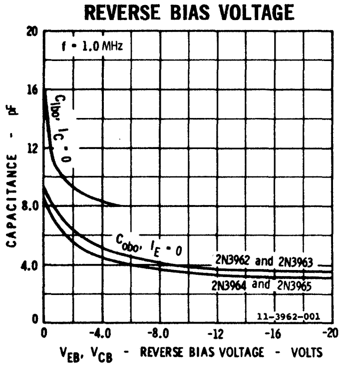
SYMBOL	CHARACTERISTICS	2N3962 • 2N3963 MIN.	TYP.	MAX.	2N3964 • 2N3965 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{CES}	Collector Reverse Current	(2N3962)	0.5	10	(2N3965)	0.5	10	nA	$V_{CE} = -50$ V	$V_{EB} = 0$
I_{CES}	Collector Reverse Current	(2N3963)	0.5	10				nA	$V_{CE} = -70$ V	$V_{EB} = 0$
I_{CES}	Collector Reverse Current				(2N3964)	0.5	10	nA	$V_{CE} = -40$ V	$V_{EB} = 0$
$I_{CES}(+150°C)$	Collector Reverse Current	(2N3962)	2.0	10	(2N3965)	0.5	10	μA	$V_{CE} = -50$ V	$V_{EB} = 0$
$I_{CES}(+150°C)$	Collector Reverse Current	(2N3963)	2.0	10				μA	$V_{CE} = -70$ V	$V_{EB} = 0$
$I_{CES}(+150°C)$	Collector Reverse Current				(2N3964)	2.0	10	μA	$V_{CE} = -40$ V	$V_{EB} = 0$
I_{EBO}	Emitter Cutoff Current			10			10	nA	$I_C = 0$	$V_{EB} = -4.0$ V
$V_{CE}(sat)$	Collector Saturation Voltage		−0.1	−0.25		−0.1	−0.25	Volts	$I_C = 10$ mA	$I_B = 0.5$ mA
$V_{CE}(sat)$	Collector Saturation Voltage (Note 5)		−0.16	−0.4		−0.16	−0.4	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
$V_{BE}(sat)$	Base Saturation Voltage		−0.72	−0.9		−0.72	−0.9	Volts	$I_C = 10$ mA	$I_B = 0.5$ mA
$V_{BE}(sat)$	Base Saturation Voltage (Note 5)		−0.81	−0.95		−0.81	−0.95	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
h_{ie}	Input Resistance (f = 1.0 kHz)	2.5	8.0	17	6.0	10	20	kΩ	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{oe}	Output Conductance (f = 1.0 kHz)	5.0	19	40	5.0	25	50	μmho	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{re}	Voltage Feedback Ratio (f = 1.0 kHz)			10			10	$x10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	100	300	550	250	360	700		$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0		8.0	2.5		8.0		$I_C = 0.5$ mA	$V_{CE} = -5.0$ V
C_{obo}	Open Circuit Output Capacitance			6.0			6.0	pF	$I_E = 0$	$V_{CB} = -5.0$ V
C_{ibo}	Open Circuit Input Capacitance			15			15	pF	$I_C = 0$	$V_{EB} = -0.5$ V

NOTES:

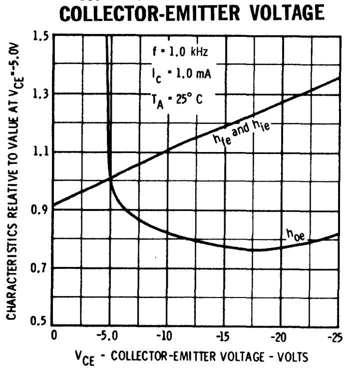
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature 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. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

TYPICAL ELECTRICAL CHARACTERISTICS
2N3962 • 2N3963 • 2N3964 • 2N3965

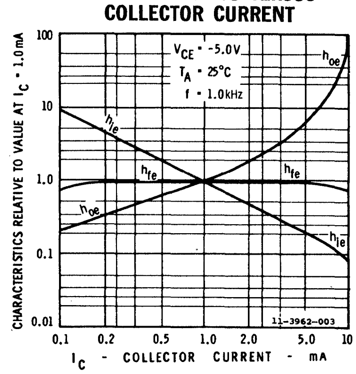
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



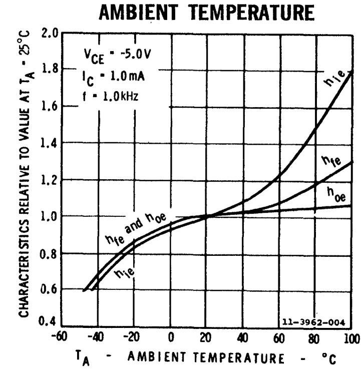
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



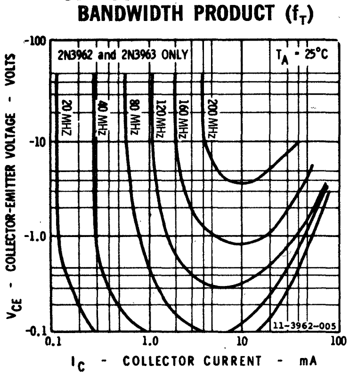
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



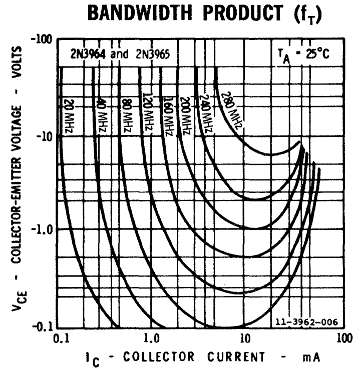
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



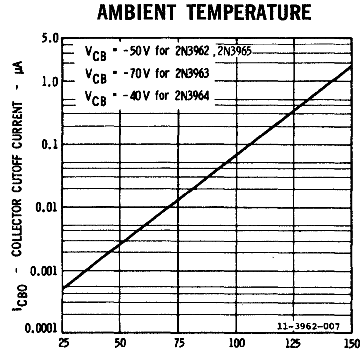
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



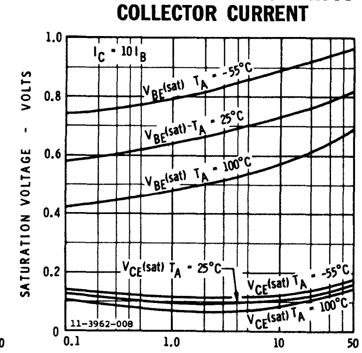
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



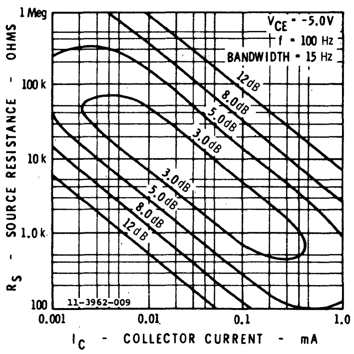
COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



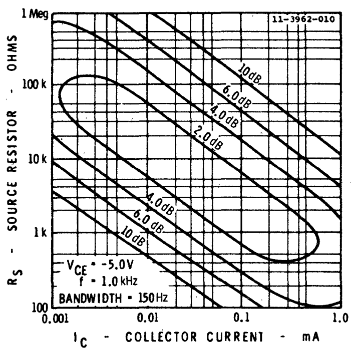
TYPICAL ELECTRICAL CHARACTERISTICS

2N3962 • 2N3963

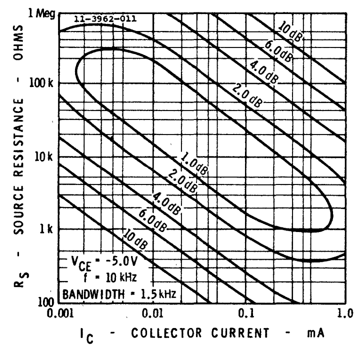
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



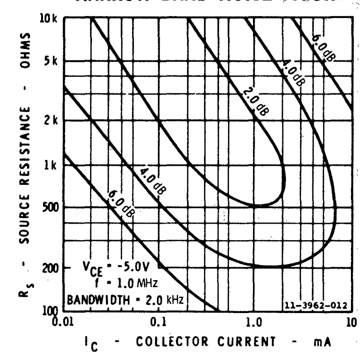
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



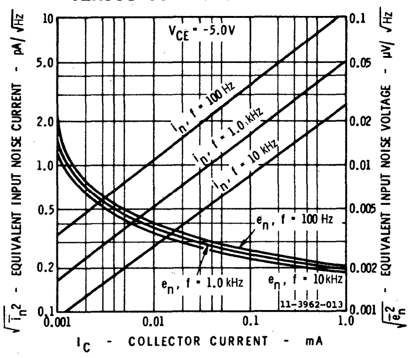
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



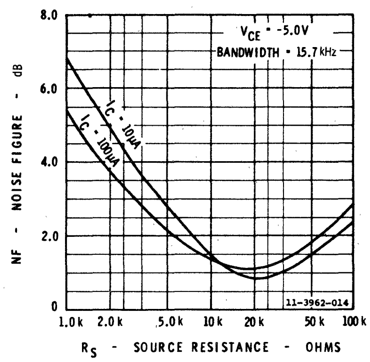
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



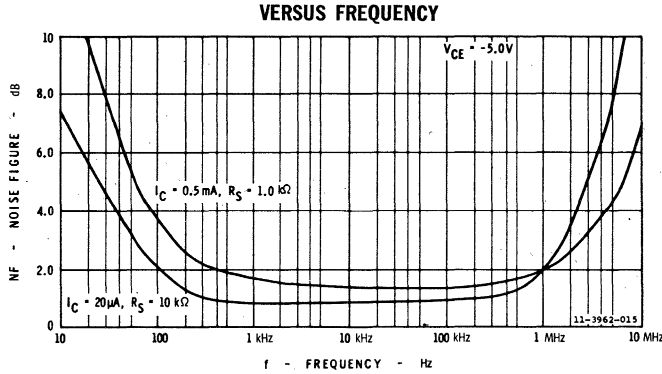
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

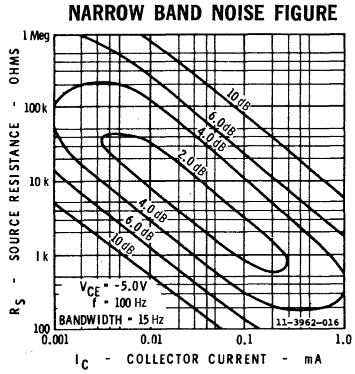


NOISE FIGURE VERSUS FREQUENCY

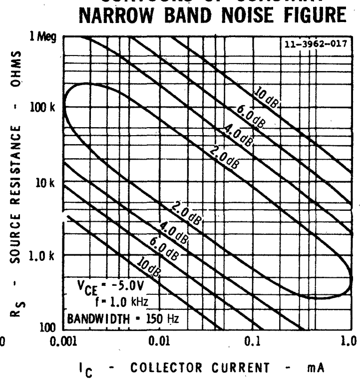


2N3964 • 2N3965

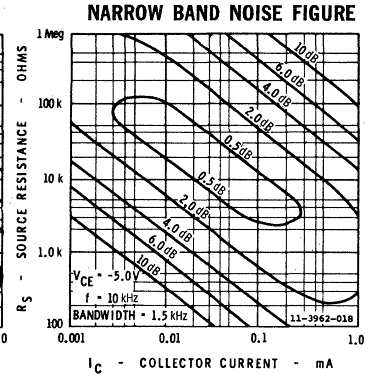
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



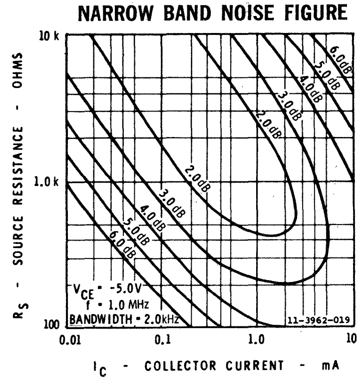
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



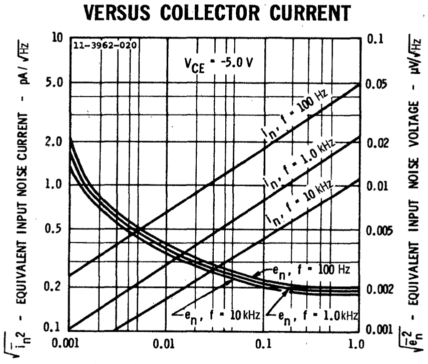
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



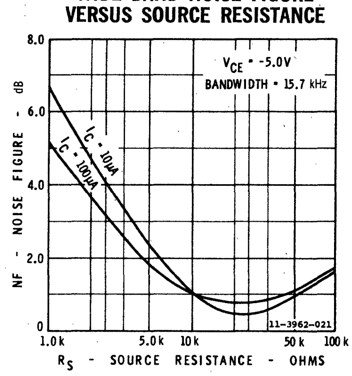
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



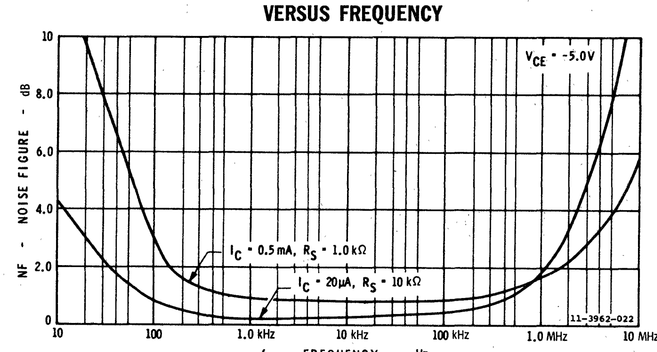
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



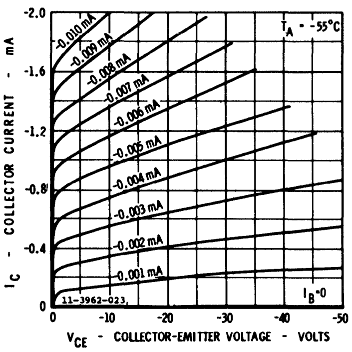
NOISE FIGURE VERSUS FREQUENCY



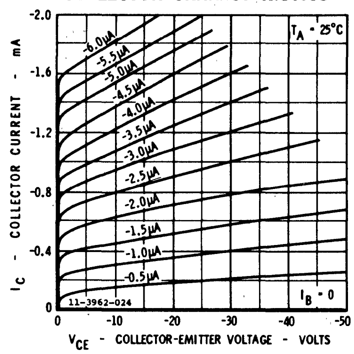
TYPICAL ELECTRICAL CHARACTERISTICS

2N3962 • 2N3963

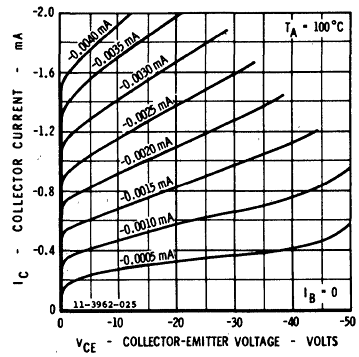
COLLECTOR CHARACTERISTICS*



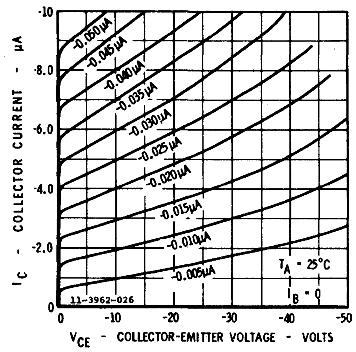
COLLECTOR CHARACTERISTICS*



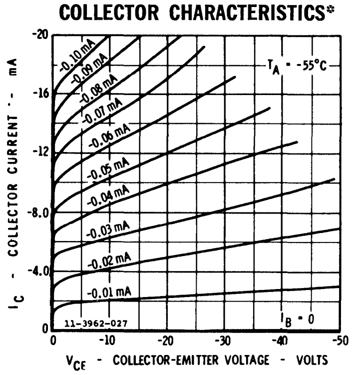
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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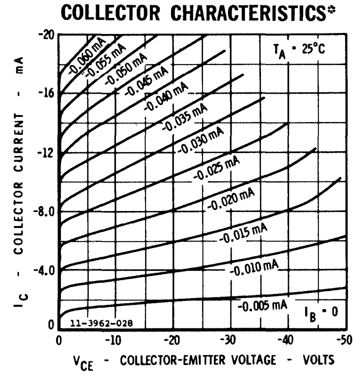
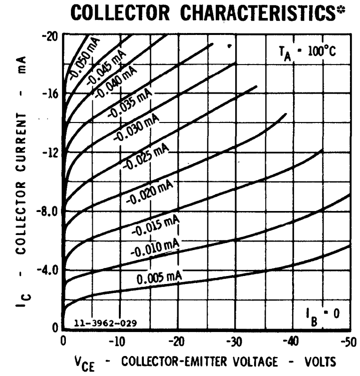
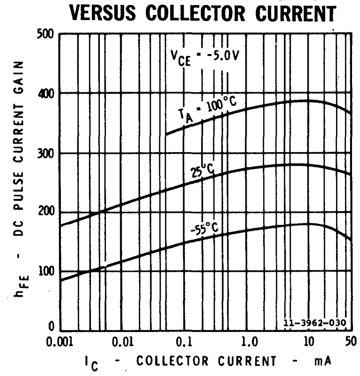


COLLECTOR CHARACTERISTICS*

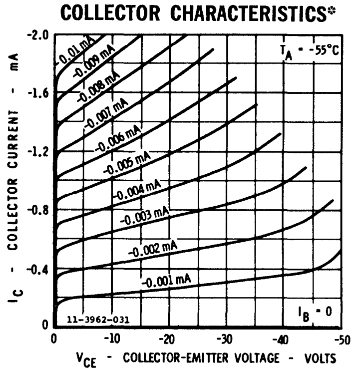


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

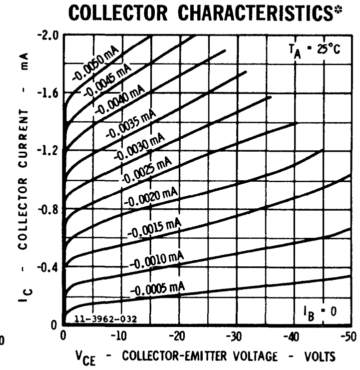


2N3964 • 2N3965

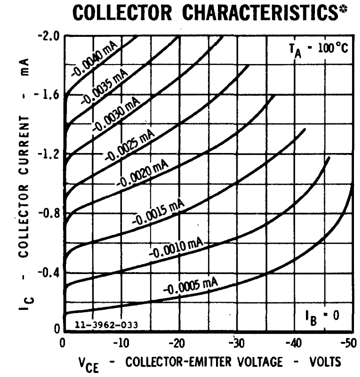
COLLECTOR CHARACTERISTICS*



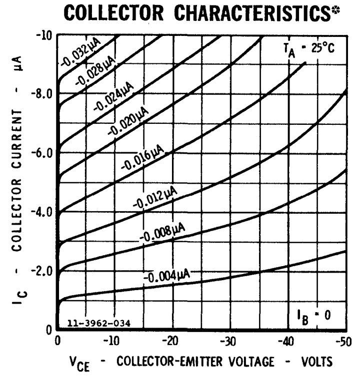
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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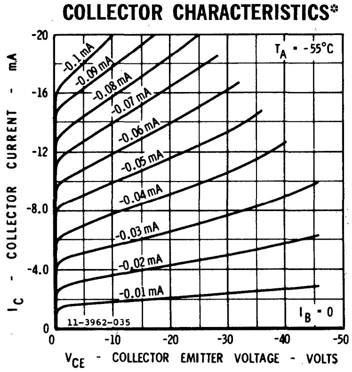
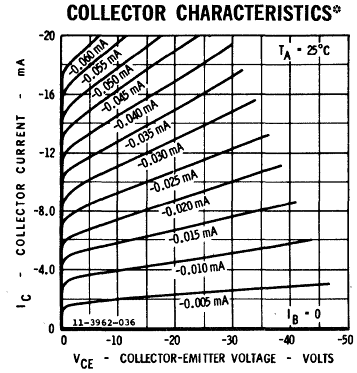
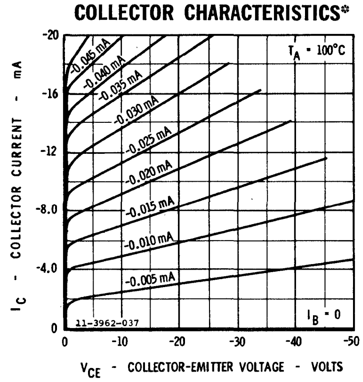


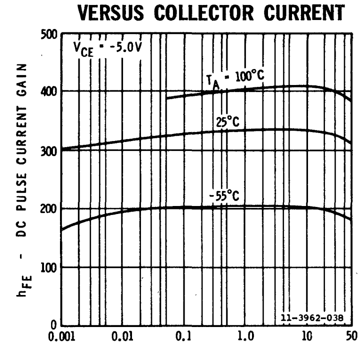
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



*Single family characteristics on Transistor Curve Tracer.

2N4026 THROUGH 2N4029

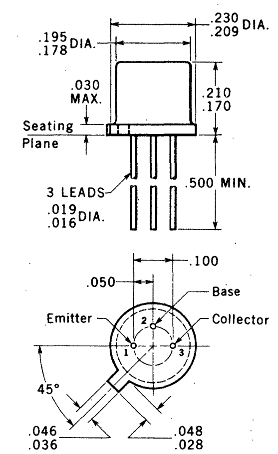
PNP HIGH-VOLTAGE GENERAL PURPOSE AMPLIFIERS

SILICON PLANAR*II EPITAXIAL TRANSISTORS

FEATURES

- **HIGH BETA - - 100-300 @ 100 mA**
- **HIGH VOLTAGE- -60 AND 80 VOLTS LV_{CEO}**
- **LOW V_{CE} (SAT) - - 1.0 VOLT (MAX.) @ 1.0 A**
- **EXCELLENT BETA LINEARITY FROM 100 μA TO 500 mA**

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 Junction 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]		2.0 Watts
at 25°C Free Air Temperature	[Notes 2 and 3]		0.5 Watt

Maximum Voltages

			2N4026 **2N4028**	2N4027 **2N4029**
V_{CBO}	Collector to Base Voltage		−60 Volts	−80 Volts
V_{CEO}	Collector to Emitter Voltage	[Note 4]	**−60 Volts**	**−80 Volts**
V_{EBO}	Emitter to Base Voltage		−5.0 Volts	−5.0 Volts

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

SYMBOL	CHARACTERISTICS	2N4026 2N4027 Min.	Typ.	Max.	**2N4028 2N4029** Min.	Typ.	Max.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Pulse Current Gain** [Note 5]	30	80		**75**	**150**			**I_C = 100 μA**	V_{CE} = −5.0 V
h_{FE}	**DC Pulse Current Gain** [Note 5]	40	80	120	**100**	**160**	**300**		**I_C = 100 mA**	V_{CE} = −5.0 V
h_{FE}	**DC Pulse Current Gain** [Note 5]	25	60		**70**	**110**			**I_C = 500 mA**	V_{CE} = −5.0 V
h_{FE}	**DC Pulse Current Gain** [Note 5]	15	(2N4026 only)		**40**	**(2N4028 only)**			**I_C = 1.0 A**	V_{CE} = −5.0 V
h_{FE}	**DC Pulse Current Gain** [Note 5]	10	(2N4027 only)		**25**	**(2N4029 only)**			**I_C = 1.0 A**	V_{CE} = −5.0 V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	15	50		40	100			I_C = 100 mA	V_{CE} = −5.0 V
h_{fe}	**High Frequency Current Gain** (f = 100 MHz)	1.0	1.5	4.0	**1.5**	**2.0**	5.0		I_C = 50 mA	V_{CE} = −10 V
C_{obo}	Common-Base, Open-Circuit Output Capacitance		15	20		15	20	pF	I_E = 0	V_{CB} = −10 V
C_{ibo}	Common-Base, Open-Circuit Input Capacitance		75	110		75	110	pF	I_C = 0	V_{EB} = −0.5 V
t_{on}	Turn On Time [Note 6]		30	100		23	100	ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA	
t_s	Storage Time [Note 6]		150	350		175	350	ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA, $I_{B2} \approx$ −50 mA	
t_f	Fall Time [Note 6]		25	50		22	50	ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA, $I_{B2} \approx$ −50 mA	

Additional Electrical Characteristics on page 2

*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

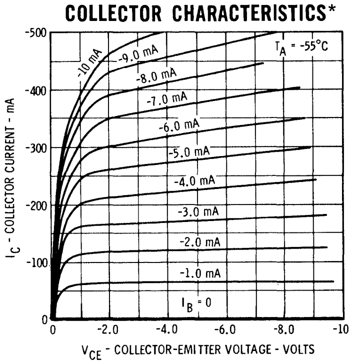
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	2N4026 **2N4028** Min.	Typ.	Max.	2N4027 **2N4029** Min.	Typ.	Max.	Units	TEST CONDITIONS	
V_{CE} (sat)	**Collector Saturation Voltage** [Note 5]		**−0.1**	**−0.15**		**−0.1**	**−0.15**	Volts	**I_C = 150 mA**	I_B = 15 mA
V_{CE} (sat)	**Collector Saturation Voltage** [Note 5]		**−0.25**	**−0.5**		**−0.25**	**−0.5**	Volts	**I_C = 500 mA**	I_B = 50 mA
V_{CE} (sat)	**Collector Saturation Voltage** [Note 5]		**−0.5**	**−1.0**				Volts	**I_C = 1000 mA**	I_B = 100 mA
V_{BE} (sat)	Base Saturation Voltage [Note 5]		−0.8	−0.9		−0.8	−0.9	Volts	I_C = 150 mA	I_B = 15 mA
V_{BE} (sat)	Base Saturation Voltage [Note 5]			−1.1		−0.95	−1.1	Volts	I_C = 500 mA	I_B = 50 mA
V_{BE} (sat)	Base Saturation Voltage [Note 5]		−1.05	−1.2				Volts	I_C = 1000 mA	I_B = 100 mA
BV_{CBO}	Collector to Base Breakdown Voltage	−60			−80			Volts	I_E = 0	I_C = 10 μA
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0			−5.0			Volts	I_C = 0	I_E = 10 μA
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** [Notes 4 and 5]	−60			**−80**			**Volts**	I_C = 10 mA (pulsed)	I_B = 0
I_{CBO}	Collector Cutoff Current		0.2	50				nA	I_E = 0	V_{CB} = −50 V
I_{CBO}	Collector Cutoff Current					0.2	50	nA	I_E = 0	V_{CB} = −60 V
I_{CBO} (150°C)	Collector Cutoff Current		0.2	50				μA	I_E = 0	V_{CB} = −50 V
I_{CBO} (150°C)	Collector Cutoff Current					0.25	50	μA	I_E = 0	V_{CB} = −60 V

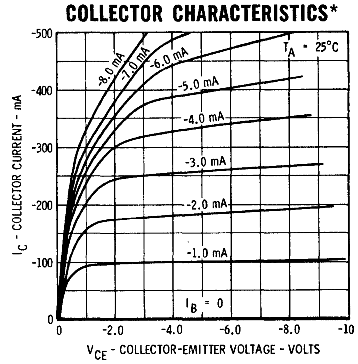
(See notes on back page)

TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4026 AND 2N4027

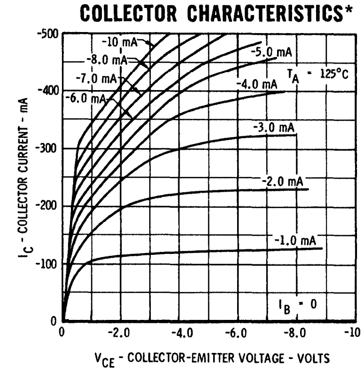
COLLECTOR CHARACTERISTICS*



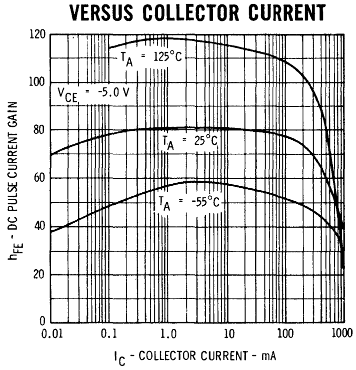
COLLECTOR CHARACTERISTICS*



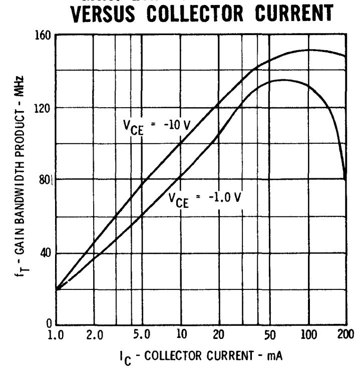
COLLECTOR CHARACTERISTICS*



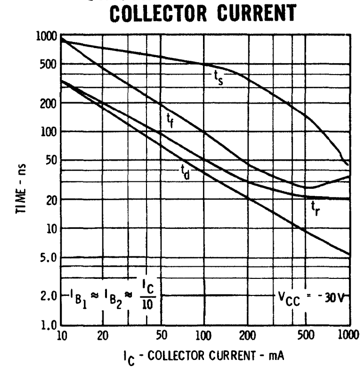
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



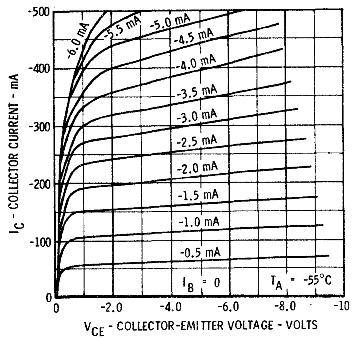
SWITCHING TIMES VERSUS COLLECTOR CURRENT



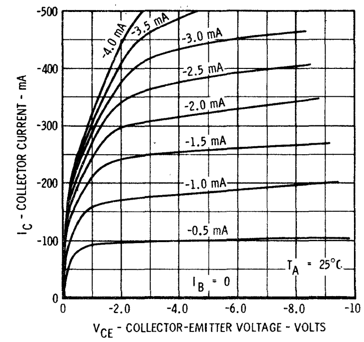
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4028 AND 2N4029

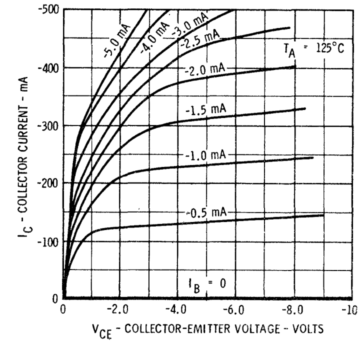
COLLECTOR CHARACTERISTICS*



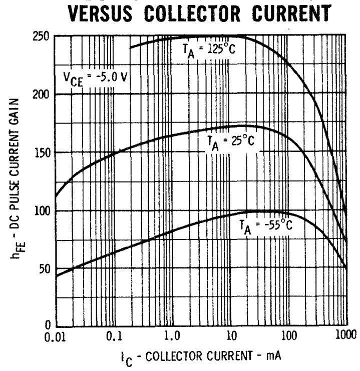
COLLECTOR CHARACTERISTICS*



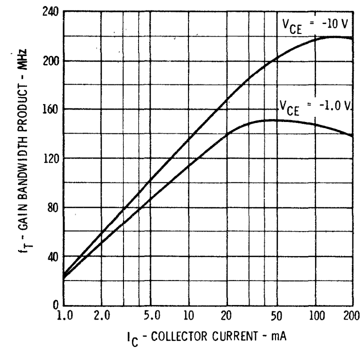
COLLECTOR CHARACTERISTICS*



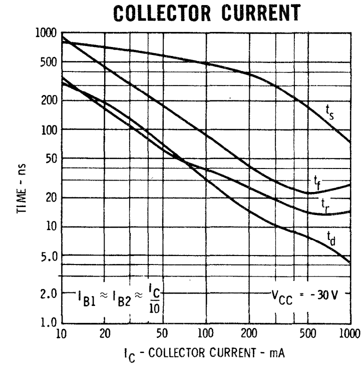
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT

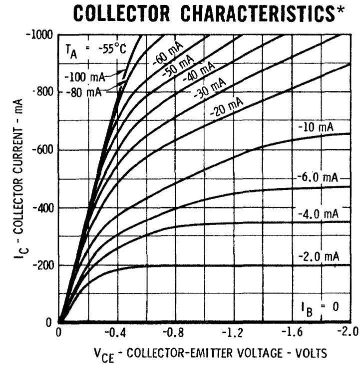


SWITCHING TIMES VERSUS COLLECTOR CURRENT

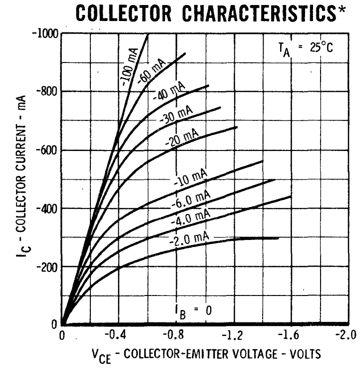


TYPICAL ELECTRICAL CHARACTERISTICS (All Types)

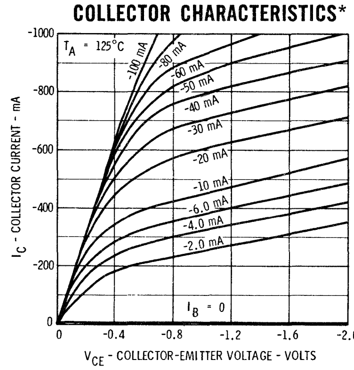
COLLECTOR CHARACTERISTICS*



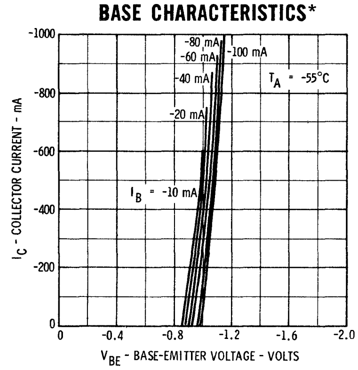
COLLECTOR CHARACTERISTICS*



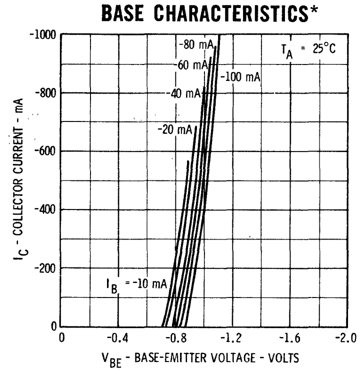
COLLECTOR CHARACTERISTICS*



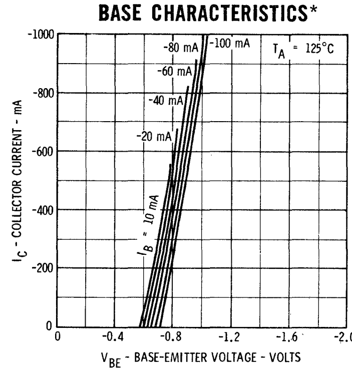
BASE CHARACTERISTICS*



BASE CHARACTERISTICS*



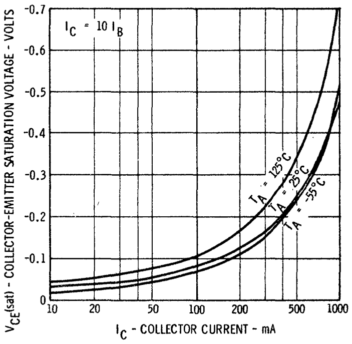
BASE CHARACTERISTICS*



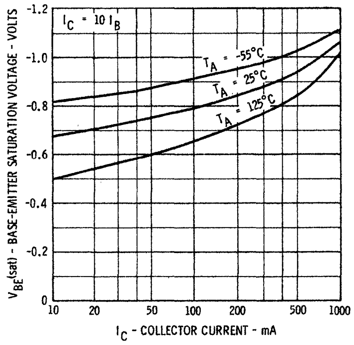
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS (All Types)

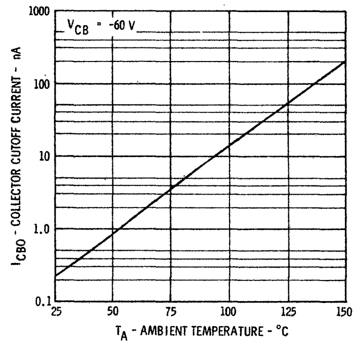
COLLECTOR-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



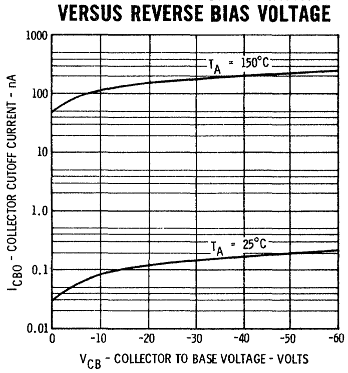
BASE-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



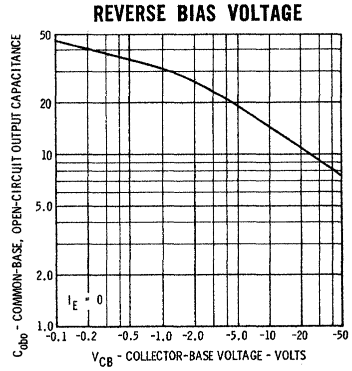
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



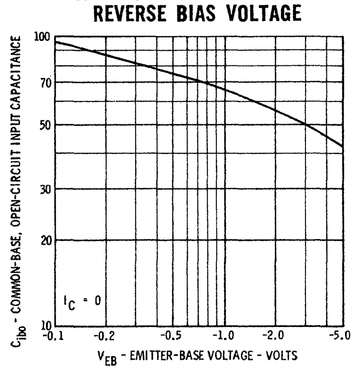
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



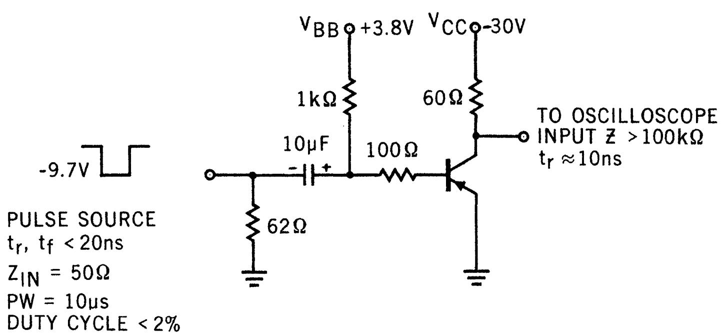
COMMON BASE OPEN CIRCUIT OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COMMON BASE OPEN CIRCUIT INPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



T_{on} AND T_{off} 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 give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 87.5°C/Watt (derating factor of 11.4 mW/°C); junction-to-ambient thermal resistance of 350°C/Watt (derating factor of 2.85 mW/°C).
(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

FAIRCHILD SEMICONDUCTOR

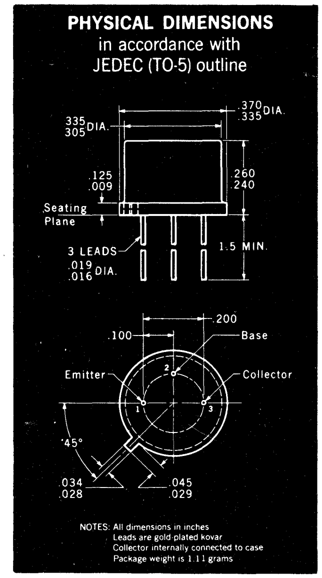
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N4030 THROUGH 2N4033

PNP HIGH-VOLTAGE GENERAL PURPOSE TYPE

SILICON PLANAR II EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The 2N4030 through 2N4033 are PNP Silicon Planar Epitaxial Transistors designed for a wide variety of applications. These devices feature 60 and 80 volt LV_{CEO}'s, excellent beta linearity with h_{FE} specified from 100 μA to 1000mA, minimum f_T of 150 Mc and low saturation voltage. They are particularly useful in complementary driver and output applications operating from supply voltages to 80 volts.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction 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)	4.0 Watts
at 25°C Free Air Temperature	(Notes 2 and 3)	0.8 Watt

Maximum Voltages

			2N4030 2N4032	2N4031 2N4033
V_{CBO}	Collector to Base Voltage		-60 Volts	-80 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-60 Volts	-80 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts	-5.0 Volts

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

Symbol	† FACT Subgroup	Characteristic	2N4030 2N4031 Min.	Typ.	Max.	2N4032 2N4033 Min.	Typ.	Max.	Units	Test Conditions
$^*h_{FE}$	1a	DC Pulse Current Gain (Note 5)	40	80	120	100	160	300		I_C = 100 mA V_{CE} = -5.0 V
h_{FE}	4	DC Current Gain	30	80		75	150			I_C = 100 μA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	25	60		70	110			I_C = 500 mA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	15 (2N4030 only)			40 (2N4032 only)				I_C = 1.0 A V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	10 (2N4031 only)			25 (2N4033 only)				I_C = 1.0 A V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 5)	15	50		40	100			I_C = 100 mA V_{CE} = -5.0 V
h_{fe}	4	High Frequency Current Gain (f = 100 Mc)	1.0	1.5		1.5	2.0			I_C = 50 mA V_{CE} = -10 V
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-5.0			-5.0			Volts	I_C = 0 I_E = 10 μA
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		15	20		15	20	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	4	Common-Base, Open-Circuit Input Capacitance		75	110		75	110	pf	I_C = 0 V_{EB} = -0.5 V
t_{on}	4	Turn On Time (Note 6)		30	100		23	100	nsec	I_C ≈ 500 mA I_{B1} ≈ 50 mA
t_s	4	Storage Time (Note 6)		150	350		175	350	nsec	I_C ≈ 500 mA, I_{B1} ≈ 50 mA, I_{B2} ≈ -50 mA
t_f	4	Fall Time (Note 6)		25	50		22	50	nsec	I_C ≈ 500 mA, I_{B1} ≈ 50 mA, I_{B2} ≈ -50 mA

† NOTE: These Numerals Apply to the Fairchild FACT Program.

*NOTE: FACT Program End-Point Measurement Parameter.

Additional Electrical Characteristics on page 2 Notes on page 4

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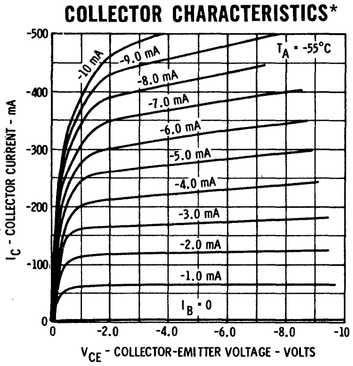
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic	2N4030 2N4032 Min.	Typ.	Max.	2N4031 2N4033 Min.	Typ.	Max.	Units	Test Conditions	
V_{CE}(sat)	4	Collector Saturation Voltage (Note 5)		-0.1	-0.15		-0.1	-0.15	Volts	I_C = 150 mA	I_B = 15 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage (Note 5)		-0.25	-0.5		-0.25	-0.5	Volts	I_C = 500 mA	I_B = 50 mA
*V_{CE}(sat)	1a	Collector Saturation Voltage (Note 5)		-0.5	-1.0				Volts	I_C = 1000 mA	I_B = 100 mA
V_{BE}(sat)	4	Base Saturation Voltage (Note 5)		-0.8	-0.9		-0.8	-0.9	Volts	I_C = 150 mA	I_B = 15 mA
*V_{BE}(sat)	1a	Base Saturation Voltage (Note 5)		-0.95	-1.1		-0.95	-1.1	Volts	I_C = 500 mA	I_B = 50 mA
*V_{BE}(sat)	1a	Base Saturation Voltage (Note 5)		-1.05	-1.2				Volts	I_C = 1000 mA	I_B = 100 mA
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-60			-80			Volts	I_E = 0	I_C = 10 μA
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-60			-80			Volts	I_C = 10 mA (pulsed)	I_B = 0
*I_{CBO}	1b	Collector Cutoff Current		0.2	50				nA	I_E = 0	V_{CB} = -50 V
*I_{CBO}	1b	Collector Cutoff Current					0.2	50	nA	I_E = 0	V_{CB} = -60 V
I_{CBO}(150°C)	4	Collector Cutoff Current		0.2	50				μA	I_E = 0	V_{CB} = -50 V
I_{CBO}(150°C)	4	Collector Cutoff Current					0.25	50	μA	I_E = 0	V_{CB} = -60 V

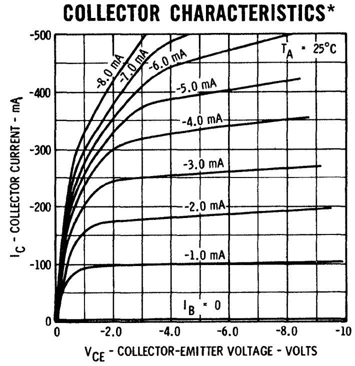
† NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4030 AND 2N4031

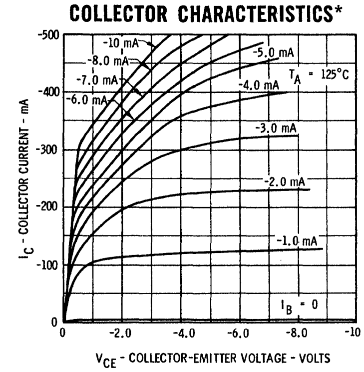
COLLECTOR CHARACTERISTICS*



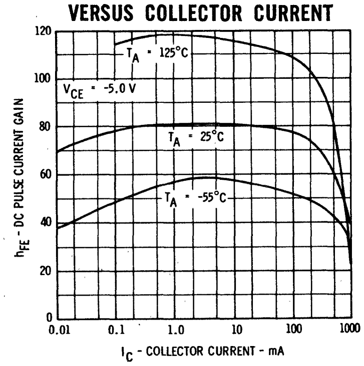
COLLECTOR CHARACTERISTICS*



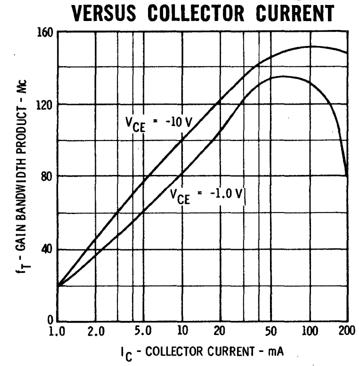
COLLECTOR CHARACTERISTICS*



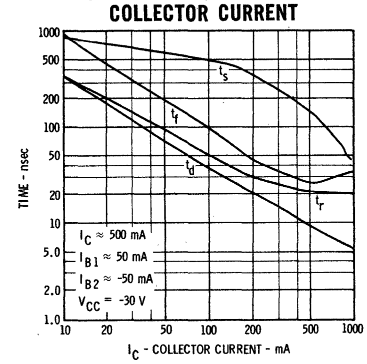
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



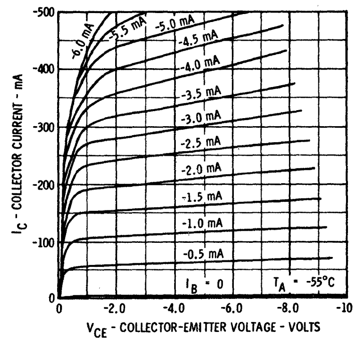
SWITCHING TIMES VERSUS COLLECTOR CURRENT



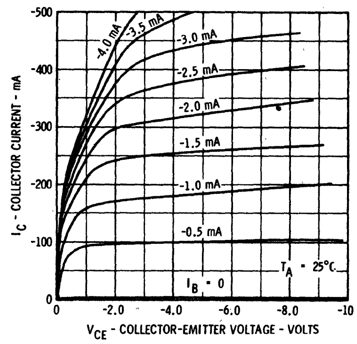
* **Single family characteristic on Transistor Curve Tracer.**

TYPICAL ELECTRICAL CHARCTERISTICS FOR 2N4032 AND 2N4033

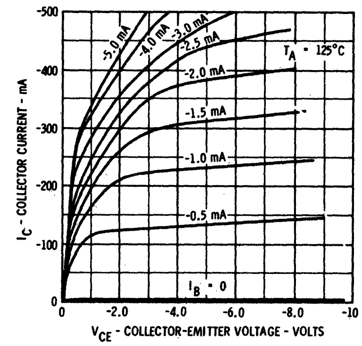
COLLECTOR CHARACTERISTICS*



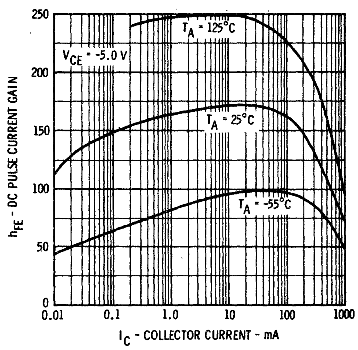
COLLECTOR CHARACTERISTICS*



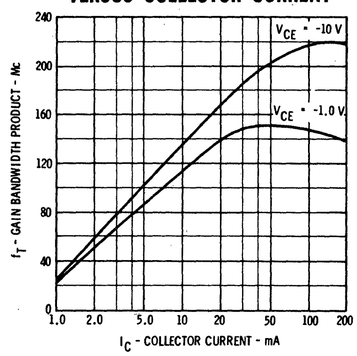
COLLECTOR CHARACTERISTICS*



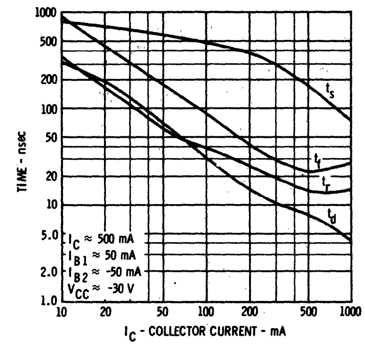
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT

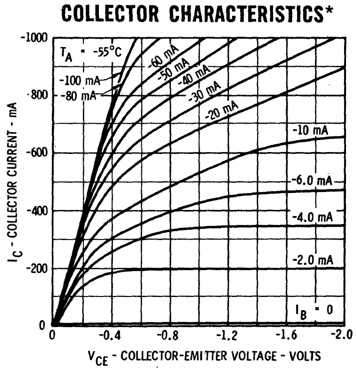


SWITCHING TIMES VERSUS COLLECTOR CURRENT

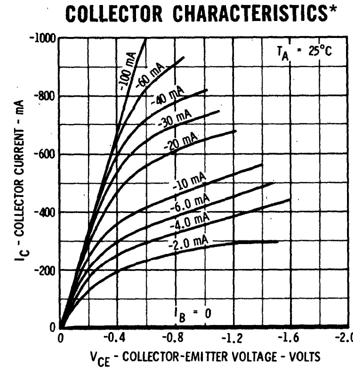


TYPICAL ELECTRICAL CHARACTERISTICS (All Types)

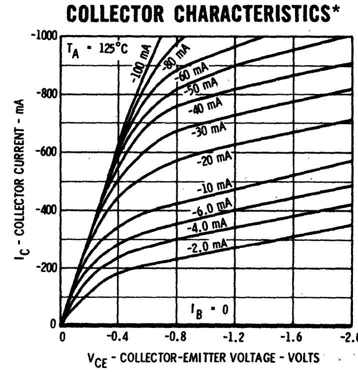
COLLECTOR CHARACTERISTICS*



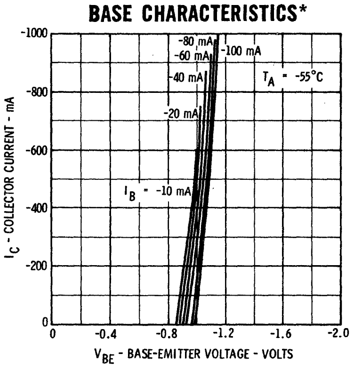
COLLECTOR CHARACTERISTICS*



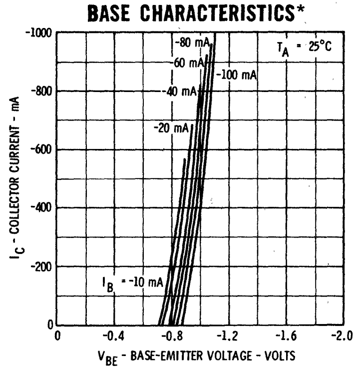
COLLECTOR CHARACTERISTICS*



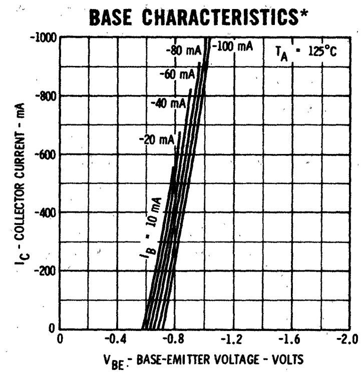
BASE CHARACTERISTICS*



BASE CHARACTERISTICS*



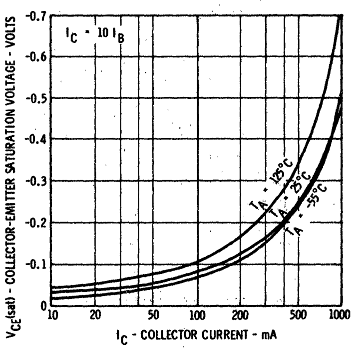
BASE CHARACTERISTICS*



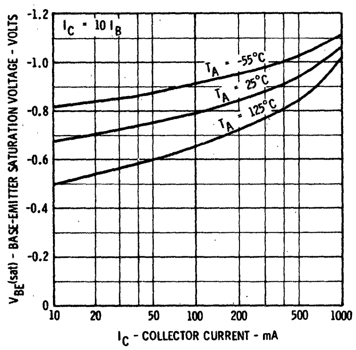
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS (All Types)

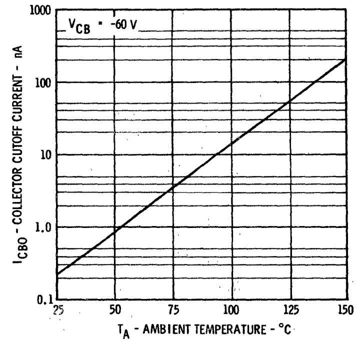
COLLECTOR-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



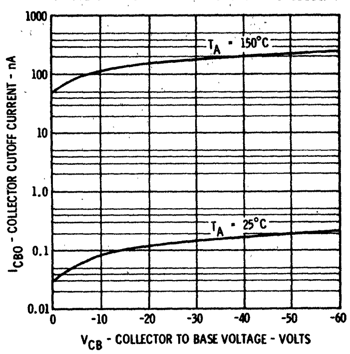
BASE-EMITTER SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



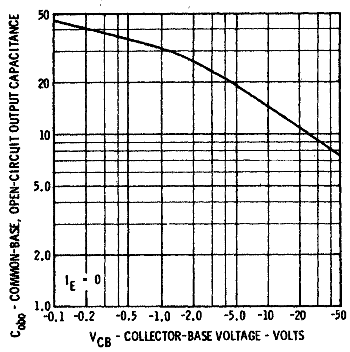
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



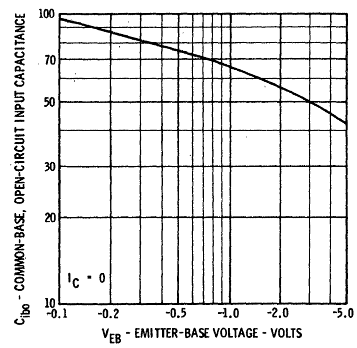
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



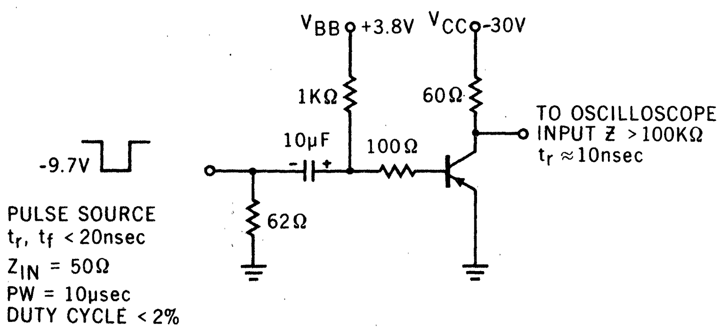
COMMON BASE OPEN CIRCUIT OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COMMON BASE OPEN CIRCUIT INPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



T_{on} AND T_{off} 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 give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 43.7°C/Watt (derating factor of 22.8 mW/°C); junction-to-ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).

(4) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

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

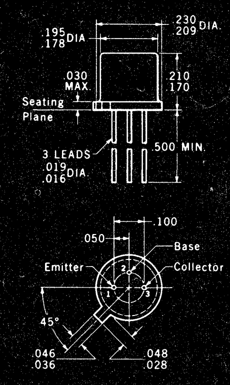
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N4034 • 2N4035

PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

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

GENERAL DESCRIPTION - The 2N4034 and 2N4035 are High-Gain Silicon PNP Transistors suitable for a wide range of applications including fast high-voltage switching, low noise, low-current requirements, and high-gain RF applications. Key performance parameters are: typical maximum available gain of 27 db at 100 Mc, low- and high-frequency noise figures of 3.5 db, and turn-on and turn-off times of 40 and 150 nsec respectively.

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)	1.0 Watt
at 25°C Ambient Temperature	(Notes 2 and 3)	0.36 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage		-40 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-40 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts
I_C	Collector Current		100 mA

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

Symbol	† FACT Subgroup	Characteristic	2N4034 Min.	2N4034 Typ.	2N4034 Max.	2N4035 Min.	2N4035 Typ.	2N4035 Max.	Units	Test Conditions
h_{FE}	4	DC Current Gain	20	50		70	100			I_C = 10 μA V_{CE} = -1.0 V
h_{FE}	4	DC Current Gain	50	90		140	180			I_C = 100 μA V_{CE} = -1.0 V
*h_{FE}	1a	DC Pulse Current Gain (Note 5)	70	150	200	150	200	300		I_C = 10 mA V_{CE} = -1.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	15	30		30	60			I_C = 50 mA V_{CE} = -1.0 V
*V_{CE}(sat)	1b	Collector Saturation Voltage (pulsed, Note 5)		-0.2	-0.3		-0.2	-0.3	Volts	I_C = 50 mA I_B = 5.0 mA
V_{CE}(sat)	4	Collector Saturation Voltage (pulsed, Note 5)		-0.1	-0.14		-0.1	-0.14	Volts	I_C = 10 mA I_B = 1.0 mA
*V_{BE}(sat)	1b	Base Saturation Voltage	-0.7	-0.77	-0.9	-0.7	-0.77	-0.9	Volts	I_C = 10 mA I_B = 1.0 mA
V_{CEO}(sust)	1a	Collector Emitter Sustaining Voltage (Notes 4 and 5)	-40			-40			Volts	I_C = 10 mA (pulsed) I_B = 0
h_{fe}	4	High Frequency Current Gain (f = 100 Mc)	4.0	5.5		4.5	6.0			I_C = 10 mA V_{CE} = -20 V
C_{obo}	4	Output Capacitance		2.2	3.5		2.2	3.5	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	4	Input Capacitance		4.0	5.5		4.0	5.5	pf	I_C = 0 V_{EB} = -0.5 V
NF	4	Noise Figure (f = 100 Mc)		3.5	6.0		3.5	6.0	db	I_C = 1.0 mA V_{CE} = -5.0 V; R_S = 100 Ω BW = 15 Mc
$r_b'c_c$	4	Collector Base Time Constant (f = 80 Mc)			40			40	psec	I_C = 10 mA V_{CE} = -20 V
t_{on}	4	Turn On Time (Note 6)		20	40		20	40	nsec	I_C ≈ 50 mA, I_{B1} ≈ 5.0 mA
t_{off}	4	Turn Off Time (Note 6)		95	150		95	150	nsec	I_C ≈ 50 mA, I_{B1} ≈ I_{B2} ≈ 5.0 mA

†NOTE: These Numerals Apply to the Fairchild FACT Program.

*NOTE: FACT Program End-Point Measurement Parameter.

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 175°C/Watt (derating factor of 5.71 mW/°C); junction-to ambient thermal resistance of 500°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. For more information send for Fairchild Publication APP-4/2.

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

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

FAIRCHILD SEMICONDUCTOR

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

FAIRCHILD TRANSISTORS 2N4034 • 2N4035

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

Symbol	†FACT Subgroup	Characteristic	2N4034 Min.	2N4034 Typ.	2N4034 Max.	2N4035 Min.	2N4035 Typ.	2N4035 Max.	Units	Test Conditions
h_{FE}	4	DC Current Gain	60	100		150	200			I_C = 1.0 mA V_{CE} = -1.0 V
h_{FE}(-55°C)	4	Pulse Current Gain (Note 5)	30	60		70	100			I_C = 10 mA V_{CE} = -1.0 V
V_{CE}(sat)	4	Collector Saturation Voltage		-0.07	-0.13		-0.07	-0.13	Volts	I_C = 1.0 mA I_B = 0.1 mA
V_{BE}(sat)	4	Base Saturation Voltage (pulsed, Note 5)		-0.88	-1.1		-0.88	-1.1	Volts	I_C = 50 mA I_B = 5.0 mA
V_{BE}(sat)	4	Base Saturation Voltage		-0.65	-0.75		-0.65	-0.75	Volts	I_C = 1.0 mA I_B = 0.1 mA
*I_{CES}	1b	Collector Reverse Current			15			15	nA	V_{CE} = -30 V V_{BE} = 0
I_{CES}(+125°C)	4	Collector Reverse Current			15			15	μA	V_{CE} = -30 V V_{BE} = 0
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-40			-40			Volts	I_C = 10 μA I_E = 0
BV_{CES}	1a	Collector to Emitter Breakdown Voltage	-40			-40			Volts	I_C = 10 μA V_{BE} = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-5.0			-5.0			Volts	I_C = 0 I_E = 10 μA

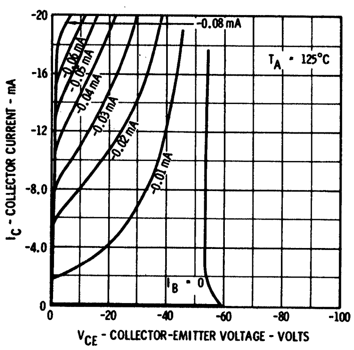
†NOTE: These Numerals Apply to the Fairchild FACT Program.
*NOTE: FACT Program End-Point Measurement Parameter.

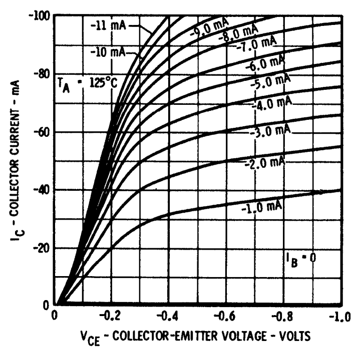
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

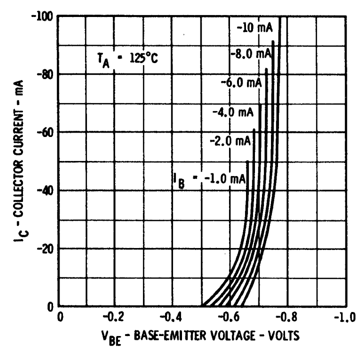
ACTIVE REGION

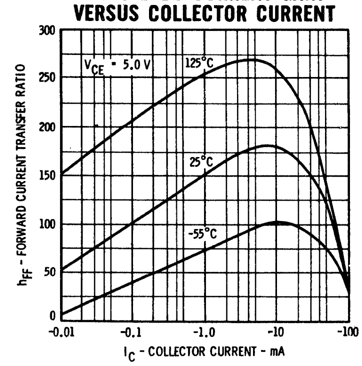
SATURATION REGION

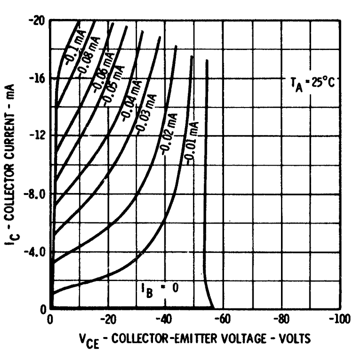
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

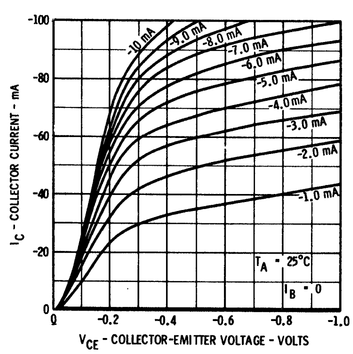


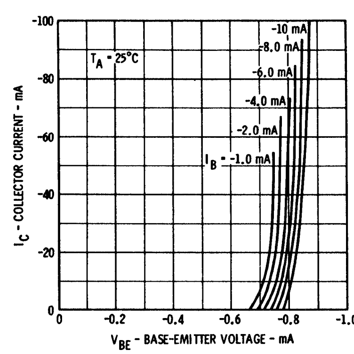




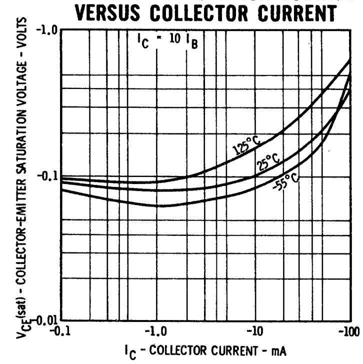


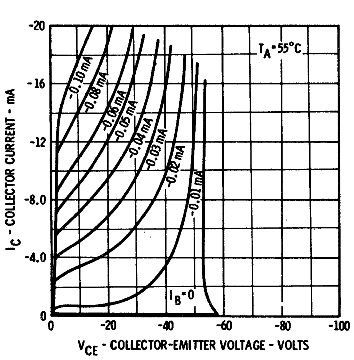


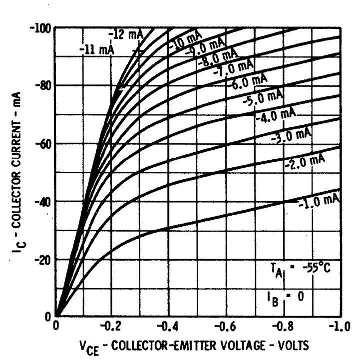


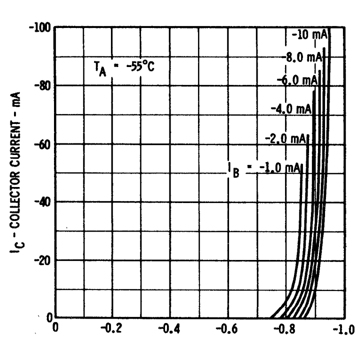


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

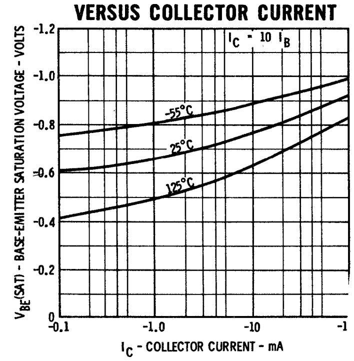






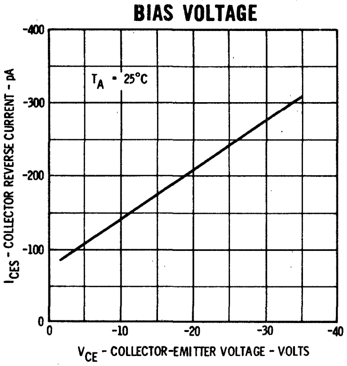


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

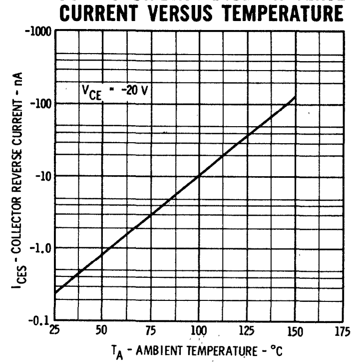


TYPICAL ELECTRICAL CHARACTERISTICS

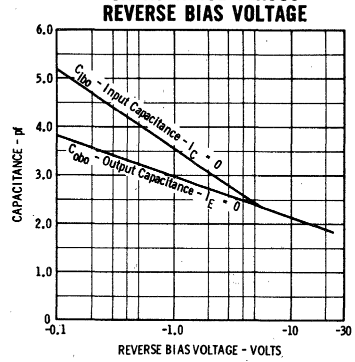
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



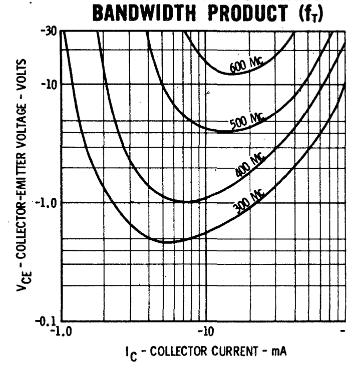
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



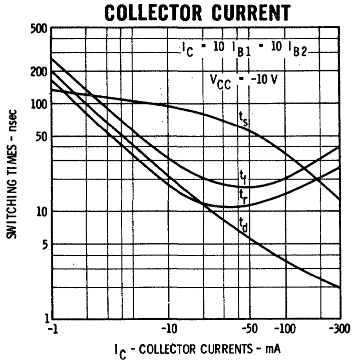
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



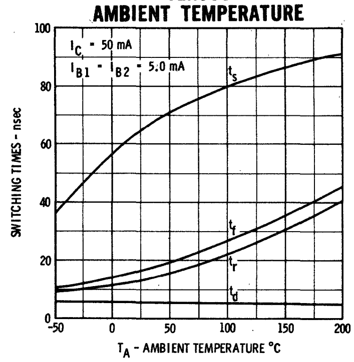
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



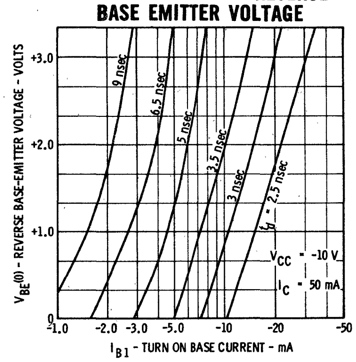
SWITCHING TIMES VERSUS COLLECTOR CURRENT



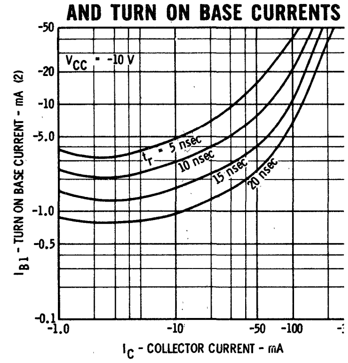
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



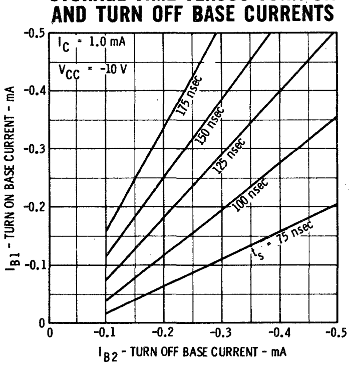
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



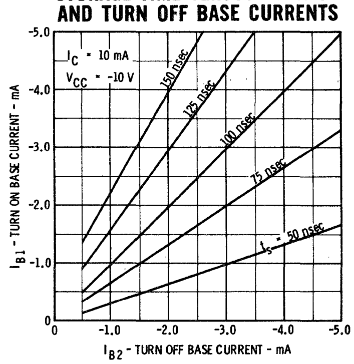
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



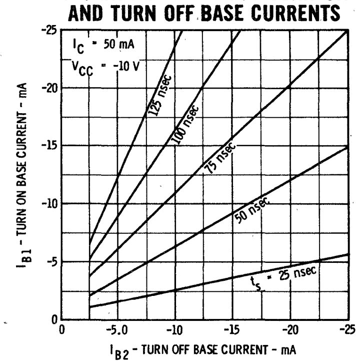
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



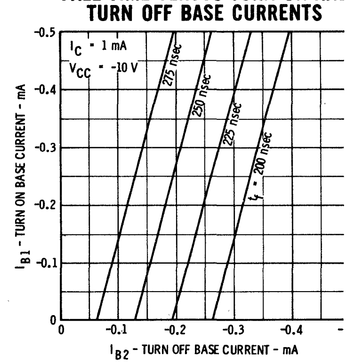
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



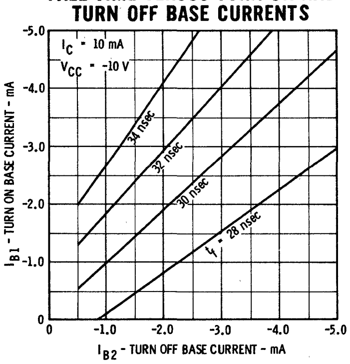
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



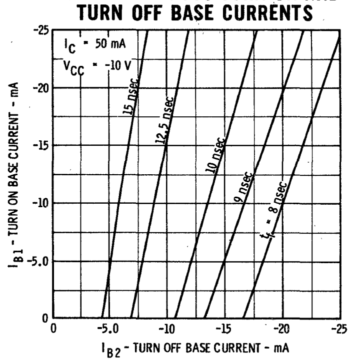
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



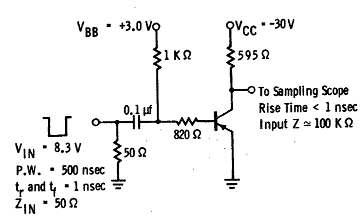
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

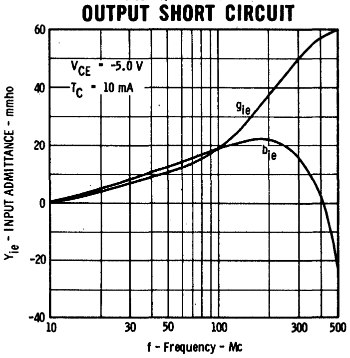


SWITCHING TIME TEST CIRCUIT

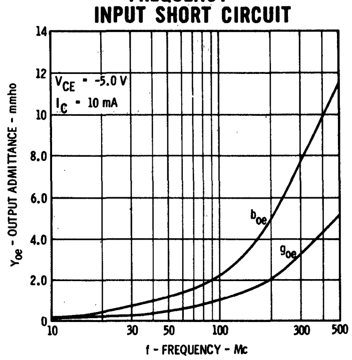


TYPICAL COMMON EMITTER "Y" PARAMETERS

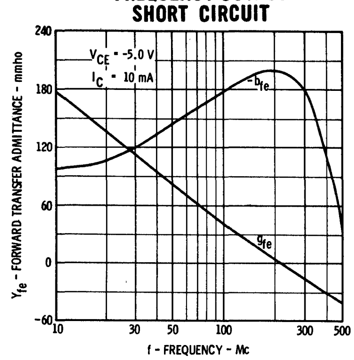
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



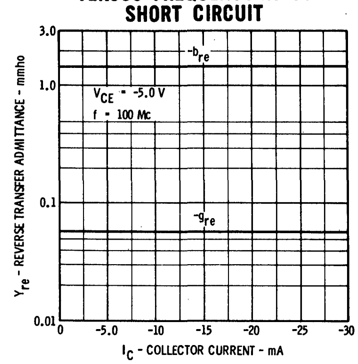
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



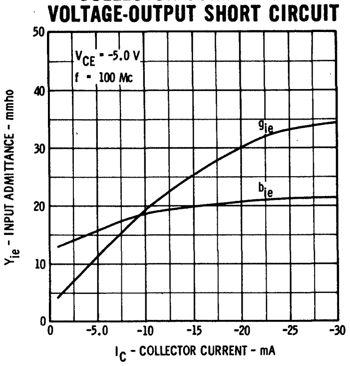
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



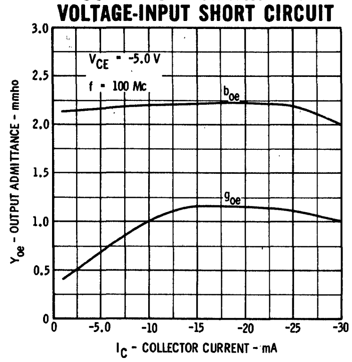
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



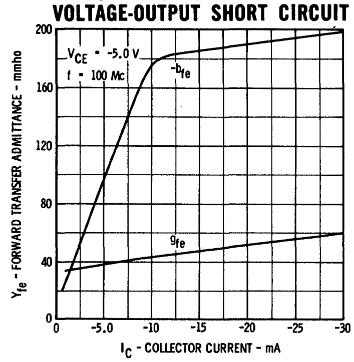
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



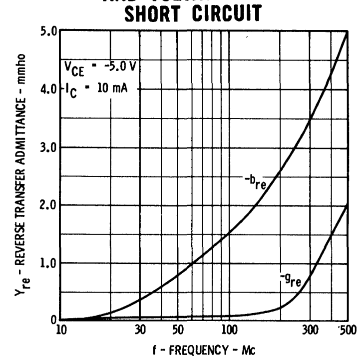
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



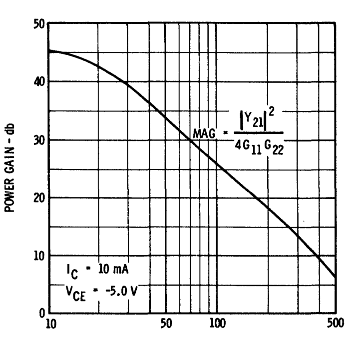
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



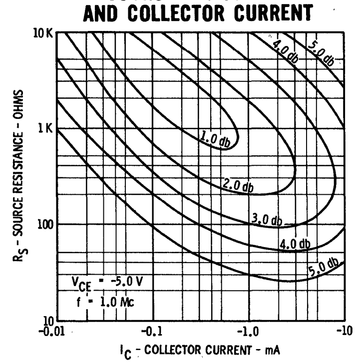
SMALL SIGNAL CHARACTERISTICS (f = 1 Kc)

Symbol	†FACT Subgroup	Characteristic	2N4034 Min.	2N4034 Max.	2N4035 Min.	2N4035 Max.	Units	Test Conditions
h_{ie}	4	Input Resistance	1.0	8.0	4.0	12	KΩ	I_C = 1.0 mA V_{CE} = 10 V
h_{oe}	4	Output Conductance	2.0	24	8.0	40	μmho	I_C = 1.0 mA V_{CE} = 10 V
h_{re}	4	Voltage Feedback Ratio		3.0		4.0	$x10^{-4}$	I_C = 1.0 mA V_{CE} = 10 V
h_{fe}	4	Forward Current Transfer Ratio	50	300	150	450		I_C = 1.0 mA V_{CE} = 10 V

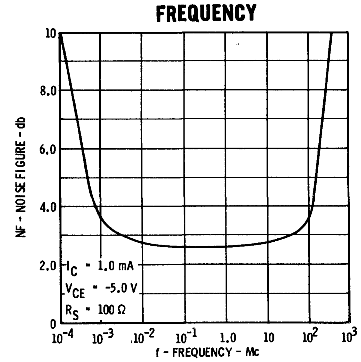
†NOTE: These Numerals Apply to the Fairchild FACT Program.



NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



NOISE FIGURE VERSUS FREQUENCY



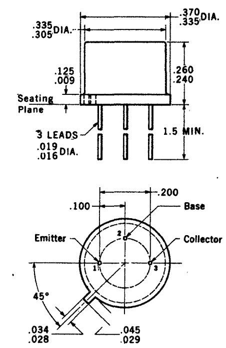
2N4046 • 2N4047

NPN HIGH-VOLTAGE, HIGH-CURRENT SWITCHES

SILICON PLANAR* EPITAXIAL TRANSISTORS

- **HIGH SPEED** . . . . **t_{on} = 35 ns (MAX) AT 500 mA**
  . . . . **t_{off} = 65 ns (MAX) AT 500 mA**
- **HIGH VOLTAGE** . . . . **LV_{CEO} = 30 V (MIN) (2N4046) OR 50 V (MIN) (2N4047)**
- **HIGH GAIN** . . . . **h_{FE} = 30 (MIN) AT 500 mA, 1.0 V**
  . . . . **h_{FE} = 25 (MIN) AT 1.0, 5.0 V**
- **LOW SATURATION VOLTAGE** . . . **V_{CE}(sat) = 0.65 V (MAX) AT 800 mA**
  . . . **V_{CE}(sat) = 0.75 V (MAX) AT 1.0A**

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65 °C to +200 °C
Operating Junction Temperature	+200 °C Maximum
Lead Temperature (Soldering, 60 second time limit)	+300 °C Maximum

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25 °C Case Temperature	3.5 Watts
at 25 °C Ambient Temperature	0.8 Watt

Maximum Voltages and Current		**2N4046**	**2N4047**
V_{CBO}	Collector to Base Voltage	50 Volts	80 Volts
V_{CES}	Collector to Emitter Voltage	50 Volts	80 Volts
V_{CEO}	**Collector to Emitter Voltage** (Note 4)	**30 Volts**	**50 Volts**
V_{EBO}	Emitter to Base Voltage	6.0 Volts	6.0 Volts
I_C	DC Collector Current	500 mA	500 mA

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

SYMBOL	CHARACTERISTICS	2N4046 MIN.	2N4046 TYP.	2N4046 MAX.	2N4047 MIN.	2N4047 TYP.	2N4047 MAX.	UNITS	TEST CONDITIONS	
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage**	**30**			**50**			**Volts**	**I_C = 10 mA** (pulsed)	I_B = 0
V_{CE}(sat)	**Collector Saturation Voltage** (Note 5)		**0.5**	**0.75**		0.6	0.95	**Volts**	**I_C = 1000 mA**(pulsed)	I_B = 100 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.3	0.42		0.4	0.52	Volts	I_C = 500 mA (pulsed)	I_B = 50 mA
t_{on}	**Turn-on Time** (Note 6)		**18**	**35**		**18**	**35**	**ns**	**$I_C \approx$ 500 mA**	**$I_{B1} \approx$ 50 mA**
t_{off}	**Turn-off Time** (Note 6)		**45**	**60**		**45**	**60**	**ns**	**$I_C \approx$ 500 mA,**	**$I_{B1} \approx$ 50 mA** $I_{B2} \approx$ −50 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	2.5	4.5		2.5	4.5			I_C = 50 mA	V_{CE} = 10 V
C_{obo}	Common Base, Open Circuit Output Capacitance		6.0	12		4.8	10	pF	I_E = 0	V_{CB} = 10 V
C_{ibo}	Common Base, Open Circuit Input Capacitance		40	55		40	55	pF	I_C = 0	V_{EB} = 0.5 V

Additional Electrical Characteristics on page 2
Notes on page 4

*Planar is a patented Fairchild process.

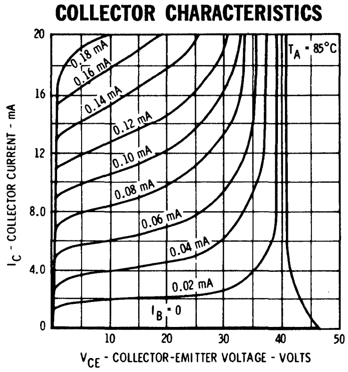
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

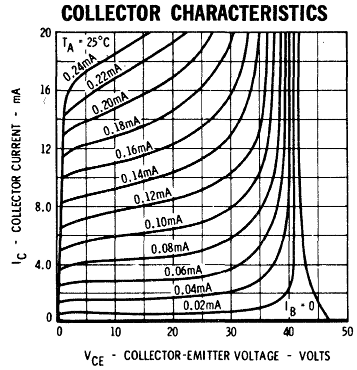
SYMBOL	CHARACTERISTICS	2N4046 MIN.	2N4046 TYP.	2N4046 MAX.	2N4047 MIN.	2N4047 TYP.	2N4047 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 5)	40	90	150	40	90	150		$I_C = 100$ mA	$V_{CE} = 1.0$ V
h_{FE}	**DC Pulse Current Gain** (Note 5)	**30**	**50**		20	45			**$I_C = 500$ mA**	**$V_{CE} = 1.0$ V**
h_{FE}	DC Pulse Current Gain (Note 5)	30	65		30	60			$I_C = 300$ mA	$V_{CE} = 1.0$ V
h_{FE}	**DC Pulse Current Gain** (Note 5)	**25**	**65**		15	65			**$I_C = 1000$ mA**	**$V_{CE} = 5.0$ V**
h_{FE}	DC Pulse Current Gain (Note 5)	20	60		20	60			$I_C = 10$ mA	$V_{CE} = 1.0$ V
h_{FE}	DC Pulse Current Gain (Note 5)	20	45		15	40			$I_C = 800$ mA	$V_{CE} = 2.0$ V
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.11	0.25		0.19	0.25	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.13	0.2		0.21	0.26	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.22	0.32		0.31	0.4	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{CE}(sat)	**Collector Saturation Voltage** (Note 5)		**0.4**	**0.65**		0.5	0.8	**Volts**	**$I_C = 800$ mA**	**$I_B = 80$ mA**
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.64	0.76		0.64	0.76	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.75	0.86		0.75	0.86	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		0.89	1.1		0.89	1.1	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)	0.9	0.95	1.2	0.9	0.95	1.2	Volts	$I_C = 500$ mA	$I_B = 50$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.0	1.5		1.0	1.5	Volts	$I_C = 800$ mA	$I_B = 80$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		1.1	1.7		1.1	1.7	Volts	$I_C = 1000$ mA	$I_B = 100$ mA
I_{CBO}	Collector Cutoff Current		0.25	1.7				µA	$I_E = 0$	$V_{CB} = 40$ V
I_{CBO}	Collector Cutoff Current					0.33	1.7	µA	$I_E = 0$	$V_{CB} = 60$ V
I_{CBO}(+85°C)	Collector Cutoff Current		25	120				µA	$I_E = 0$	$V_{CB} = 40$ V
I_{CBO}(+85°C)	Collector Cutoff Current					25	120	µA	$I_E = 0$	$V_{CB} = 60$ V
BV_{CBO}	Collector to Base Breakdown Voltage	50			80			Volts	$I_C = 10$ µA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	50			80			Volts	$I_C = 10$ µA	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			6.0			Volts	$I_C = 0$	$I_E = 10$ µA

TYPICAL ELECTRICAL CHARACTERISTICS
2N4046

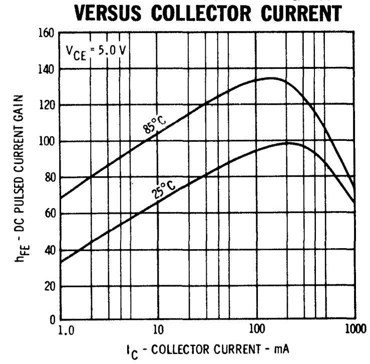
COLLECTOR CHARACTERISTICS



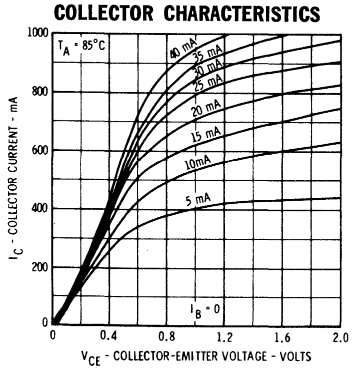
COLLECTOR CHARACTERISTICS



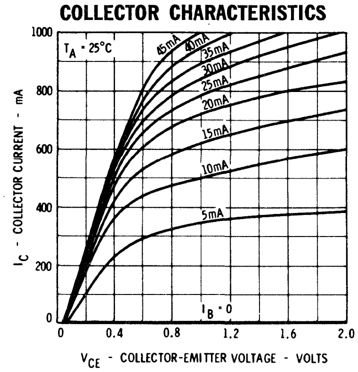
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



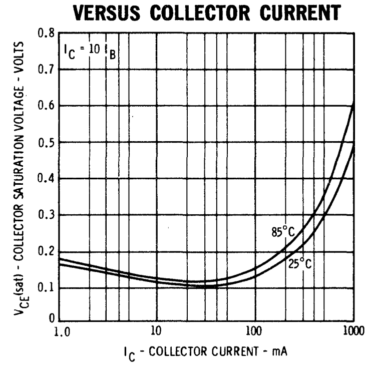
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



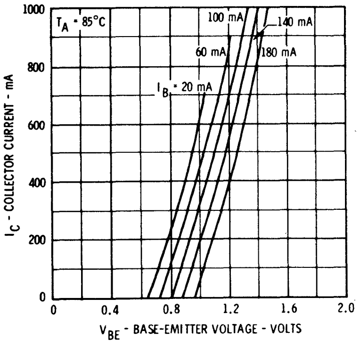
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



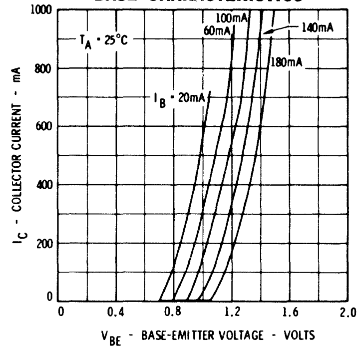
TYPICAL ELECTRICAL CHARACTERISTICS

2N4046 • 2N4047

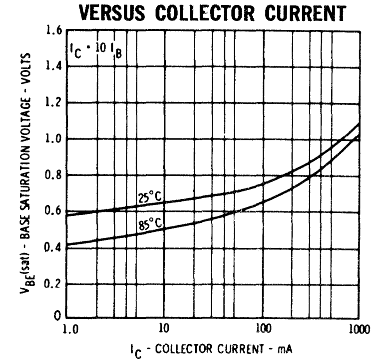
BASE CHARACTERISTICS



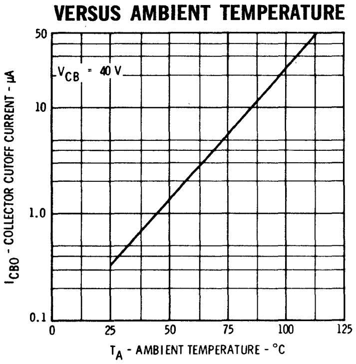
BASE CHARACTERISTICS



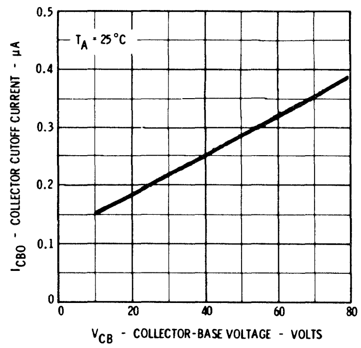
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



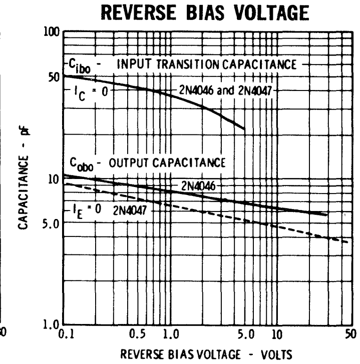
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



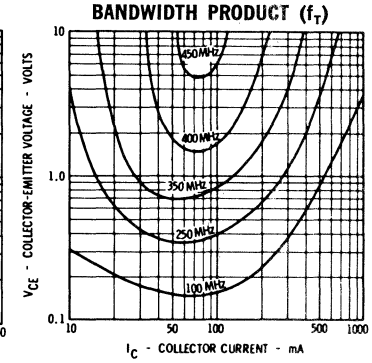
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

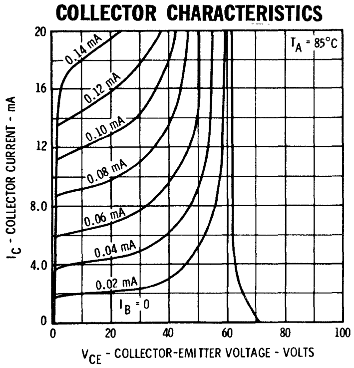


CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)

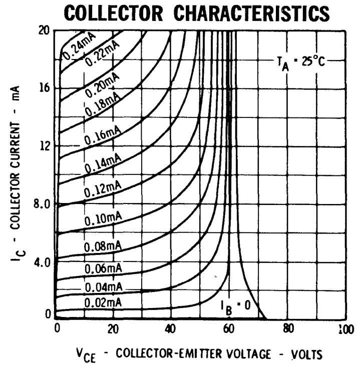


2N4047

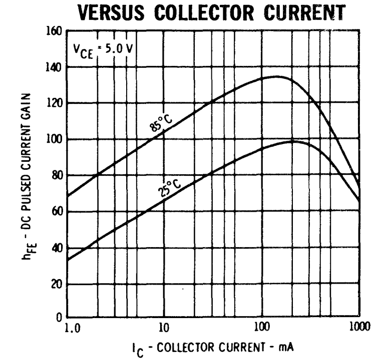
COLLECTOR CHARACTERISTICS



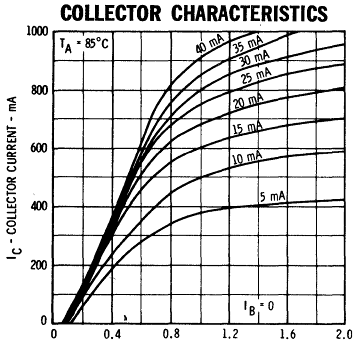
COLLECTOR CHARACTERISTICS



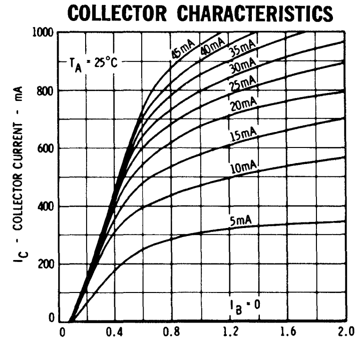
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



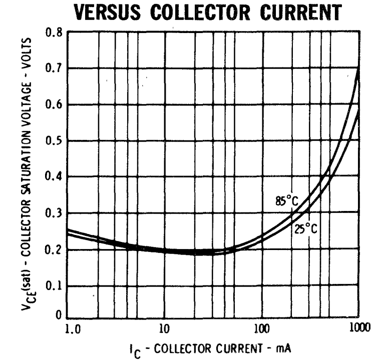
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



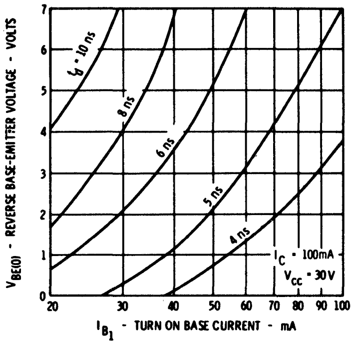
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



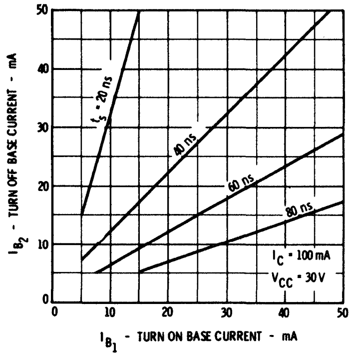
TYPICAL ELECTRICAL CHARACTERISTICS

2N4046 • 2N4047

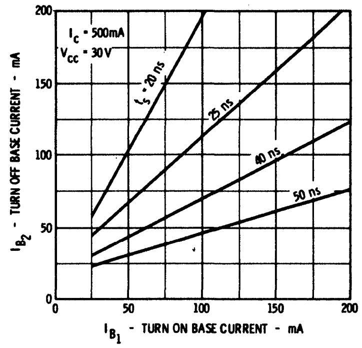
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



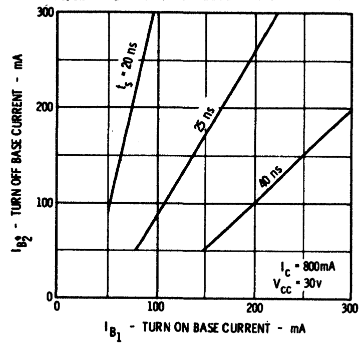
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



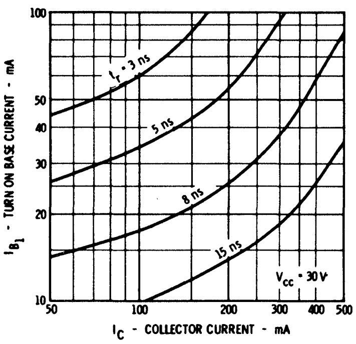
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



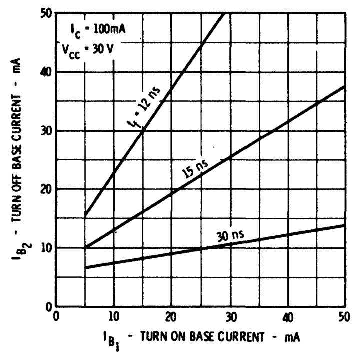
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



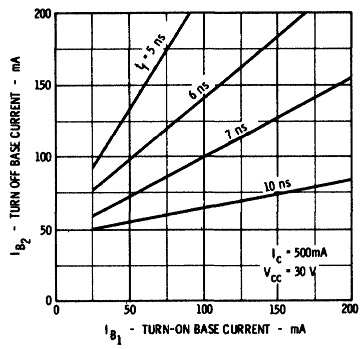
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



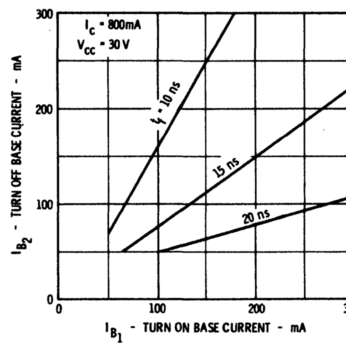
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



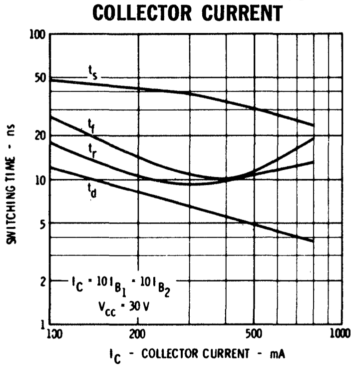
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



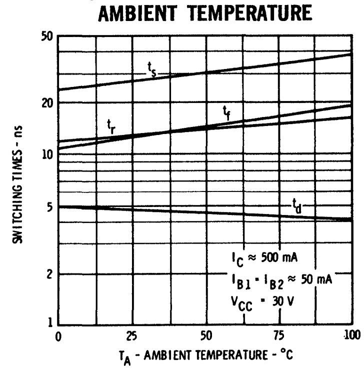
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



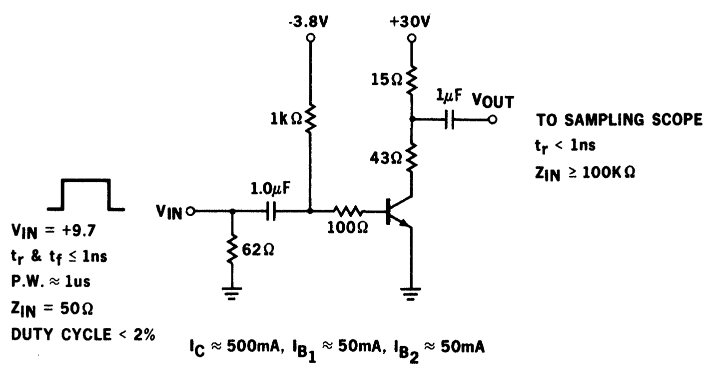
SWITCHING TIMES VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



SWITCHING TIME 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 give a maximum junction temperature of 200°C and junction to case thermal resistance of 50°C/Watt (derating factor of 20 mW/°C). Junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C).
(4) Ratings refer to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact value of I_C, I_{B1}, and I_{B2}.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

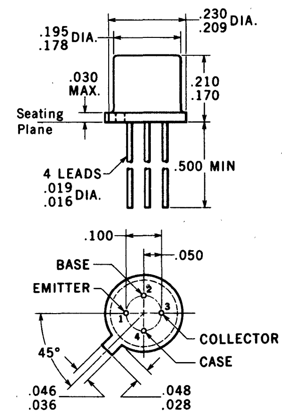
2N4134 • 2N4135

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**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-72)



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.47 gram

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

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

Notes on page 2

* Planar is a patented Fairchild process.

FAIRCHILD SEMICONDUCTOR
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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. For more information send for Fairchild Publication APP-4/2.

(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.

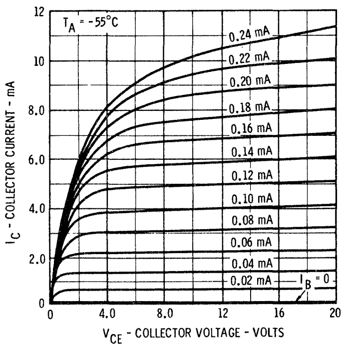
(6) Test conditions are as shown in Figure 2. Amplifier Gain is measured with amplifier input tuned for minimum noise figure. Neutralization is used to minimize input bandpass skewing. With neutralization network removed, amplifier gain will be 2 to 3 db lower, but noise figure will not change measurably.

(7) Test conditions are as shown in Figure 3.

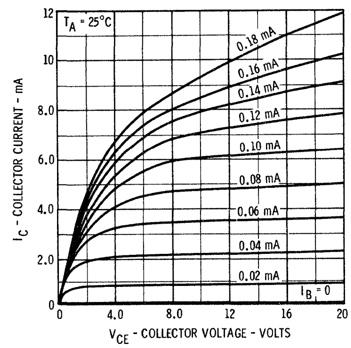
(8) Socket Capacitance is typically 0.5 pF and will degrade amplifier gain and stability. Best performance is obtained by omitting sockets and soldering or clipping transistor to the ground plane. If a socket is required, a shield should be used between the base and collector socket pins.

TYPICAL ELECTRICAL CHARACTERISTICS

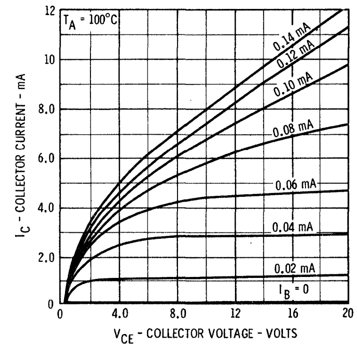
COLLECTOR CHARACTERISTICS*



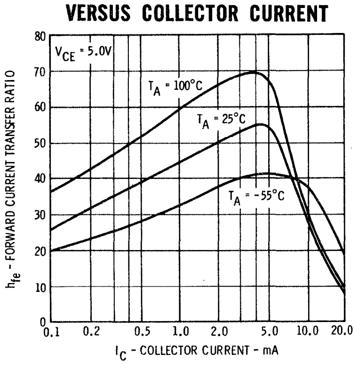
COLLECTOR CHARACTERISTICS*



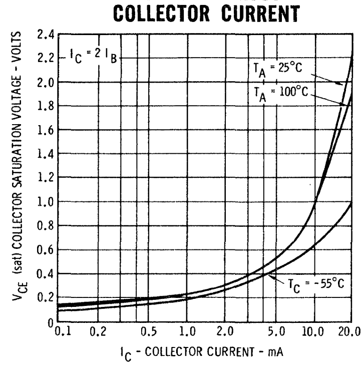
COLLECTOR CHARACTERISTICS*



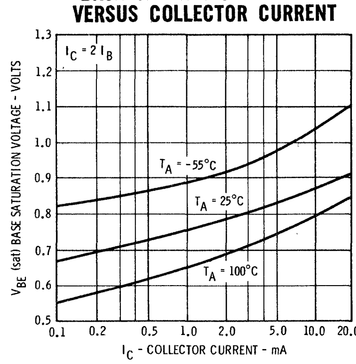
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



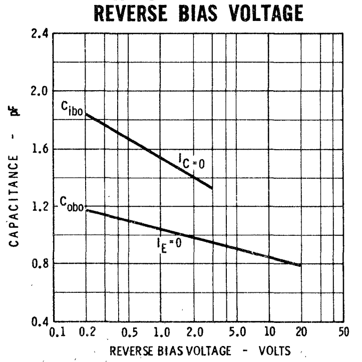
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



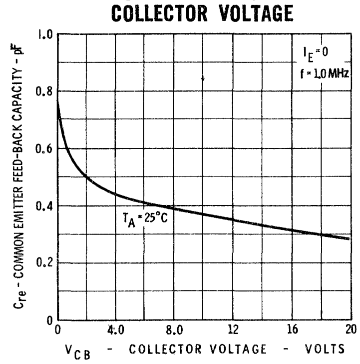
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



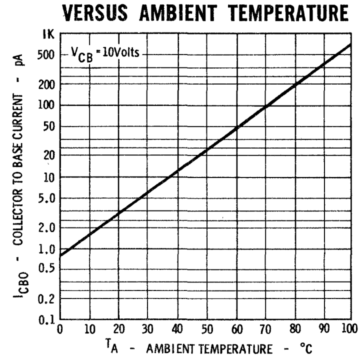
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COMMON EMITTER FEED-BACK CAPACITY VERSUS COLLECTOR VOLTAGE

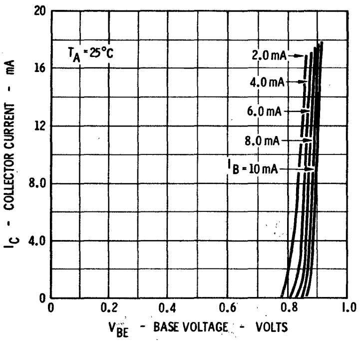


COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE

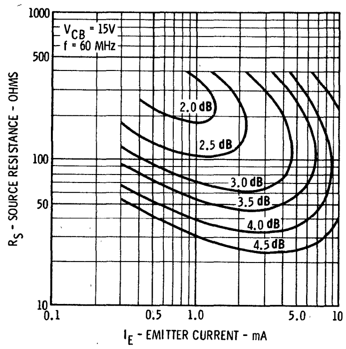


* Single family characteristic on Transistor Curve Tracer.

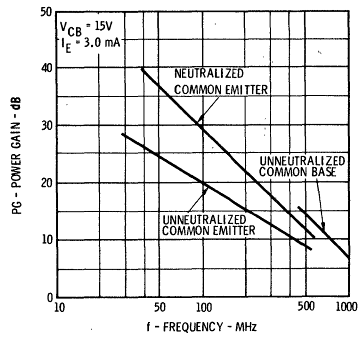
BASE CHARACTERISTICS*



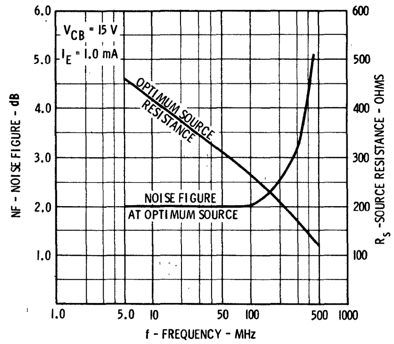
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



POWER GAIN VERSUS FREQUENCY

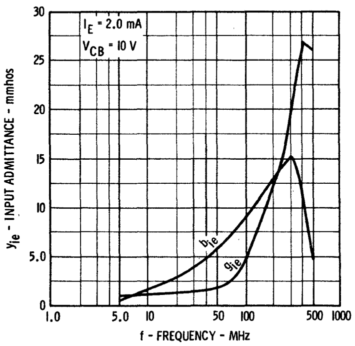


NOISE FIGURE AND SOURCE RESISTANCE VERSUS FREQUENCY

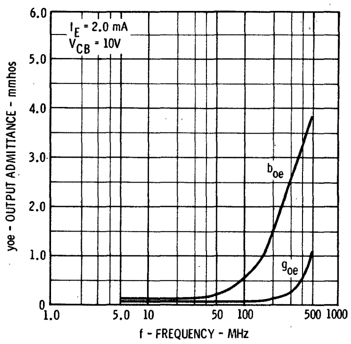


TYPICAL "Y" PARAMETERS

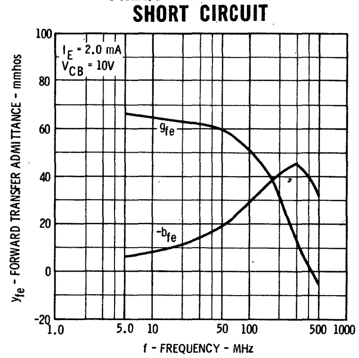
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



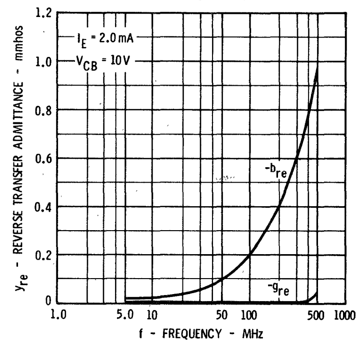
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



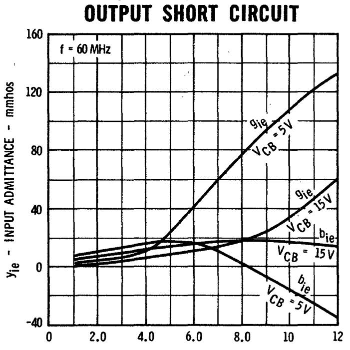
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



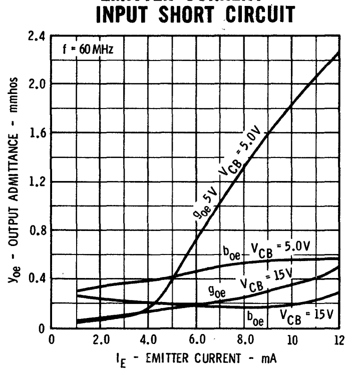
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



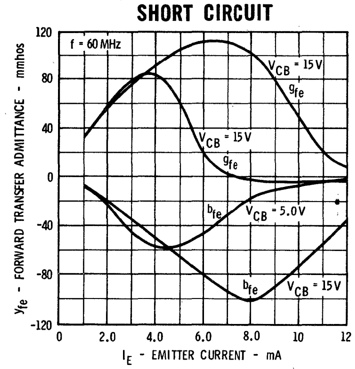
INPUT ADMITTANCE VERSUS EMITTER CURRENT — OUTPUT SHORT CIRCUIT



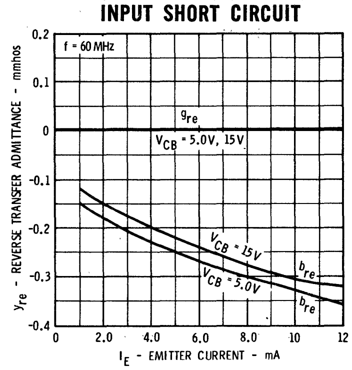
OUTPUT ADMITTANCE VERSUS EMITTER CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS EMITTER CURRENT — OUTPUT SHORT CIRCUIT



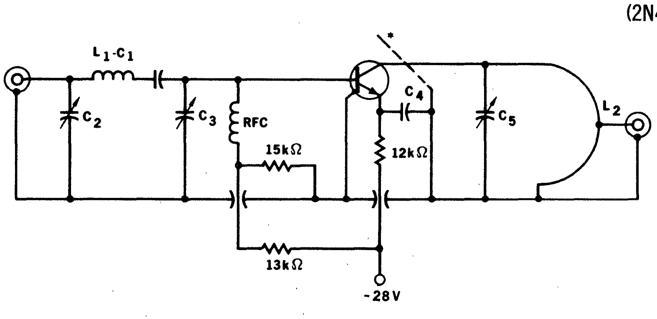
REVERSE TRANSFER ADMITTANCE VERSUS EMITTER CURRENT — INPUT SHORT CIRCUIT



* 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)

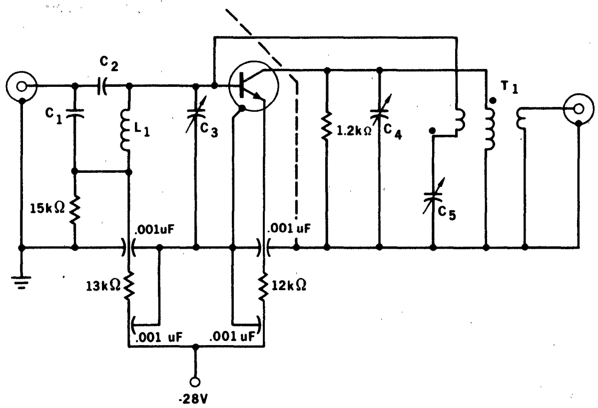
C_4 500 pF, UNCASED CERAMIC (CENTRALAB DA121 OR EQUIVALENT)

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

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

*See Note 8

FIG. 2 60 MHz NOISE FIGURE AND POWER GAIN CIRCUIT



C_1 - 62 pF DIPPED MICA CAPACITOR

C_2 - 51 pF DIPPED MICA CAPACITOR

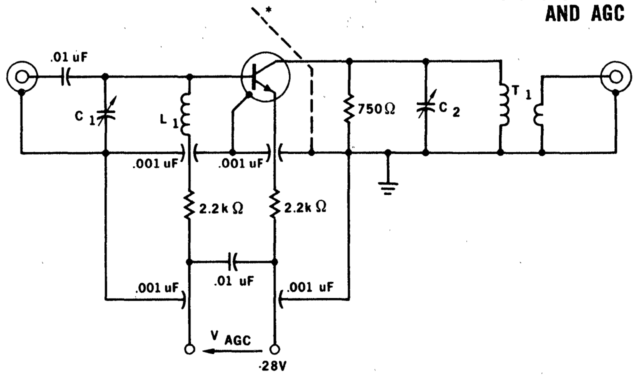
C_3, C_4, C_5 - 0.8 - 10pF, AIR VARIABLE, (JOHANSEN 2950 OR EQUIVALENT)

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



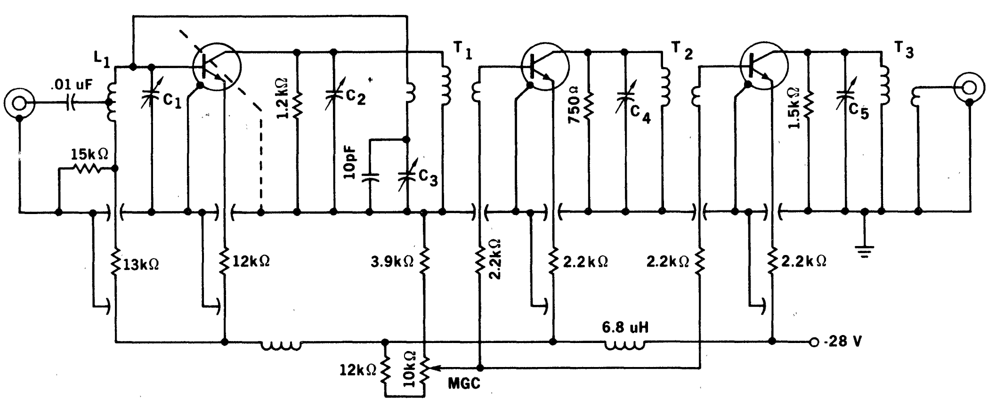
*See Note 8

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 dBAGC

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).

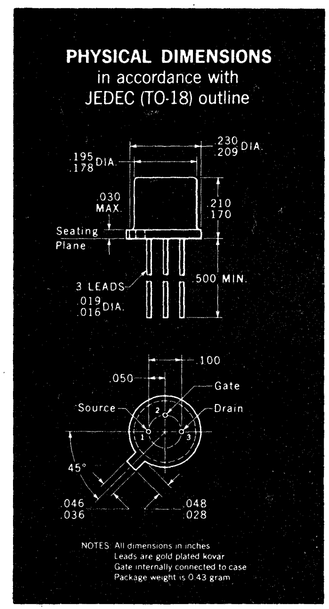
2N4137

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.**



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	FACT† Subgroup	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
*h_{FE}	1a	DC Pulse Current Gain [Note 5]	40	66	120		I_C = 10 mA	V_{CE} = 1.0 V
h_{FE} (−55°C)	4	**DC Pulse Current Gain [Note 5]**	**20**	**50**			**I_C = 10 mA**	**V_{CE} = 0.35 V**
*V_{BE} (sat)	1a	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)	4	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)	4	Pulsed Base Saturation Voltage [Note 5]		0.9	1.15	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE} (sat)	4	Pulsed Base Saturation Voltage [Note 5]		1.1	1.6	Volts	I_C = 100 mA	I_B = 10 mA
***V_{CE} (sat)**	1a	**Pulse Collector Saturation Voltage (125°C)** [Note 5]		**0.19**	**0.3**	**Volts**	**I_C = 10 mA**	I_B = 1.0 mA
*I_{CES}	1b	Collector Reverse Current		0.05	0.4	μA	V_{BE} = 0	V_{CE} = 20 V
I_{CBO} (150°C)	4	Collector Cutoff Current		10	30	μA	I_E = 0	V_{CB} = 20 V
BV_{CES}	4	Collector to Emitter Breakdown Voltage	40			Volts	I_C = 10 μA	V_{BE} = 0
BV_{CBO}	1a	Collector to Base Breakdown Voltage	40			Volts	I_C = 10 μA	I_E = 0
V_{CEO} (sust)	1a	**Collector to Emitter Sustaining Voltage** [Notes 4 and 5]	**20**			**Volts**	**I_C = 10 mA** (pulsed)	I_B = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	4.5			Volts	I_E = 10 μA	I_C = 0

† NOTE: These Numerals Apply to the Fairchild FACT Program.
* NOTE: FACT Program End-Point Measurement Parameter.

Additional Electrical Characteristics on page 2

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. For more information send for Fairchild Publication APP-4.

(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

FAIRCHILD TRANSISTOR 2N4137

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

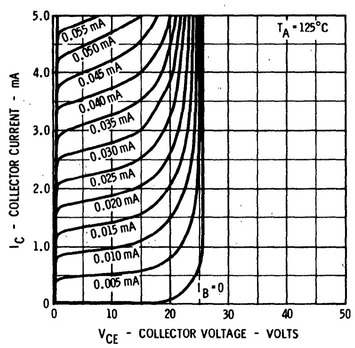
SYMBOL	FACT† Subgroup	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	4	**DC Pulse Current Gain** [Note 5]	**40**	**63**	**120**		**$I_C = 10$ mA**	**$V_{CE} = 0.35$ V**
h_{FE}	4	DC Pulse Current Gain [Note 5]	30	71			$I_C = 30$ mA	$V_{CE} = 0.4$ V
h_{FE}	4	DC Pulse Current Gain [Note 5]	20				$I_C = 100$ mA	$V_{CE} = 1.0$ V
V_{CE} (sat)	4	**Pulsed Collector Saturation Voltage** [Note 5]		**0.14**	**0.2**	**Volts**	**$I_C = 10$ mA**	$I_B = 1.0$ mA
V_{CE} (sat)	4	**Pulsed Collector Saturation Voltage [Note 5]**		0.12	0.18	Volts	$I_C = 10$ mA	$I_B = 3.3$ mA
V_{CE} (sat)	4	Pulsed Collector Saturation Voltage [Note 5]		0.17	0.25	Volts	$I_C = 30$ mA	$I_B = 3.0$ mA
V_{CE} (sat)	4	Pulsed Collector Saturation Voltage [Note 5]		0.28	0.5	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE} (sat)	4	Pulsed Base Saturation Voltage [Note 5]	0.74	0.85	1.0	Volts	$I_C = 10$ mA	$I_B = 3.3$ mA
h_{fe}	4	**High Frequency Current Gain (f = 100 mc)**	**5.0**	**6.75**			**$I_C = 10$ mA**	$V_{CE} = 10$ V
C_{ob}	4	**Output Capacitance**		2.3	**4.0**	**pf**	$I_E = 0$	**$V_{CB} = 5.0$ V**
τ_S	4	**Charge Storage Time Constant** [Note 6]		**6.0**	13	**nsec**	**$I_C = I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA**	
t_{on}	4	Turn On Time [Note 6]		9.0	12	nsec	$I_C \approx 10$ mA	$I_{B1} \approx 3.3$ mA
t_{off}	4	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	

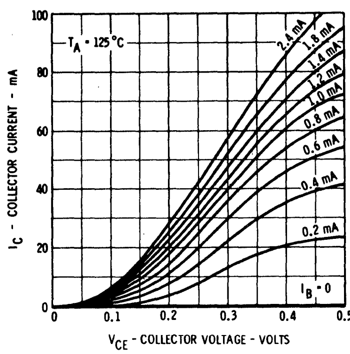
† NOTE: These Numerals Apply to the Fairchild FACT Program.

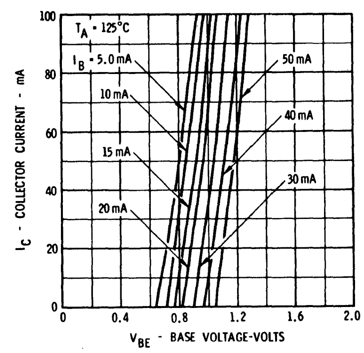
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

ACTIVE REGION

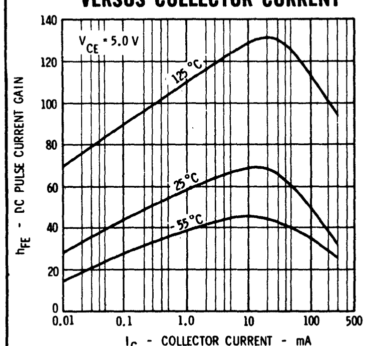
SATURATION REGION

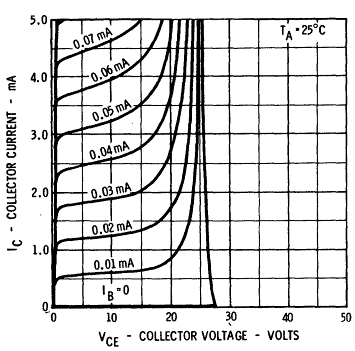


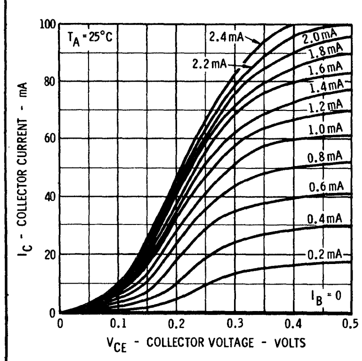


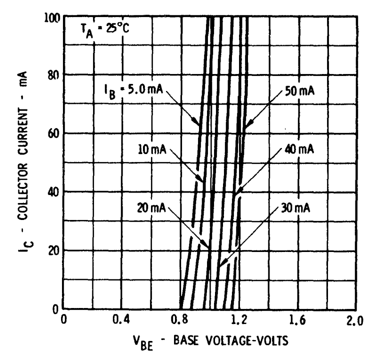


PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

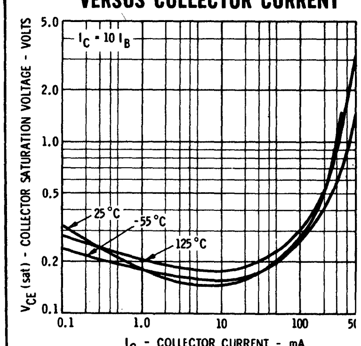


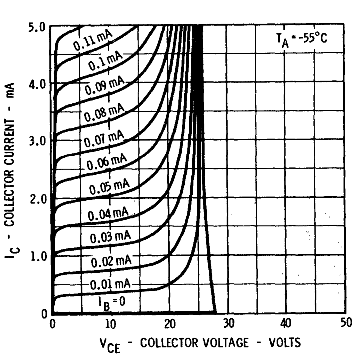


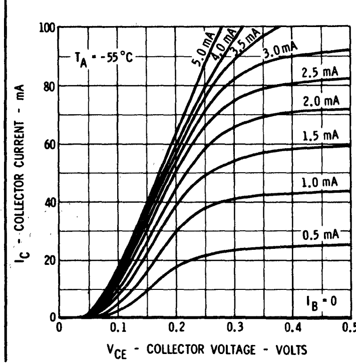


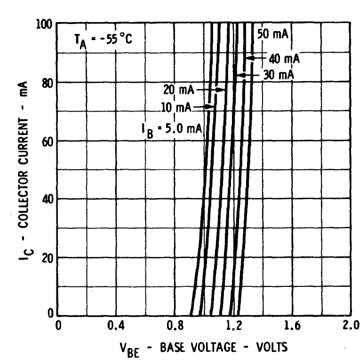


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

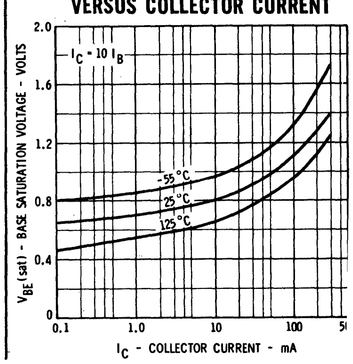






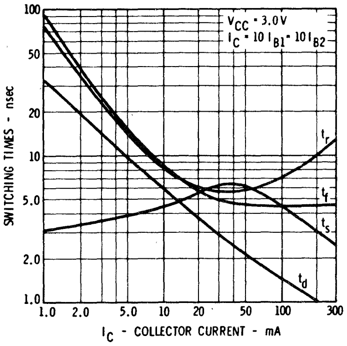


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

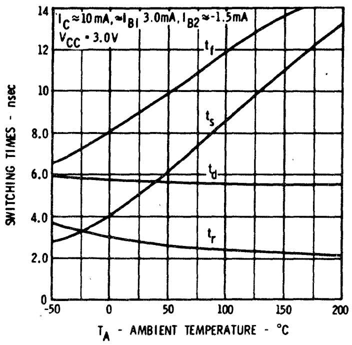


TYPICAL ELECTRICAL CHARACTERISTICS

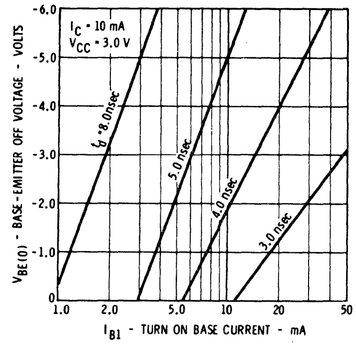
SWITCHING TIMES VERSUS COLLECTOR CURRENT



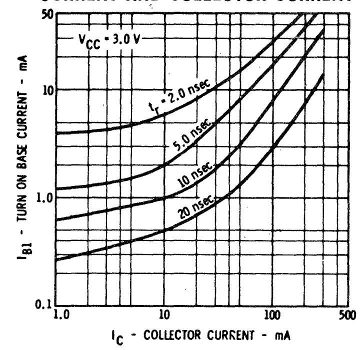
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



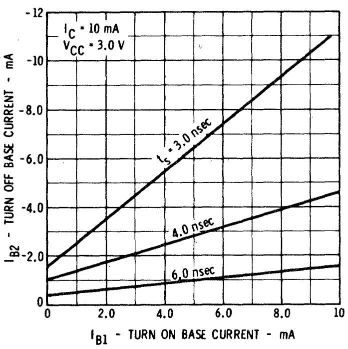
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



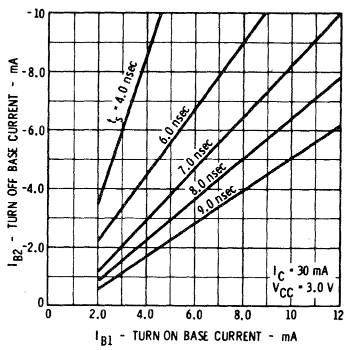
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



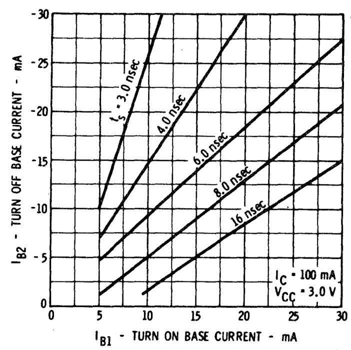
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



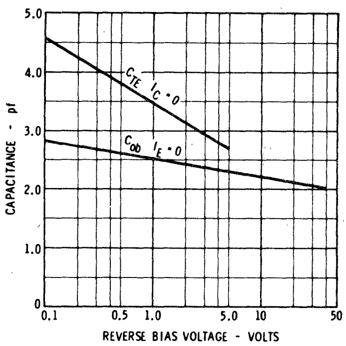
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



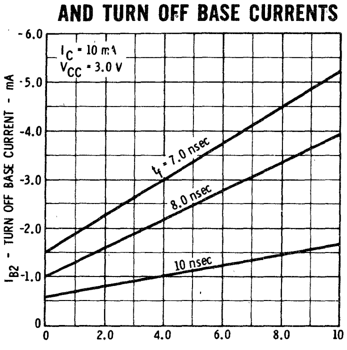
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



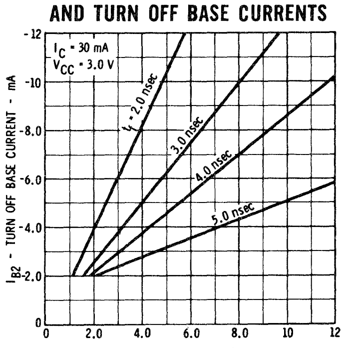
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



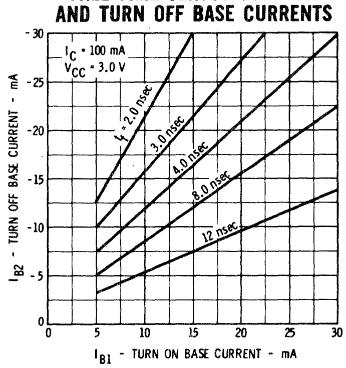
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



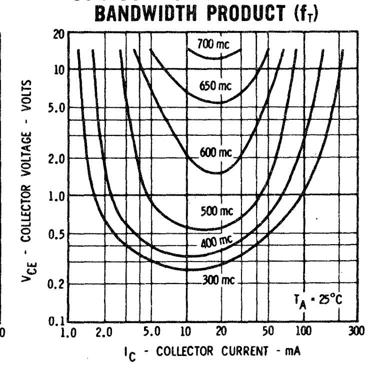
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



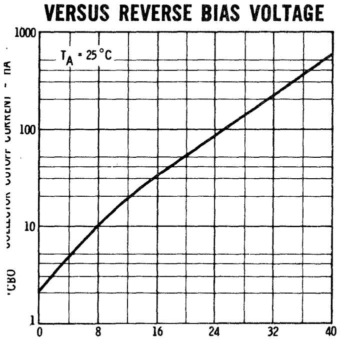
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



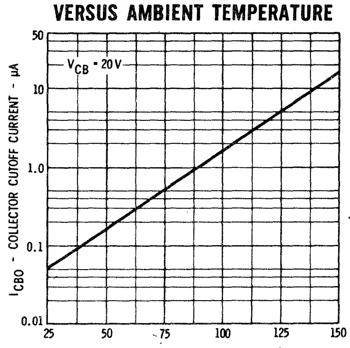
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



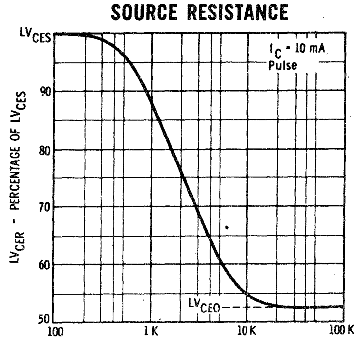
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



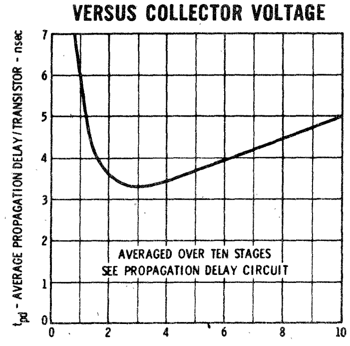
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



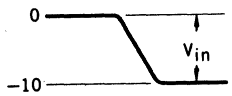
LOWER LIMITING VOLTAGE VERSUS SOURCE RESISTANCE



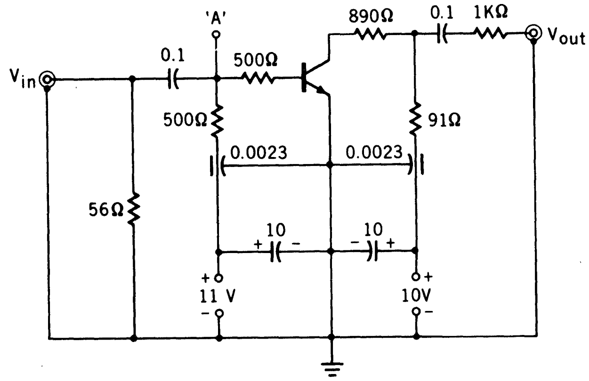
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE

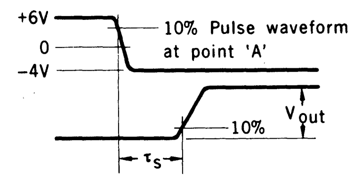


CHARGE STORAGE TIME MEASUREMENT CIRCUIT



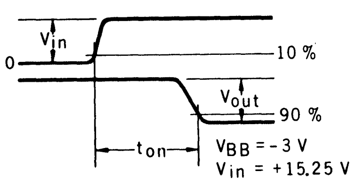
Pulse Generator
V_{in} Rise Time < 1 nsec
Source Impedance = 50Ω
PW ≥ 300 nsec
Duty Cycle < 2 %



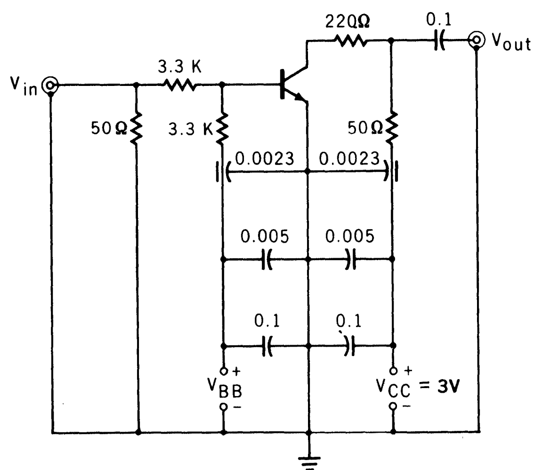


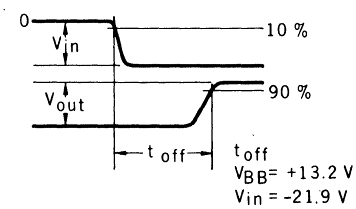
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 nsec

t_{ON} — t_{OFF} MEASUREMENT CIRCUIT



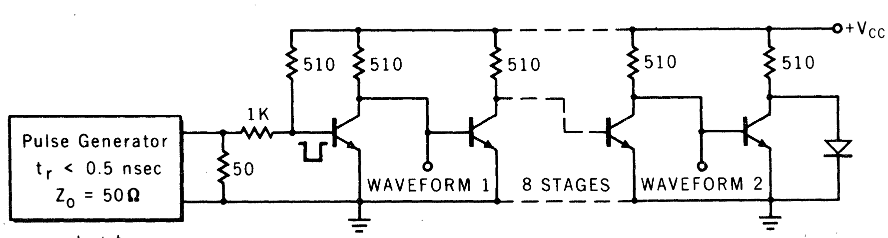
Pulse Generator
V_{in} Rise Time < 1 nsec
Source Impedance = 50Ω
PW ≥ 300 nsec
Duty Cycle < 2 %

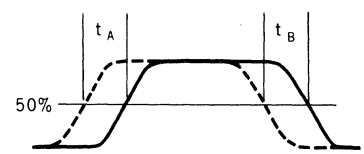




To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 nsec

CIRCUIT FOR MEASUREMENT OF PROPAGATION DELAY





Waveforms 1 and 2 Superimposed

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

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

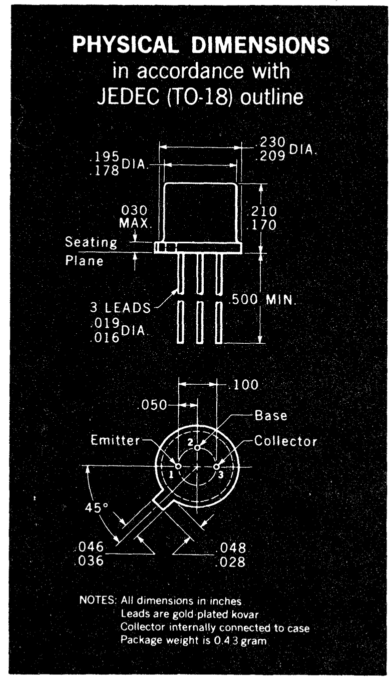
FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N4207 • 2N4208 • 2N4209

PNP ULTRA HIGH-SPEED SWITCHES

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTORS

- **ULTRA-FAST SWITCHING TIME -- t_{off} = 20 ns MAX.**
- **LOW CAPACITY -- C_{obo} = 3.0 pF MAX. and C_{ibo} = 3.5 pF MAX.**
- **HIGH FREQUENCY -- f_T = 850 MHz MIN.**
- **LOW SATURATION VOLTAGE -- $V_{CE}(sat)$ = 0.18 V MAX. @ I_C = 10 mA**
- **HIGH BREAKDOWN VOLTAGE -- LV_{CEO} = 15 V MIN.**



ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

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

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	0.7 Watt
at 25°C Ambient Temperature [Notes 2 and 3]	0.35 Watt

Maximum Voltages and Current for Each Transistor

		2N4207	2N4208	**2N4209**
V_{CBO}	Collector to Base Voltage	−6.0 Volts	−12 Volts	−15 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	−6.0 Volts	−12 Volts	−15 Volts
V_{EBO}	Emitter to Base Voltage	−4.5 Volts	−4.5 Volts	−4.5 Volts
I_C	Collector Current	50 mA	50 mA	50 mA

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

SYMBOL	CHARACTERISTIC	2N4207 MIN.	2N4207 TYP.	2N4207 MAX.	2N4208 MIN.	2N4208 TYP.	2N4208 MAX.	**2N4209** MIN.	**2N4209** TYP.	**2N4209** MAX.	UNITS	TEST CONDITIONS
τ_s	Charge Storage Time [Note 6]		12	15		16	20		16	20	ns	I_C = 10 mA I_{B1} = I_{B2} = 10 mA
t_{on}	**Turn On Time** [Note 6]		11	15		11	15		**11**	**15**	**ns**	**I_C = 10 mA I_{B1} = 1.0 mA**
t_{off}	**Turn Off Time** [Note 6]		11	15		14	20		**14**	**20**	**ns**	**I_C = 10 mA I_{B1} = I_{B2} = 1.0 mA**
C_{obo}	**Common Base, Open Circuit Output Capacitance**		2.0	3.0		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		**2.4**	**3.5**	**pF**	I_C = 0 **V_{EB} = −0.5 V**
h_{fe}	High Frequency Current Gain (f = 100 MHz)	6.5	11									I_C = 10 mA V_{CE} = −5.0 V
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**				7.0	13		**8.5**	**13**			**I_C = 10 mA V_{CE} = −10 V**
h_{FE}	DC Current Gain	35	85		15	60		35	60			I_C = 1.0 mA V_{CE} = −0.5 V
h_{FE}	**DC Pulse Current Gain** [Note 5]	50	100	120	30	67	120	**50**	**67**	**120**		**I_C = 10 mA** V_{CE} = −0.3 V
h_{FE}	DC Pulse Current Gain [Note 5]	40	75		30	60		40	60			I_C = 50 mA V_{CE} = −1.0 V
h_{FE} (−55°C)	**DC Pulse Current Gain** [Note 5]	20	50		12	40		**20**	**40**			**I_C = 10 mA** V_{CE} = −0.3 V

Additional Electrical Characteristics on page 2

* Planar is a patented Fairchild process.

NOTES:

1) These ratings are limiting values above which the serviceability of any 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 ambient thermal resistance of 500°C/watt (derating factor of 2.3 mW/°C). Junction to case thermal resistance of 250°C/watt (derating factor of 4.57 mW/°C).
4) Rating refers to a high current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
6) See switching circuit for exact values of I_C, I_{B1} and I_{B2}.

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

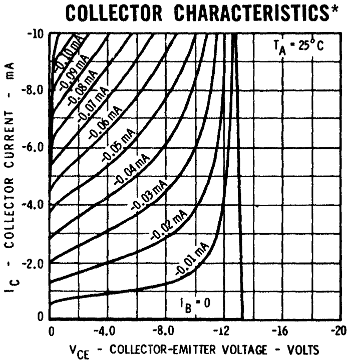
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N4207 MIN.	2N4207 TYP.	2N4207 MAX.	2N4208 MIN.	2N4208 TYP.	2N4208 MAX.	**2N4209** MIN.	**2N4209** TYP.	**2N4209** MAX.	UNITS	TEST CONDITIONS	
V_{CE} (sat)	Collector Saturation Voltage		—.07	−0.13		—.07	−0.13		—.07	−0.15	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{CE} (sat)	**Pulsed Collector Saturation Voltage** [Note 5]		—.08	−0.15		—.08	−0.15		—.08	**−0.18**	**Volts**	**$I_C = 10$ mA**	$I_B = 1.0$ mA
V_{CE} (sat)	Pulsed Collector Saturation Voltage (Note 5)		—0.2	−0.5		−0.25	−0.5		−0.25	−0.6	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{BE} (sat)	Base Saturation Voltage		−0.73	−0.8		−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	−0.8	−0.88	−0.95	−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		−1.15	−1.5		−1.15	−1.5		−1.15	−1.5	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CES}	Collector Reverse Current		0.020	10							nA	$V_{CE} = -3.0$ V	$V_{BE} = 0$
I_{CES}	Collector Reverse Current					0.048	10				nA	$V_{CE} = -6.0$ V	$V_{BE} = 0$
I_{CES}	Collector Reverse Current								0.068	10	nA	$V_{CE} = -8.0$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current		0.012	5.0							μA	$V_{CE} = -3.0$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current					0.012	5.0				μA	$V_{CE} = -6.0$ V	$V_{BE} = 0$
I_{CES} (125°C)	Collector Reverse Current								0.012	5.0	μA	$V_{CE} = -8.0$ V	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.5			−4.5			−4.5			Volts	$I_C = 0$	$I_E = 100$ μA
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** [Note 4]	−6.0			−12			**−15**			**Volts**	**$I_C = 3.0$ mA**	$I_B = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−6.0			−12			−15			Volts	$I_C = 100$ μA	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−6.0			−12			−15			Volts	$I_C = 100$ μA	$I_B = 0$

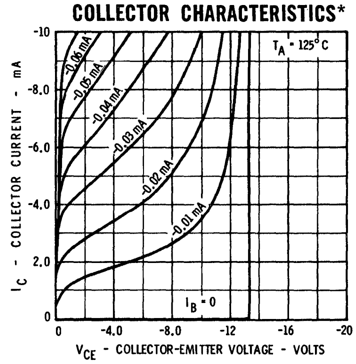
TYPICAL ELECTRICAL CHARACTERISTICS

2N4207

COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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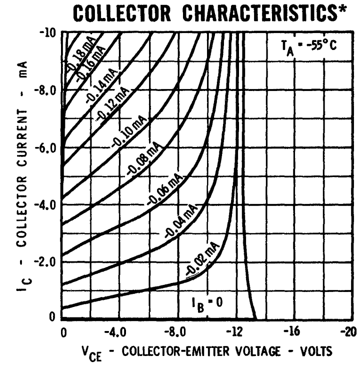
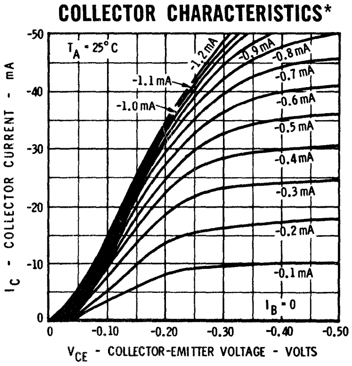
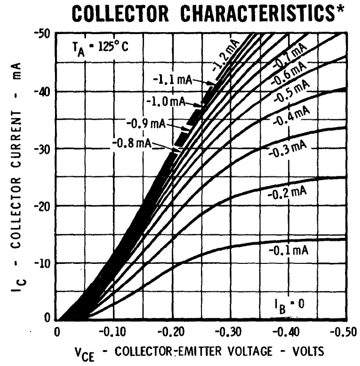


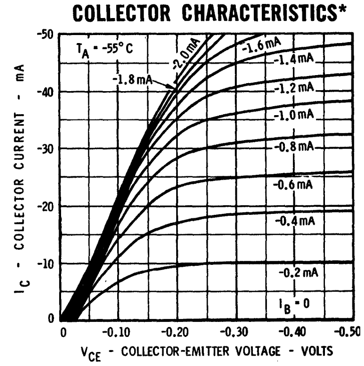
COLLECTOR CHARACTERISTICS*



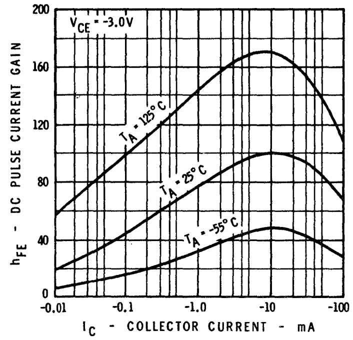
COLLECTOR CHARACTERISTICS*



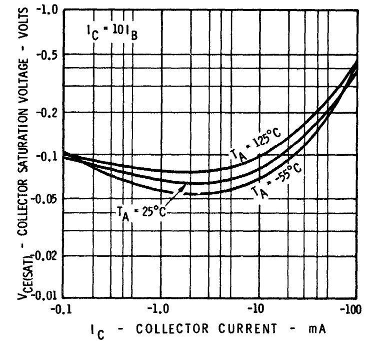
COLLECTOR CHARACTERISTICS*



DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



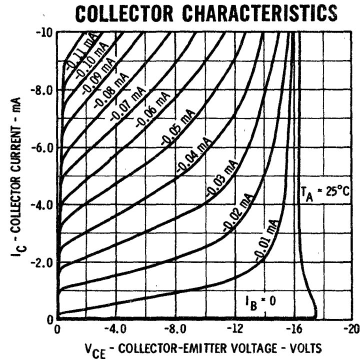
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



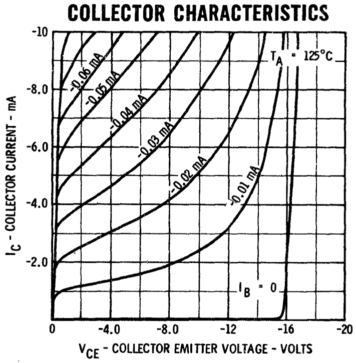
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS
2N4208 • 2N4209

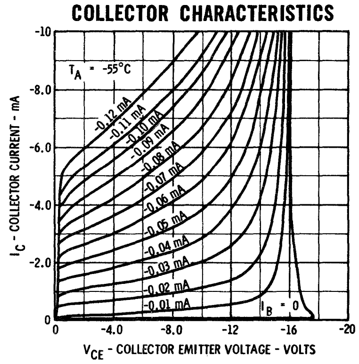
COLLECTOR CHARACTERISTICS



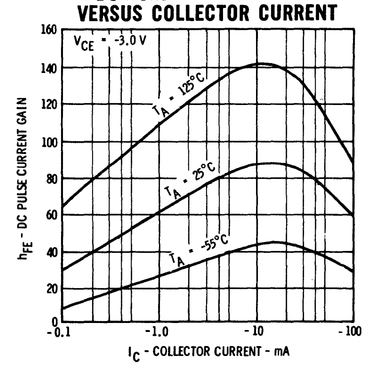
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



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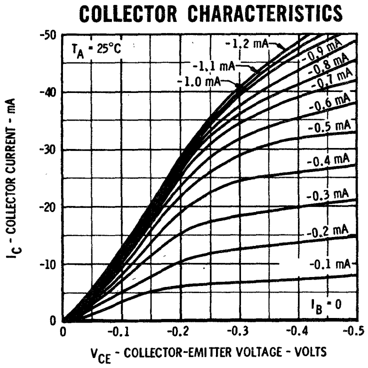

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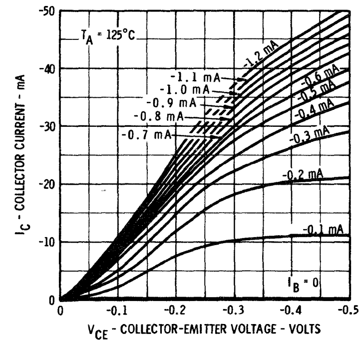
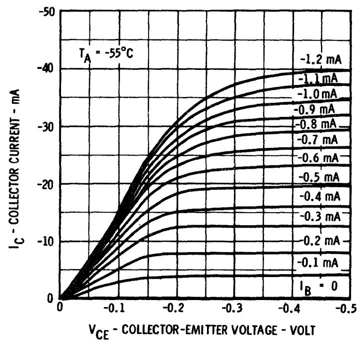
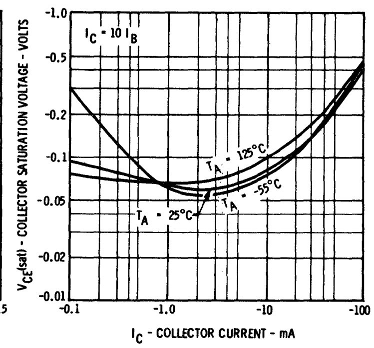


COLLECTOR CHARACTERISTICS

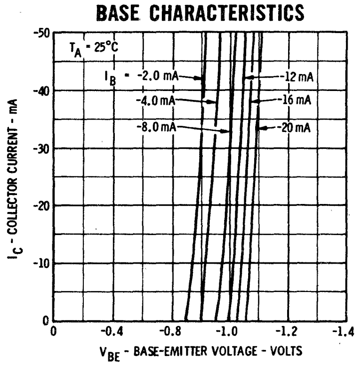


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

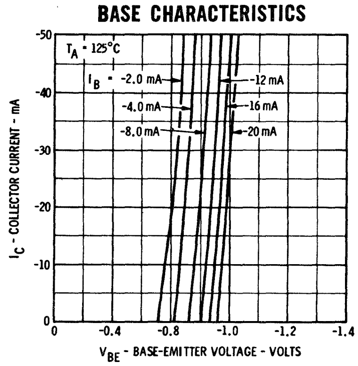


TYPICAL ELECTRICAL CHARACTERISTICS
2N4207 • 2N4208 • 2N4209

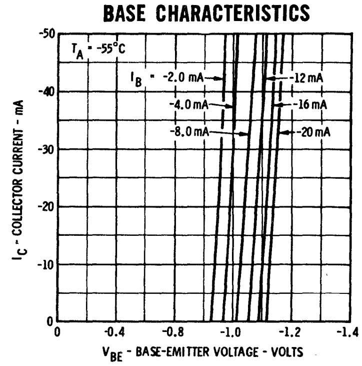
BASE CHARACTERISTICS



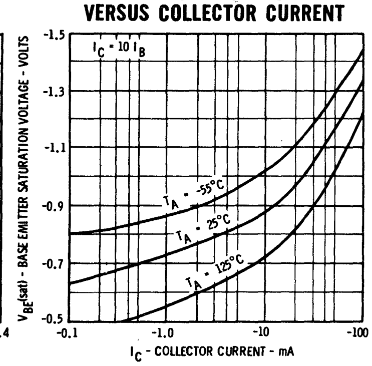
BASE CHARACTERISTICS



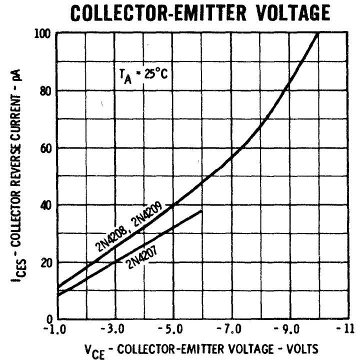
BASE CHARACTERISTICS



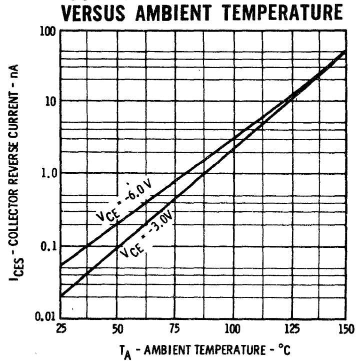
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



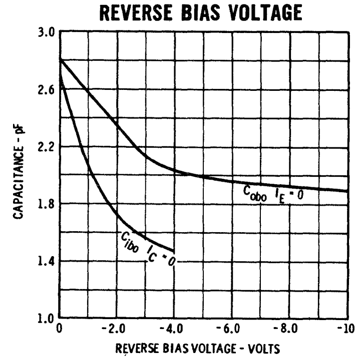
COLLECTOR REVERSE CURRENT VERSUS COLLECTOR-EMITTER VOLTAGE



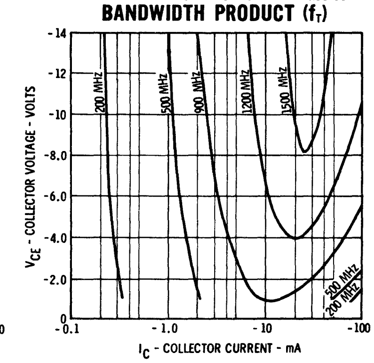
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE

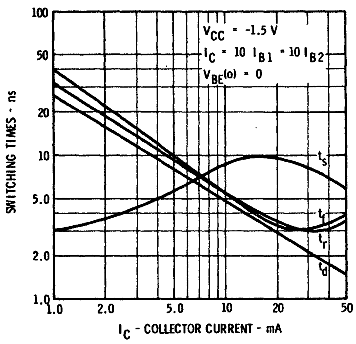


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

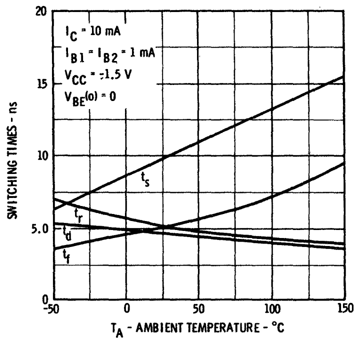


TYPICAL ELECTRICAL CHARACTERISTICS
2N4207 • 2N4208 • 2N4209

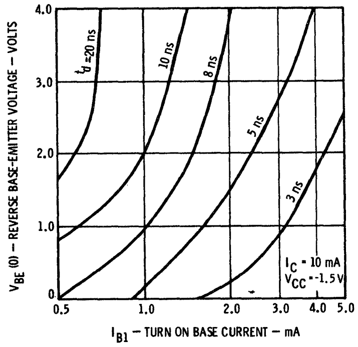
SWITCHING TIMES VERSUS COLLECTOR CURRENT



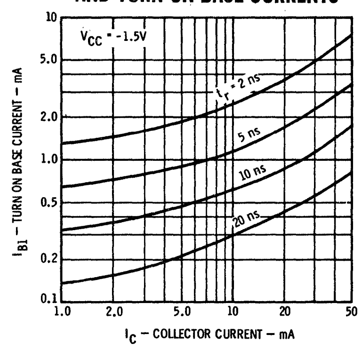
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



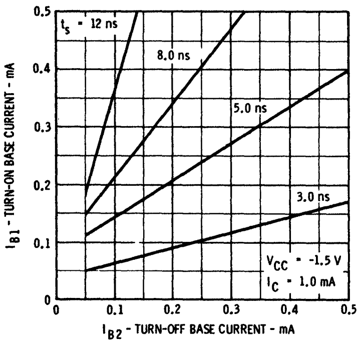
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



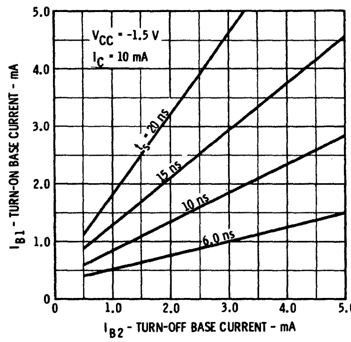
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



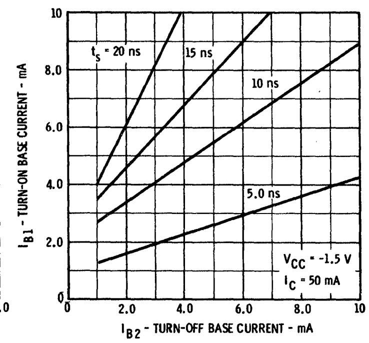
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



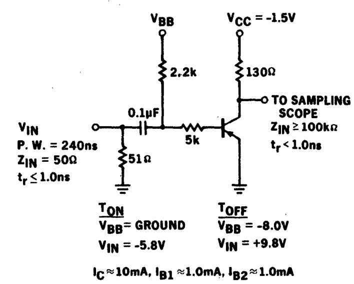
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



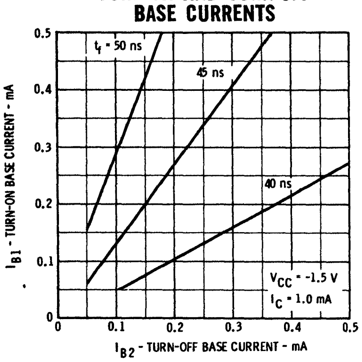
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



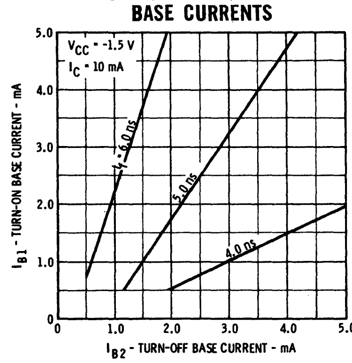
TURN ON AND TURN OFF TEST CIRCUIT



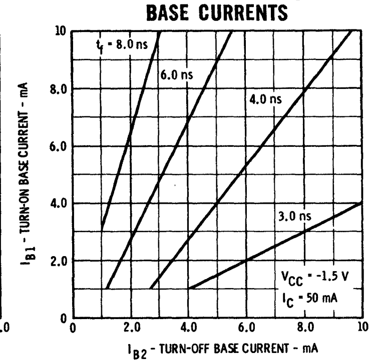
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



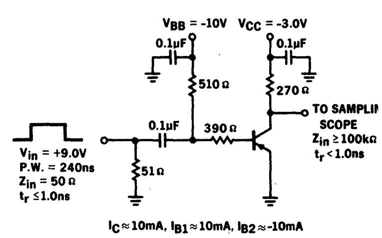
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



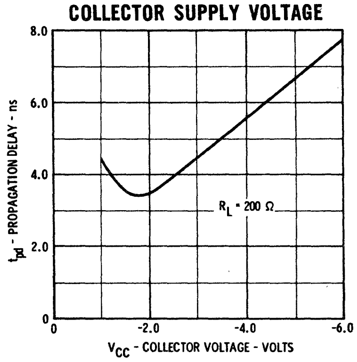
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



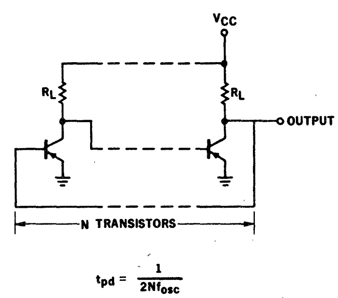
CHARGE STORAGE TIME TEST CIRCUIT



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



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

2N4251

NPN RADIATION RESISTANT SWITCH

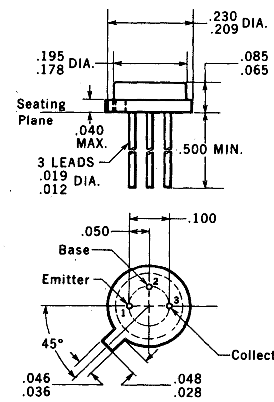
DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

(FORMERLY FT40)

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.	TYP.	MAX.	POST-IRRADIATION MIN.	TYP.	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

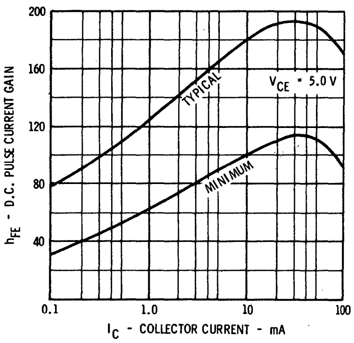
(See notes on back page)

* Planar is a patented Fairchild process.

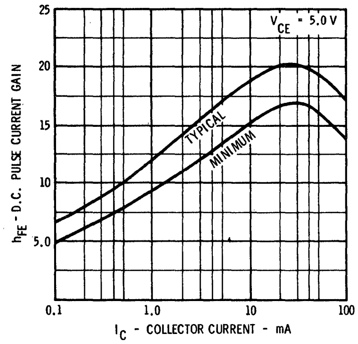
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

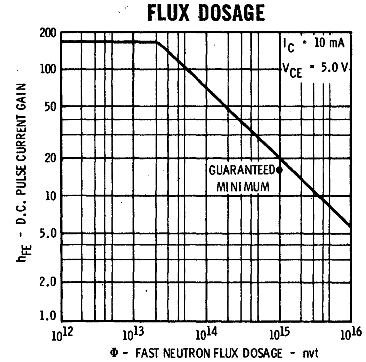


FIGURE 1

t_{on}, t_{off} TEST CIRCUIT

t_{on} : V_{in} = +4.8V, V_{BB} = -1.2V
t_{off}: V_{in} = -4.0V, V_{BB} = +4.8V

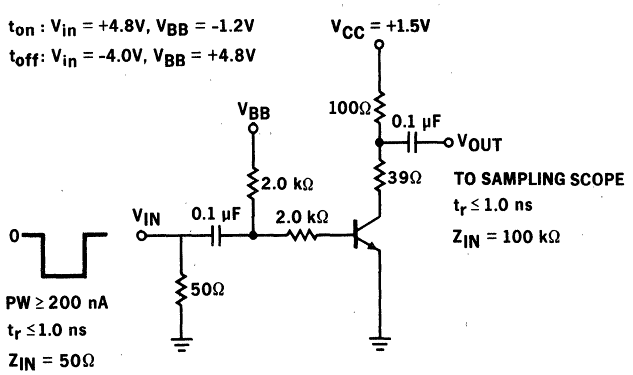
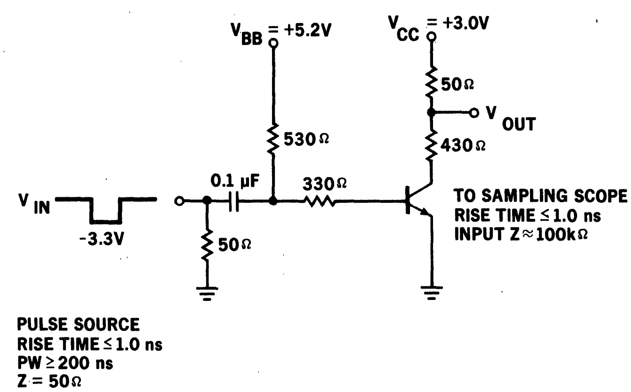


FIGURE 2

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. For more information send for Fairchild Publication APP-4/2.

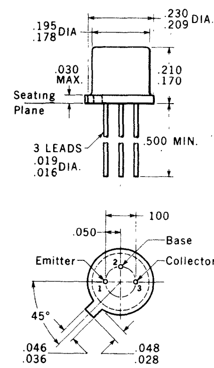
2N4359

PNP LOW-NOISE, LOW-LEVEL AMPLIFIER

DIFFUSED SILICON PLANAR* II 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 R_S = 10 kΩ Power Bandwidth = 15.7 kHz	V_{CE} = −5.0 V
NF	Narrow Band Noise Figure (f = 10 kHz)		1.0	3.0	dB	I_C = 20 μA R_S = 10 kΩ Power Bandwidth = 1.5 kHz	V_{CE} = −5.0 V
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		**1.5**	**4.0**	**dB**	**I_C = 20 μA R_S = 10 kΩ, Power Bandwidth = 150 Hz**	**V_{CE} = −5.0 V**
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.

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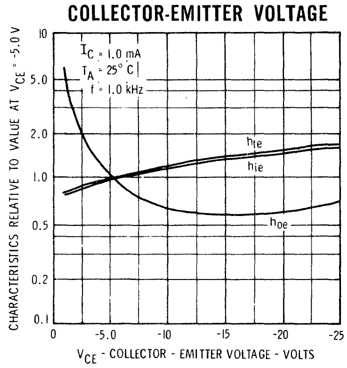
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

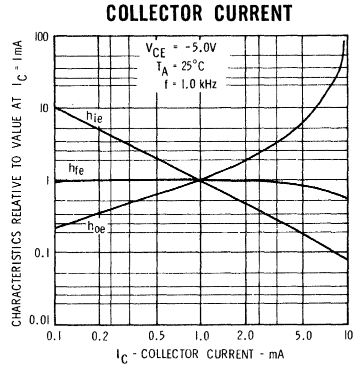
SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{fe}	Small Signal Current Gain	50	700		$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{ie}	Input Resistance	1.0	20	k ohms	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{oe}	Output Conductance	5.0	60	μmhos	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{re}	Voltage Feedback Ratio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

TYPICAL ELECTRICAL CHARACTERISTICS

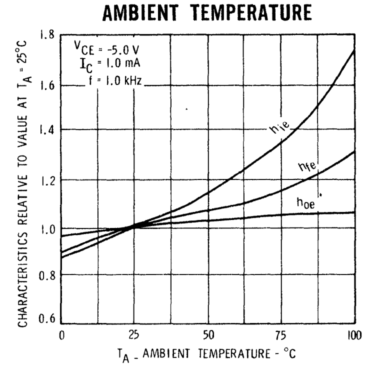
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



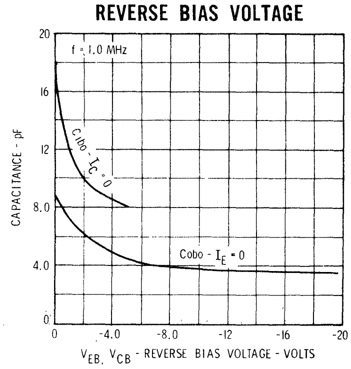
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



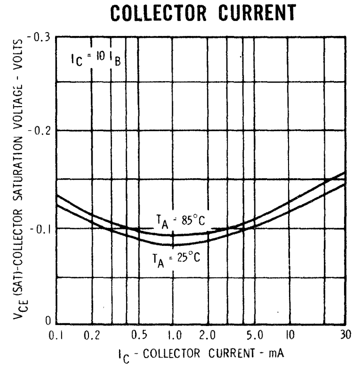
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



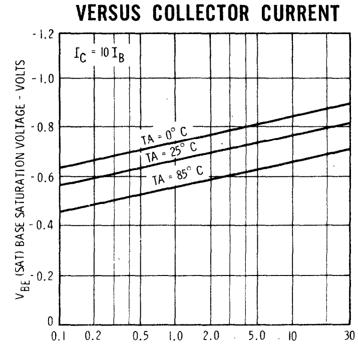
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

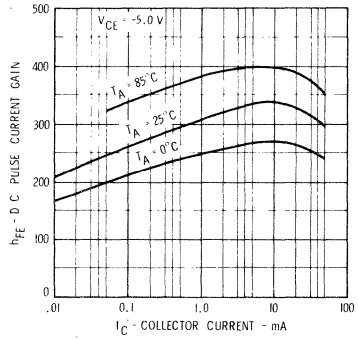


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

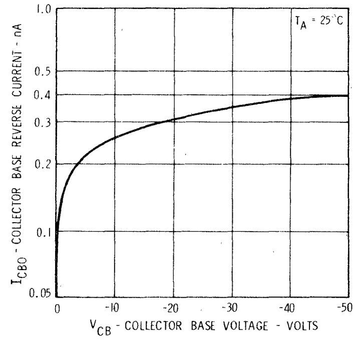


TYPICAL ELECTRICAL CHARACTERISTICS

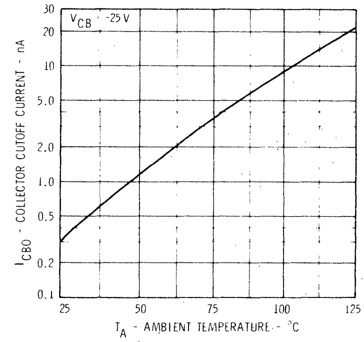
DC PULSE-CURRENT GAIN VERSUS COLLECTOR CURRENT



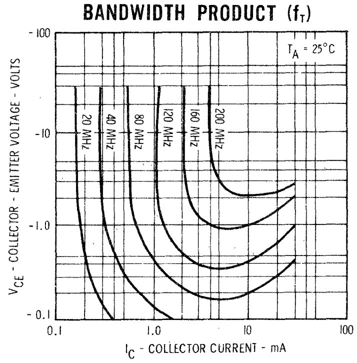
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



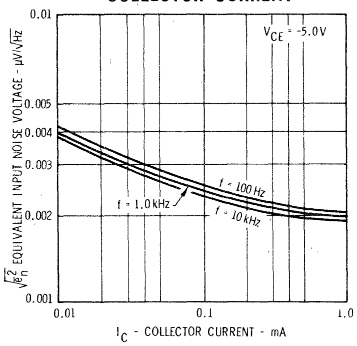
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



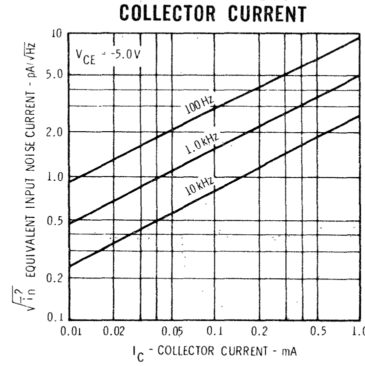
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



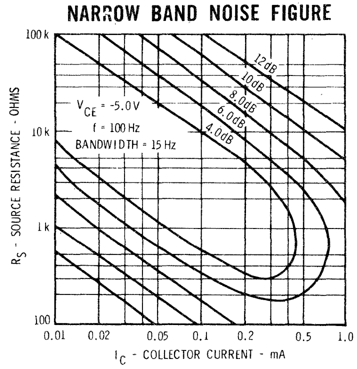
EQUIVALENT INPUT NOISE VOLTAGE VERSUS COLLECTOR CURRENT



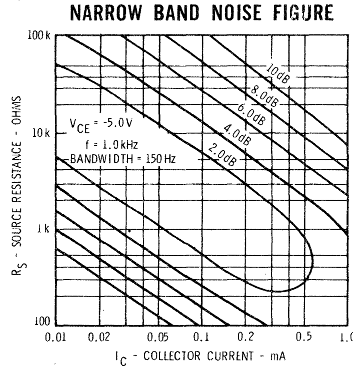
EQUIVALENT INPUT NOISE CURRENT VERSUS COLLECTOR CURRENT



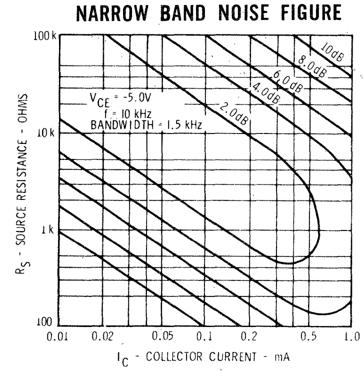
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



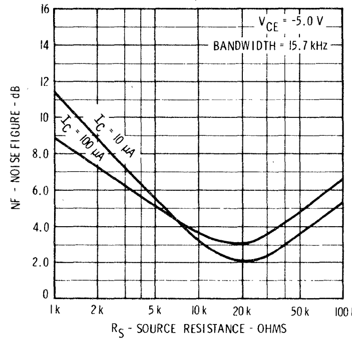
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



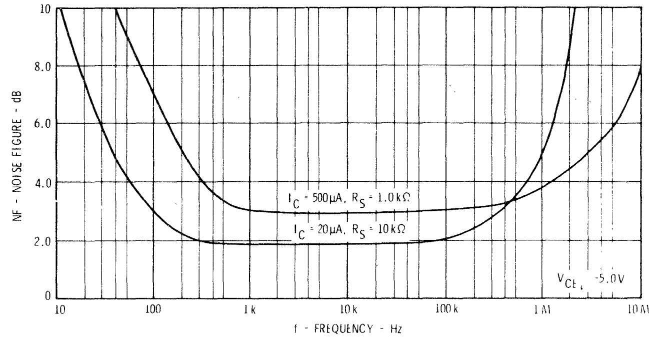
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

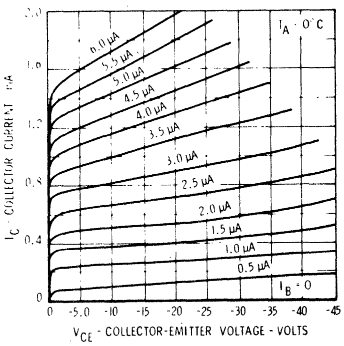


NOISE FIGURE VERSUS FREQUENCY

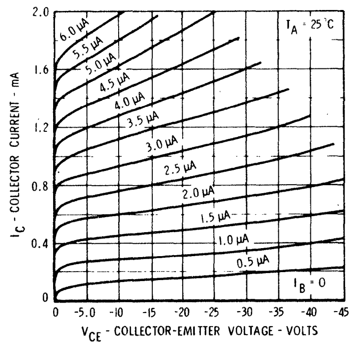


TYPICAL ELECTRICAL CHARACTERISTICS

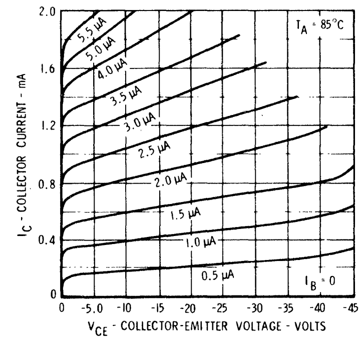
COLLECTOR CHARACTERISTICS*



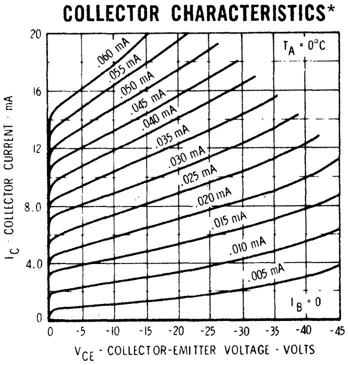
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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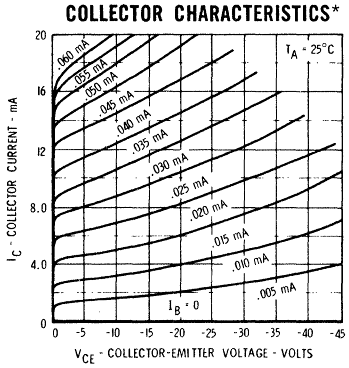
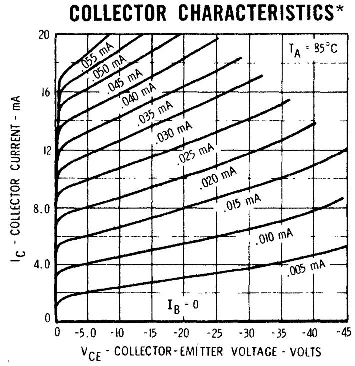


COLLECTOR CHARACTERISTICS*



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.

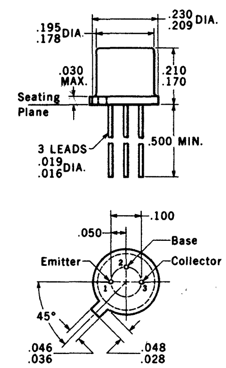
2N4872

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)

		PRE-IRRADIATION			POST-IRRADIATION 3X10[14] nvt(>10 keV)					
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	MIN.	TYP.	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 ≈ 10 mA**	**I_{B1} ≈ 1.0 mA**
t_{off}	**Turn Off Time** (Note 6)		**15**	**20**		**9.0**	**20**	**ns**	**I_C ≈ 10 mA**	**I_{B1} = I_{B2} ≈ 1.0 mA**
τ_S	Charge Storage Time Constant (Note 6)		14	20		6.0	20	ns	I_C ≈ 10 mA	I_{B1} = I_{B2} ≈ 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

Notes on page 2

*Planar is a patented Fairchild process.

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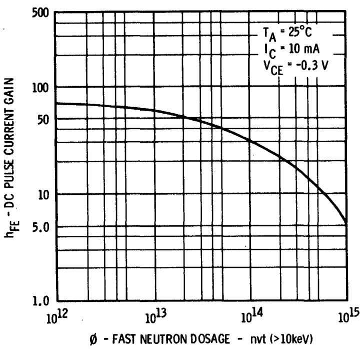
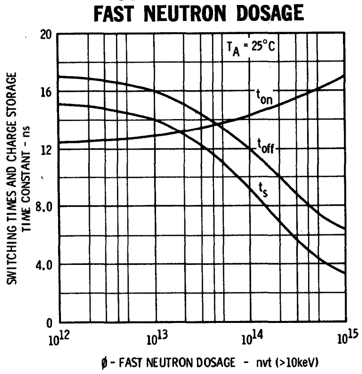
TYPICAL ELECTRICAL CHARACTERISTICS

POST-IRRADITION

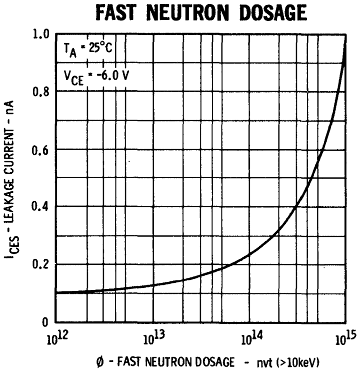
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



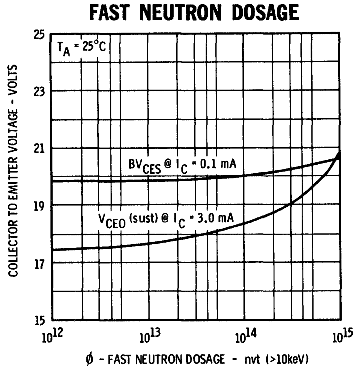
SWITCHING TIMES AND CHARGE STORAGE TIME CONSTANT VERSUS FAST NEUTRON DOSAGE



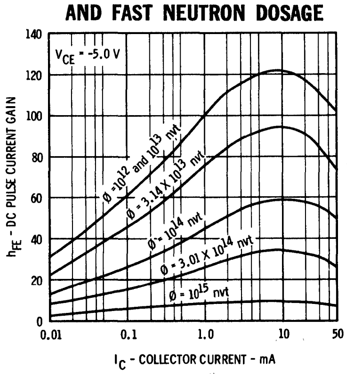
LEAKAGE CURRENT VERSUS FAST NEUTRON DOSAGE



COLLECTOR TO EMITTER VOLTAGES VERSUS FAST NEUTRON DOSAGE

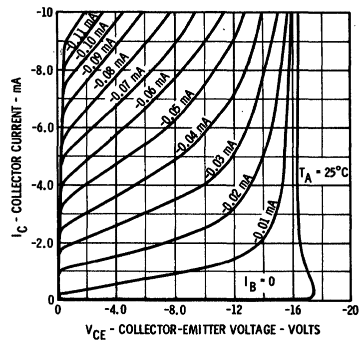


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT AND FAST NEUTRON DOSAGE

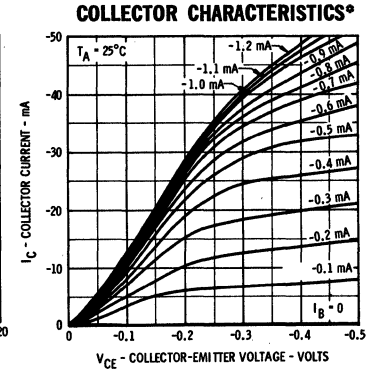


PRE-IRRADIATION

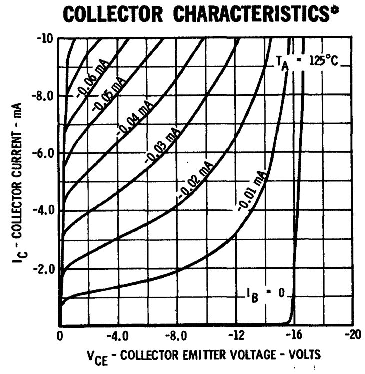
COLLECTOR CHARACTERISTICS*



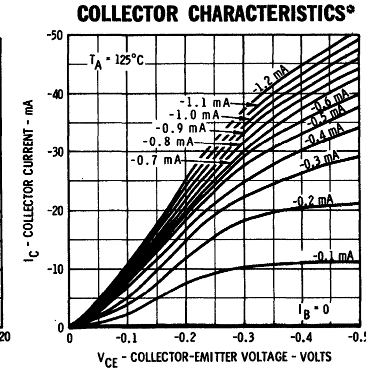
COLLECTOR CHARACTERISTICS*



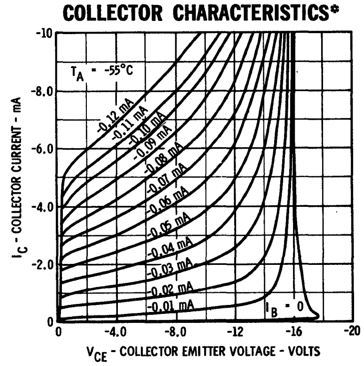
COLLECTOR CHARACTERISTICS*



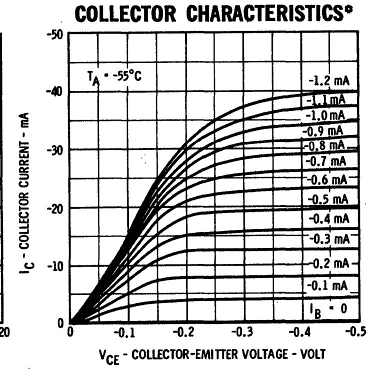
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



* Single family characteristic on Transistor Curve Tracer.

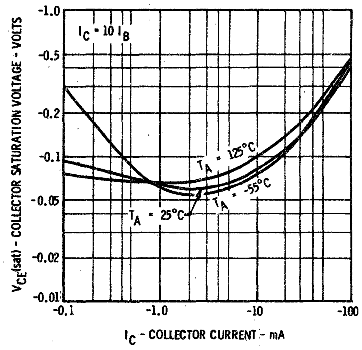
NOTES:

(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. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

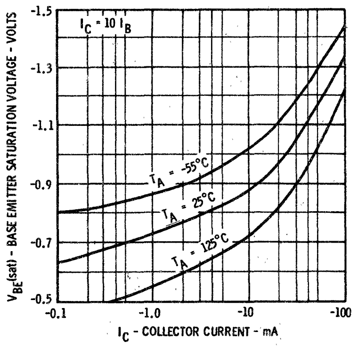
TYPICAL ELECTRICAL CHARACTERISTICS

PRE-IRRADIATION

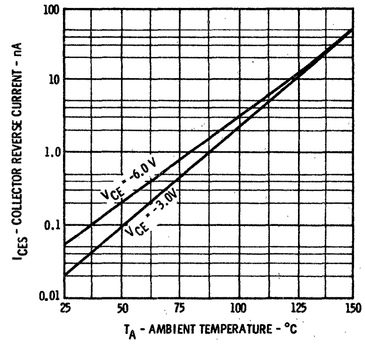
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



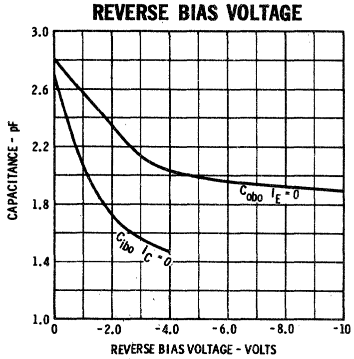
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



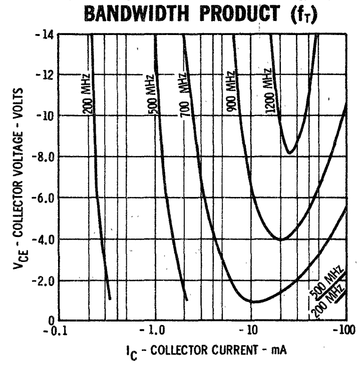
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



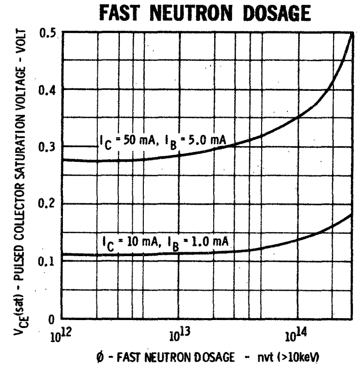
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



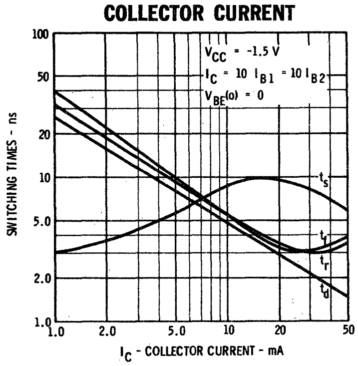
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



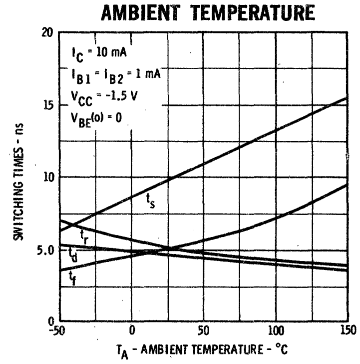
PULSED COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



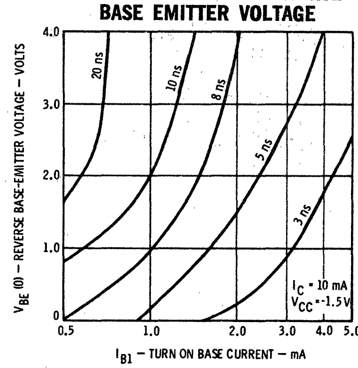
SWITCHING TIMES VERSUS COLLECTOR CURRENT



SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



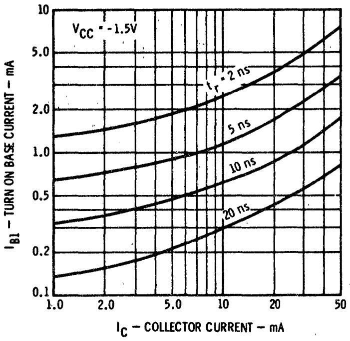
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



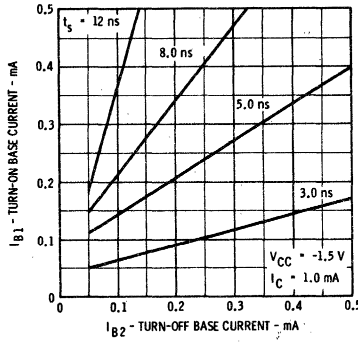
TYPICAL ELECTRICAL CHARACTERISTICS

PRE-IRRADIATION

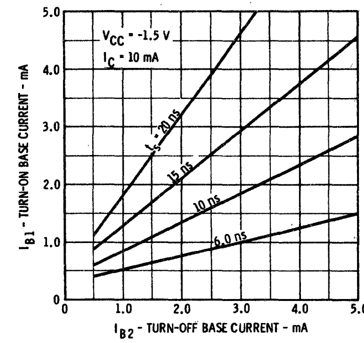
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



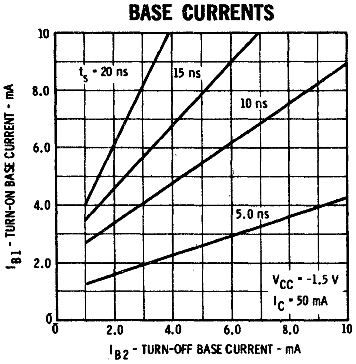
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



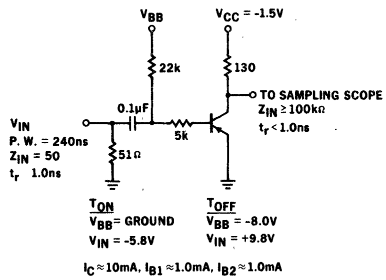
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



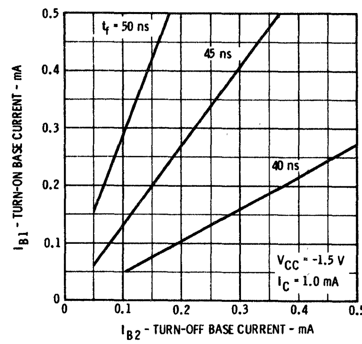
STORAGE TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



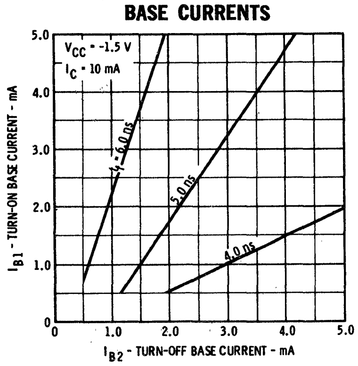
TURN ON AND TURN OFF TEST CIRCUIT



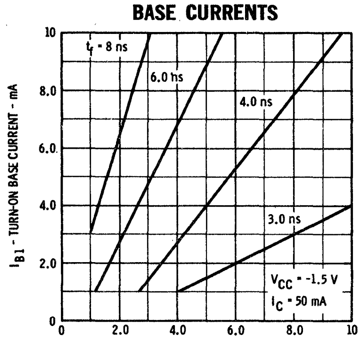
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



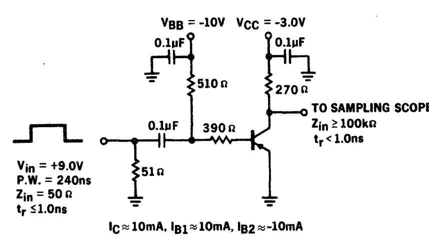
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



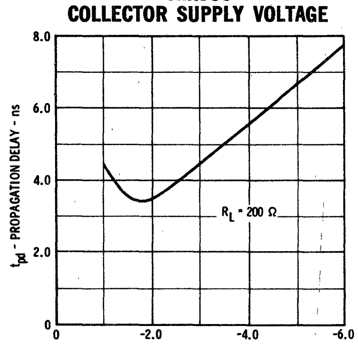
FALL TIME VERSUS TURN-ON AND TURN-OFF BASE CURRENTS



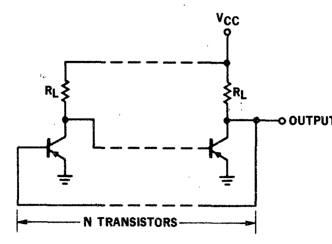
CHARGE STORAGE TIME TEST CIRCUIT



PROPAGATION DELAY TIME VERSUS COLLECTOR SUPPLY VOLTAGE



FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



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

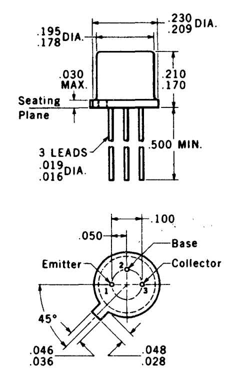
2N4873

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.	TYP.	MAX.	POST-IRRADIATION (3 x 10^{14} nvt >10 keV) MIN.	TYP.	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	$I_C = 10\ \mu A$ $V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	40			40			Volts	$I_C = 10\ \mu A$ $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5	6.0		4.5	6.0		Volts	$I_E = 10\ \mu A$ $I_C = 0$
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.
Additional Electrical Characteristics on page 2.

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. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle ≤2%.
(6) See switching circuits for exact value of I_C, I_{B1}, and I_{B2}.

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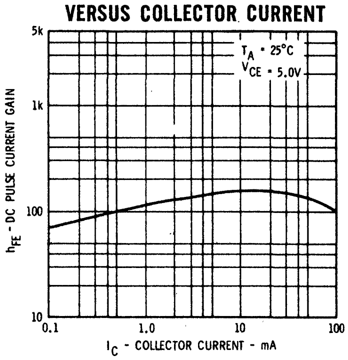
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

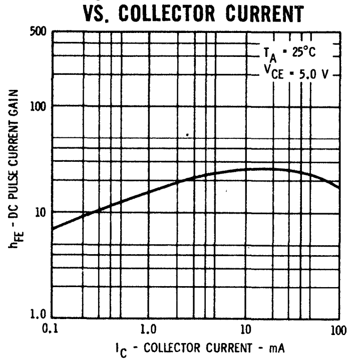
SYMBOL	CHARACTERISTIC	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION (3×10^{14} nvt >10 keV) MIN.	POST-IRRADIATION (3×10^{14} nvt >10 keV) TYP.	POST-IRRADIATION (3×10^{14} nvt >10 keV) MAX.	UNITS	TEST CONDITIONS
V_{CE} (sat)	**Pulsed Collector Saturation Voltage** [Note 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

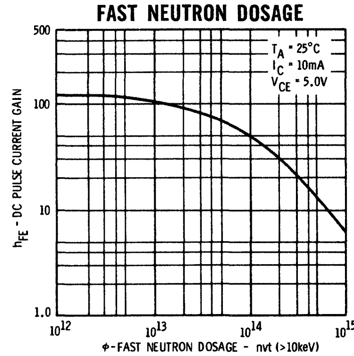
PRE-IRRADIATION DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



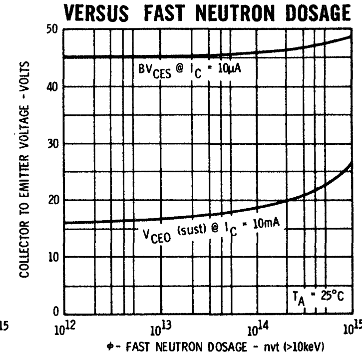
POST-IRRADIATION (3×10^{14} nvt >10 keV) DC PULSE CURRENT GAIN VS. COLLECTOR CURRENT



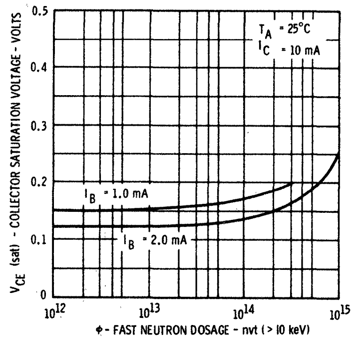
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



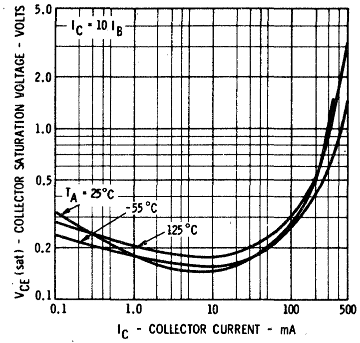
COLLECTOR TO EMITTER VOLTAGE VERSUS FAST NEUTRON DOSAGE



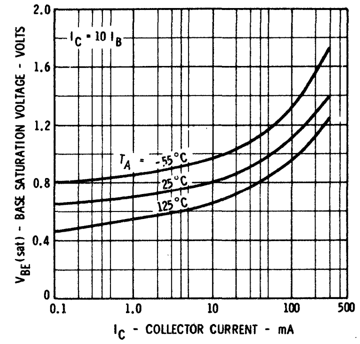
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

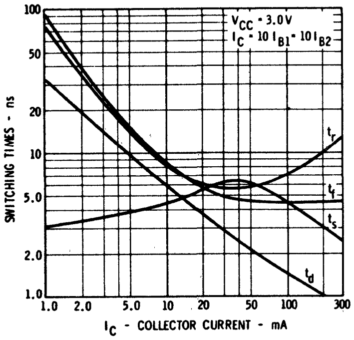


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

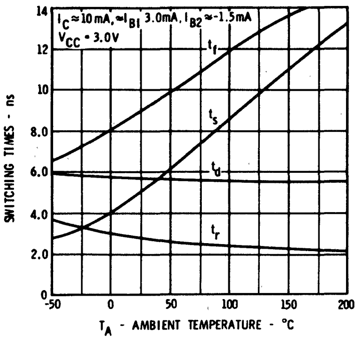


TYPICAL ELECTRICAL CHARACTERISTICS

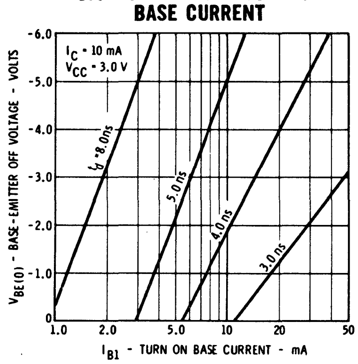
SWITCHING TIMES VERSUS COLLECTOR CURRENT



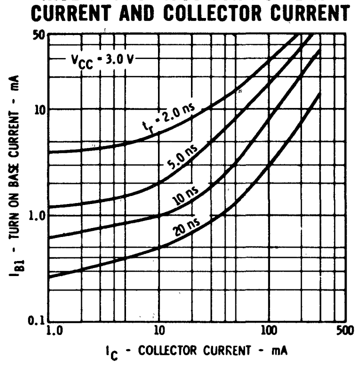
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



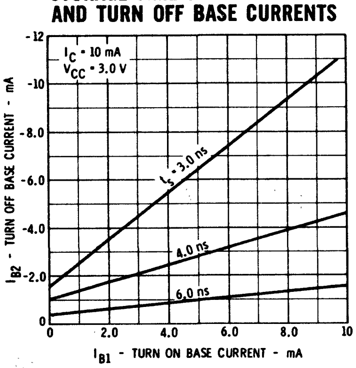
DELAY TIME VERSUS BASE-EMITTER OFF VOLTAGE AND TURN ON BASE CURRENT



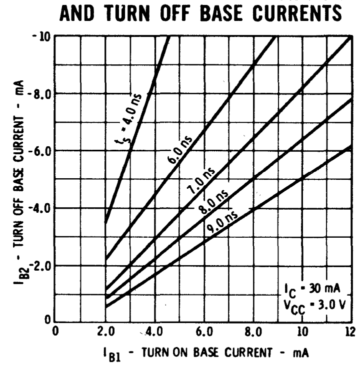
RISE TIME VERSUS TURN ON BASE CURRENT AND COLLECTOR CURRENT



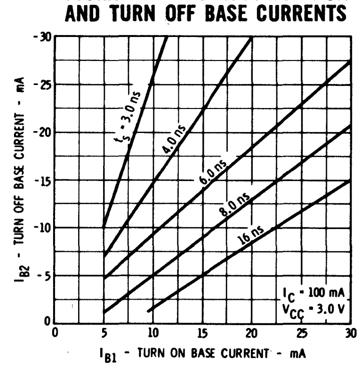
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



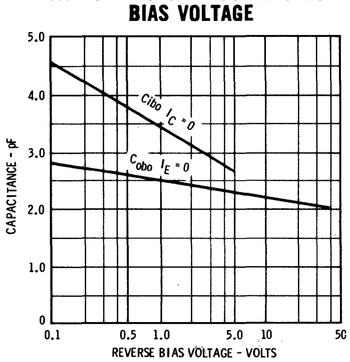
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



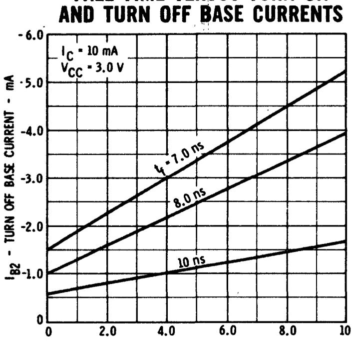
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



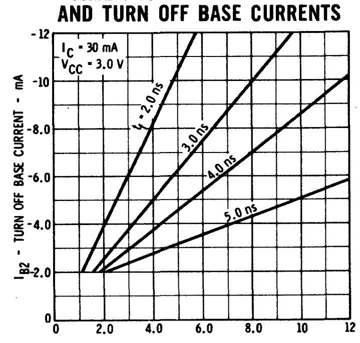
EMITTER TRANSITION AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



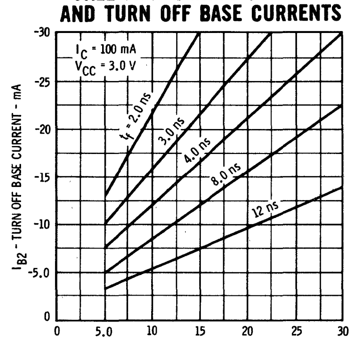
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



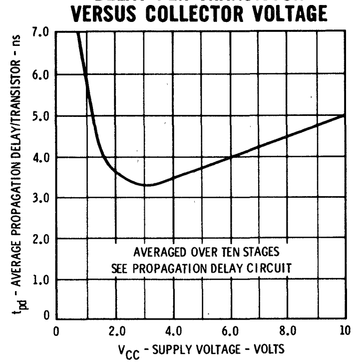
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



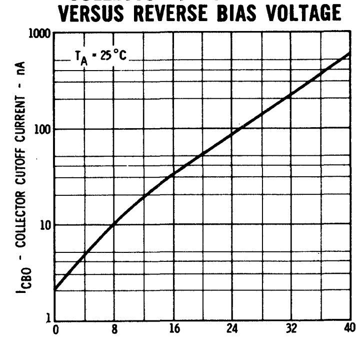
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



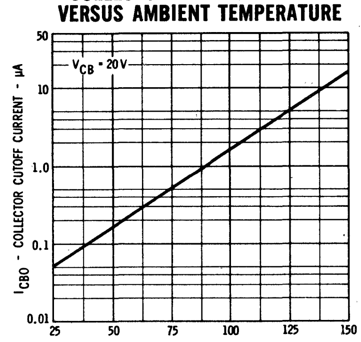
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



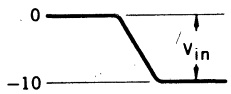
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



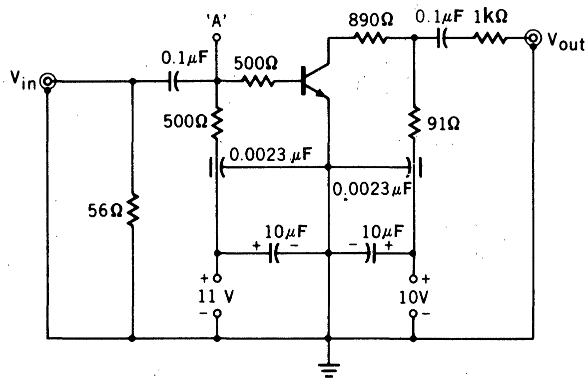
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE

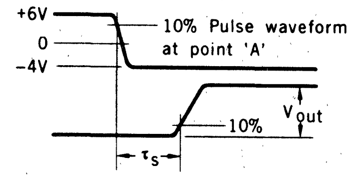


CHARGE STORAGE TIME MEASUREMENT CIRCUIT



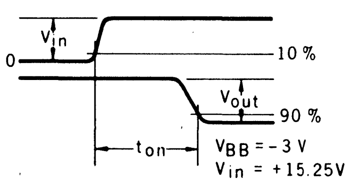
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %



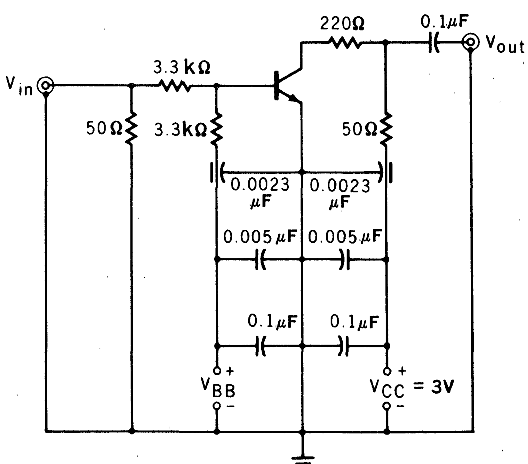


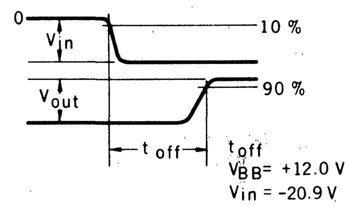
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

t_{ON} — t_{OFF} MEASUREMENT CIRCUIT



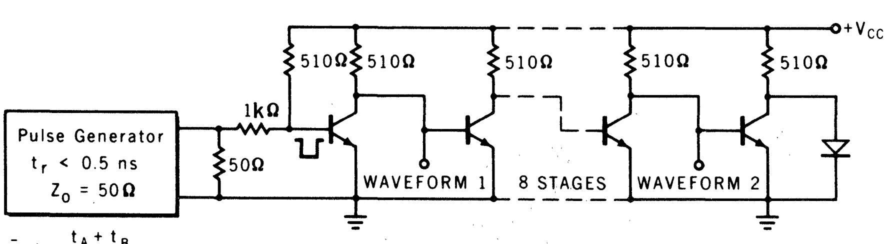
Pulse Generator
V_{in} Rise Time < 1 ns
Source Impedance = 50Ω
PW ≥ 300 ns
Duty Cycle < 2 %





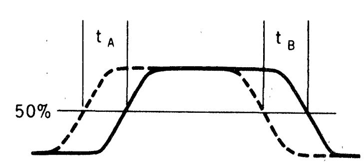
To Sampling Oscilloscope
Input Impedance = 50Ω
Rise Time ≤ 1 ns

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

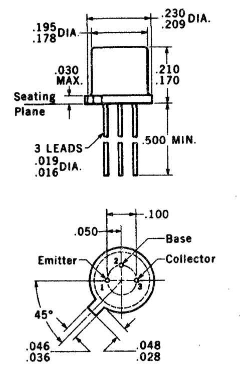
2N4960 · 2N4961 · 2N4962 · 2N4963

NPN GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- LV_{CEO} -- 80 VOLTS MIN.
- h_{FE} -- 12 SPECIFICATIONS FROM 100 µA TO 500 mA; −55°C TO +125°C
- $V_{CE(sat)}$ -- 0.5 V MAX. AT 500 mA; 0.18 V MAX. AT 150 mA
- f_T -- 250 MHz MIN. AT 50 mA

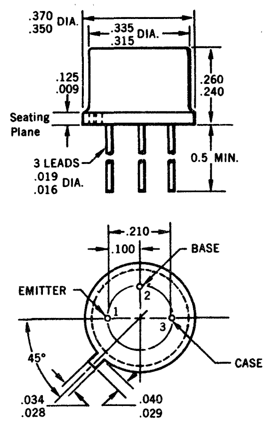
PHYSICAL DIMENSIONS in accordance with JEDEC (TO-18) outline



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

2N4962 · 2N4963

PHYSICAL DIMENSIONS in accordance with JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold-plated KOVAR
Lead No. 3 internally connected to case
Package weight is 1.23 grams

2N4960 · 2N4961

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C				
Operating Junction Temperature	+200°C				

Maximum Power Dissipation (Note 2 & 3)	2N4960	2N4961	2N4962	2N4963	
Total Dissipation at Case Temperature, 25°C	3.5	3.5	1.5	1.5	Watts
at Ambient Temperature, 25°C	0.8	0.8	0.5	0.5	Watts
Maximum Voltages					
V_{CBO} Collector to Base Voltage	60	80	60	80	Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	60	80	60	80	Volts
V_{EBO} Emitter to Base Voltage	6.5	6.5	6.5	6.5	Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	30	60		30	60			I_C=100µA	V_{CE}=10 V
h_{FE}	DC Current Gain	60	100		60	100			I_C=1.0 mA	V_{CE}=10 V
h_{FE}	DC Pulse Current Gain (Note 5)	90	140		90	140			I_C=10 mA	V_{CE}=10 V
h_{FE}	DC Pulse Current Gain (Note 5)	100	150		100	150			I_C=50 mA	V_{CE}=10 V
h_{FE} (−55°C)	**DC Pulse Current Gain (Note 5)**	**10**	**40**		**10**	**40**			**I_C=150 mA**	**V_{CE}=1.0 V**
h_{FE}	**DC Pulse Current Gain (Note 5)**	**40**	**100**		**40**	**100**			**I_C=150 mA**	**V_{CE}=1.0 V**
h_{FE} (125°C)	DC Pulse Current Gain (Note 5)		130	500		130	500		I_C=150 mA	V_{CE}=1.0 V
h_{FE} (−55°C)	DC Pulse Current Gain (Note 5)	25	60		25	60			I_C=150 mA	V_{CE}=10 V
h_{FE}	**DC Pulse Current Gain (Note 5)**	**100**	**180**	**300**	**100**	**180**	**300**		**I_C=150 mA**	**V_{CE}=10 V**
h_{FE} (125°C)	**DC Pulse Current Gain (Note 5)**		**270**	**650**		**270**	**650**		**I_C=150 mA**	**V_{CE}=10 V**
h_{FE}	DC Pulse Current Gain (Note 5)	70	100		70	100			I_C=300 mA	V_{CE}=10 V
h_{FE}	DC Pulse Current Gain (Note 5)	45	60		45	60			I_C=500 mA	V_{CE}=10 V
h_{fe}	**High Frequency Current Gain (f=100MHz)**	**2.5**	**4.0**	**6.0**	**2.5**	**4.0**	**6.0**		**I_C=50 mA**	**V_{CE}=10 V**
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.04	0.07		0.04	0.07	Volts	I_C=10 mA	I_B=1.0 mA
V_{CE}(sat)	**Pulsed Collector Saturation Voltage (Note 5)**		**0.15**	**0.18**		**0.15**	**0.18**	**Volts**	**I_C=150 mA**	**I_B=15 mA**
V_{CE}(sat) (125°C)	Pulsed Collector Saturation Voltage (Note 5)		0.18	0.36		0.18	0.36	Volts	I_C=150 mA	I_B=15 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.25	0.31		0.25	0.31	Volts	I_C=300 mA	I_B=30 mA
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.38	0.50		0.38	0.50	Volts	I_C=500 mA	I_B=50 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		0.67	0.72		0.67	0.72	Volts	I_C=10 mA	I_B=1.0 mA
V_{BE}(sat)(−55°C)	**Pulsed Base Saturation Voltage (Note 5)**		**0.92**	**1.10**		**0.92**	**1.10**	**Volts**	**I_C=150 mA**	**I_B=15 mA**
V_{BE}(sat)	**Pulsed Base Saturation Voltage (Note 5)**	**0.78**	**0.82**	**0.90**	0.78	0.82	0.90	**Volts**	**I_C=150 mA**	**I_B=15 mA**
V_{BE}(sat)(125°C)	**Pulsed Base Saturation Voltage (Note 5)**	**0.63**	**0.73**		**0.63**	**0.73**		**Volts**	**I_C=150 mA**	**I_B=15 mA**
V_{BE}(sat)	**Pulsed Base Saturation Voltage (Note 5)**		**0.95**	**1.05**		**0.95**	**1.05**	**Volts**	**I_C=300 mA**	**I_B=30 mA**
V_{BE}(sat)	**Pulsed Base Saturation Voltage (Note 5)**		**1.1**	**1.3**		**1.1**	**1.3**	**Volts**	**I_C=500 mA**	**I_B=50 mA**
V_{BE}(on)	Pulsed Base Emitter On Voltage (Note 5)		0.75	0.88		0.75	0.88	Volts	I_C=150 mA	V_{CE}=10 V

(See notes on page 4)

*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

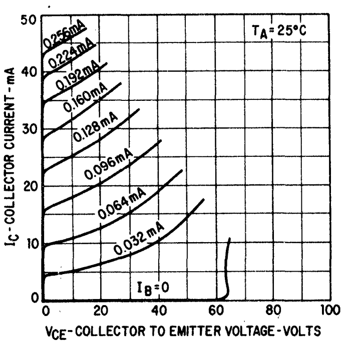
ELECTRICAL CHARACTERISTICS (25° Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	2N4960 • 2N4962 MIN.	TYP.	MAX.	2N4961 • 2N4963 MIN	TYP.	MAX.	UNIT	TEST CONDITIONS	
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Note 4 & 5)	**60**			**80**			**Volts**	**I_C=10 mA**	**I_B=0**
BV_{CES}	Collector to Emitter Breakdown Voltage	60			80			Volts	I_C=10 μA	I_B=0
BV_{CBO}	Collector to Base Breakdown Voltage	60			80			Volts	I_C=10 μA	I_E=0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.5			6.5			Volts	I_C=0	I_E=10 μA
I_{CBO}	Collector Cutoff Current		1.0	10		1.0	10	nA	I_E=0	V_{CB}=50 V
I_{CBO}(125°C)	Collector Cutoff Current		1.0	10		1.0	10	μA	I_E=0	V_{CB}=50 V
I_{EBO}	Emitter Cutoff Current		1.0	10		1.0	10	nA	I_C=0	V_{EB}=4.0 V
C_{cb}	Collector to Base Capacitance (f=1.0 MHz)		11	15		11	15	pF	I_E=0	V_{CB}=10 V
C_{eb}	Emitter to Base Capacitance (f=1.0 MHz)		50	75		50	75	pF	I_C=0	V_{EB}=0.5 V
t_{on}	Turn On Time (Note 6, Fig. 1)		70	150		70	150	ns	I_C≈150 mA	I_{B1}≈15 mA
t_{off}	Turn Off Time (Note 6, Fig. 1)		700	1000		700	1000	ns	I_C≈150 mA	I_{B1}≈15 mA I_{B2}≈−15 mA
t_{on}	Turn On Time (Note 6, Fig. 1)		80			80		ns	I_C≈300 mA	I_{B1}≈30 mA
t_{off}	Turn Off Time (Note 6, Fig. 1)		600			600		ns	I_C≈300 mA	I_{B1}≈30 mA I_{B2}≈−30 mA
t_{on}	Turn On Time (Note 6, Fig. 1)		100			100		ns	I_C≈500 mA	I_{B1}≈50 mA
t_{off}	Turn Off Time (Note 6, Fig. 1)		500			500		ns	I_C≈500 mA	I_{B1}≈50 mA I_{B2}≈−50 mA

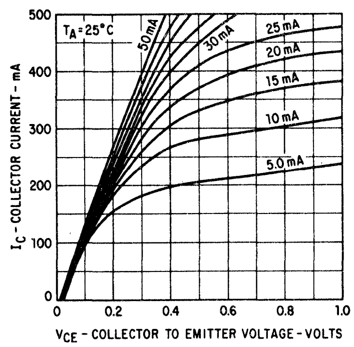
TYPICAL COLLECTOR AND BASE CHARACTERISTICS

2N4960 · 2N4962

ACTIVE REGION

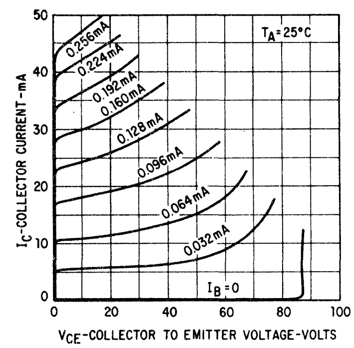


SATURATION REGION

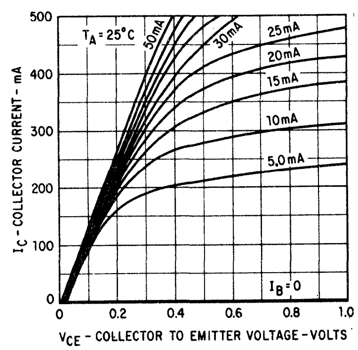


2N4961 · 2N4963

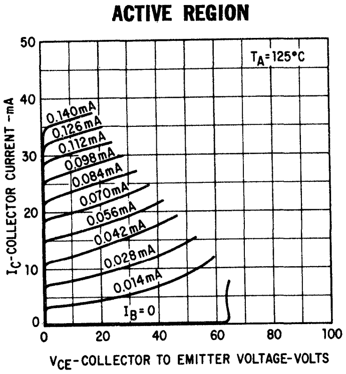
ACTIVE REGION



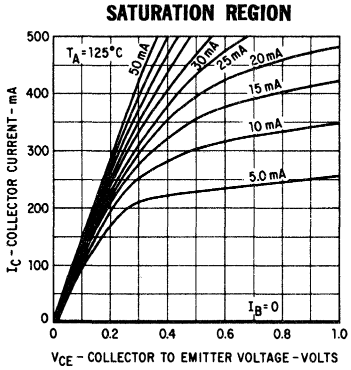
SATURATION REGION



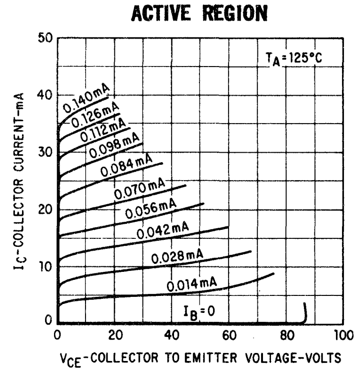
ACTIVE REGION



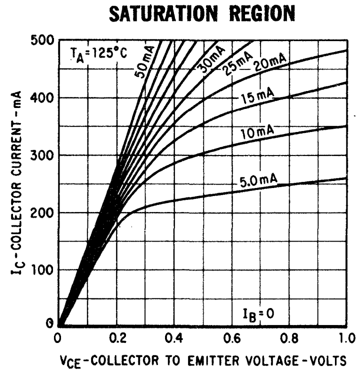
SATURATION REGION



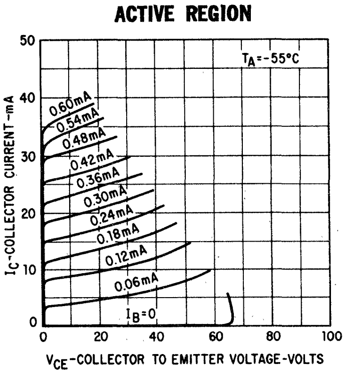
ACTIVE REGION



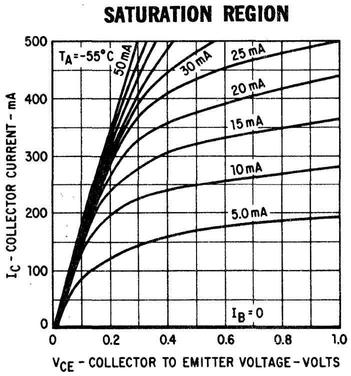
SATURATION REGION



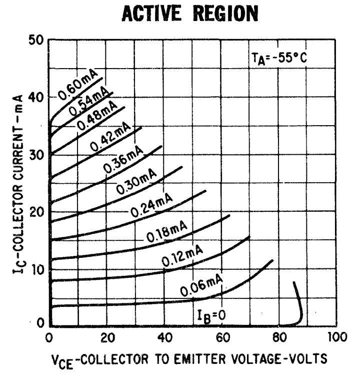
ACTIVE REGION



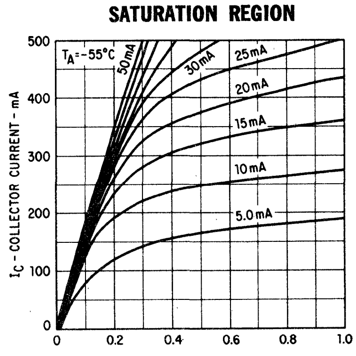
SATURATION REGION



ACTIVE REGION

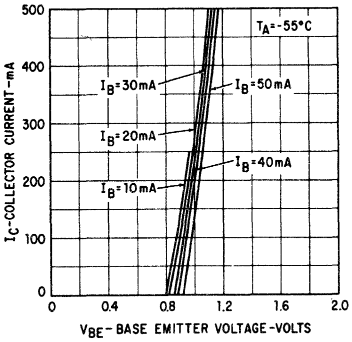


SATURATION REGION

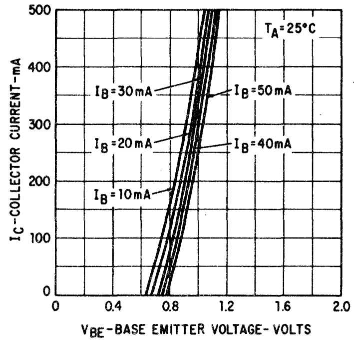


TYPICAL ELECTRICAL CHARACTERISTICS

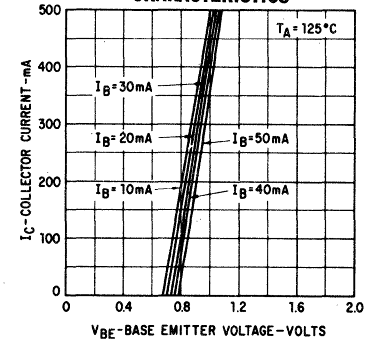
TYPICAL BASE CHARACTERISTICS



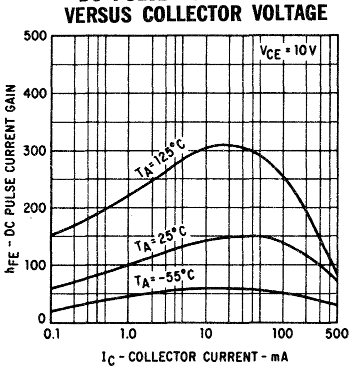
TYPICAL BASE CHARACTERISTICS



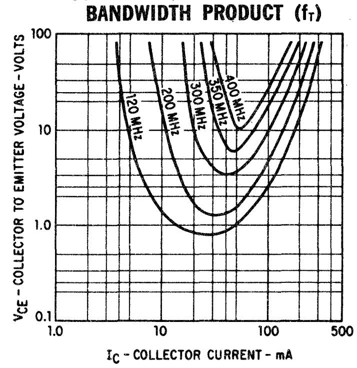
TYPICAL BASE CHARACTERISTICS



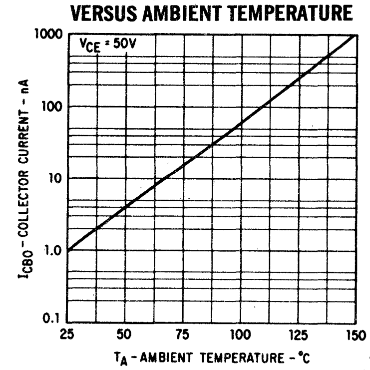
DC PULSE CURRENT GAIN VERSUS COLLECTOR VOLTAGE



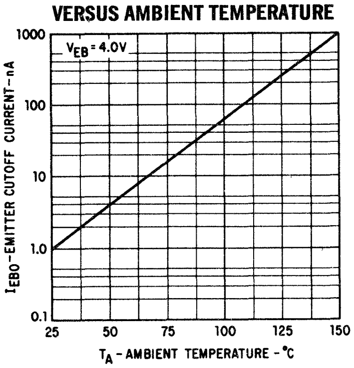
CONTOUR OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



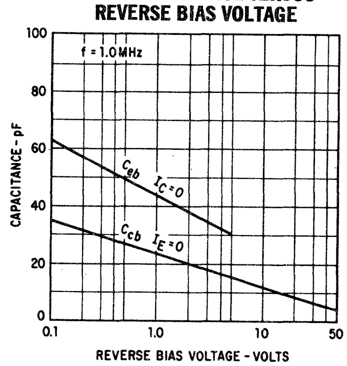
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



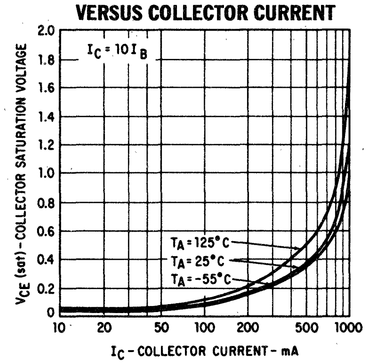
EMITTER CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



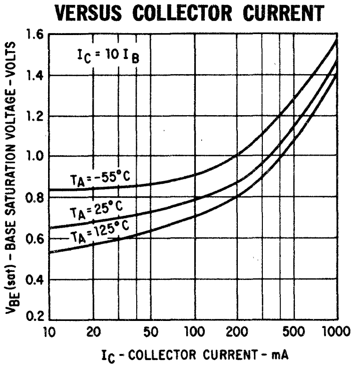
COLLECTOR-BASE AND EMITTER-BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



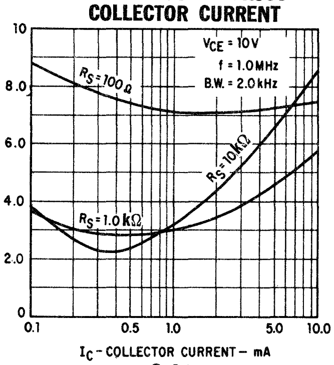
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



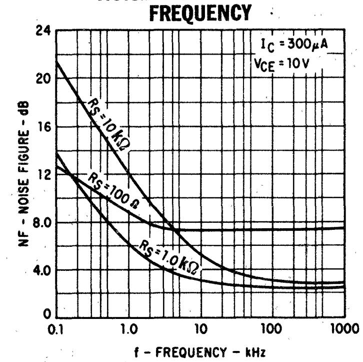
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



NOISE FIGURE VERSUS COLLECTOR CURRENT

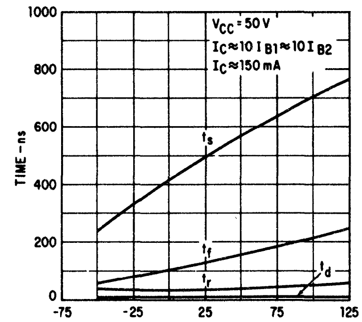


NOISE FIGURE VERSUS FREQUENCY

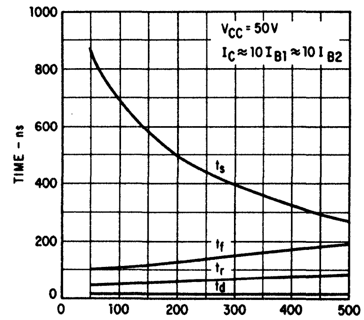


TYPICAL ELECTRICAL CHARACTERISTICS

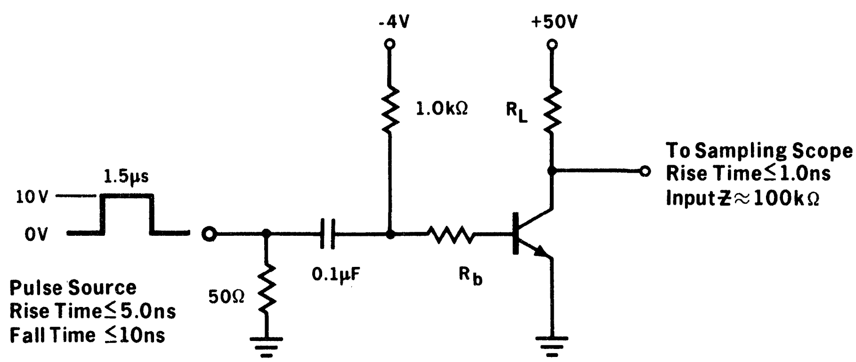
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



SWITCHING TIMES VERSUS COLLECTOR CURRENT



t_{on}-t_{off} TEST CIRCUIT



I_C	R_b	R_L
150mA	314Ω	330Ω
300mA	157Ω	167Ω
500mA	94Ω	100Ω

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 50°C/Watt (derating factor of 20 mW/°C) for the 2N4960 and 2N4961; 117°C/Watt (derating factor of 8.6 mW/°C) for the 2N4962 and 2N4963 . Junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.6 mW/°C) for the 2N4960 and 2N4961 350°C/Watt derating factor of 2.9 mW/°C) for the 2N4962 and 2N4963 .
4. Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
5. Pulse Conditions: length = 300 μS; duty cycle = 1%.
6. See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

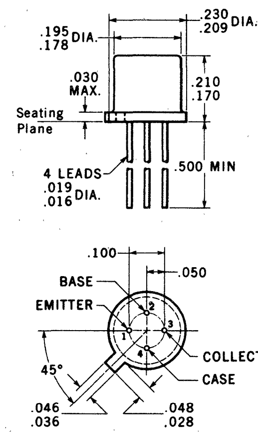
SE5020 · SE5021 · SE5022 · SE5023 · SE5024

NPN RF-AGC AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

GENERAL DESCRIPTION - The SE5020, SE5021, SE5022, SE5023, and SE5024 are RF transistors with gain, bandwidth, noise characteristics, and package suitable for high-performance, high-stability TV applications.

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-72)



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.47 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-55°C to +175°C
Operating Junction Temperature	175°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Note 2)	0.260 Watt
at 25°C Ambient Temperature	(Note 2)	0.175 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		20 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 3)	20 Volts
V_{EBO}	Emitter to Base Voltage		3.0 Volts

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

Symbol	Characteristic		Min.	Typ.	Max.	Units	Test Conditions
NF	Noise Figure (f = 200 MHz)	SE5020		2.8	3.3	dB	V_{AGC} = 1.4 V, R_S = 75 Ω (Note 5), Neutralized Performance
		SE5021		3.5	4.0	dB	
PG	Power Gain (f = 200 MHz)	SE5020	20	25	27	dB	
		SE5021	20	25	27	dB	
		SE5022	18	21		dB	
$V_{AGC(30)}$	AGC Voltage for 30 dB Gain Reduction (f = 200 MHz)	SE5020	4.0	4.5	5.0	Volts	R_S = 75 Ω (Note 5)
NF	Noise Figure (f = 45 MHz)	SE5023		3.0	6.0	dB	V_{AGC} = 2.75 V, R_S = 50 Ω (Note 6), Unneutralized Performance
		SE5024		3.0	6.0	dB	
PG	Power Gain (f = 45 MHz)	SE5023	22.5	25.5	28.5	dB	
		SE5024	22.5	25.5	28.5	dB	
$V_{AGC(30)}$	AGC Voltage for 30 db Gain Reduction (f = 45 MHz)	SE5023	4.4	4.9	5.4	Volts	R_S = 50 Ω (Note 6)
		SE5024	5.2	5.7	6.2	Volts	
C_{re}	Reverse Transfer Capacity, Common Emitter	SE5020 through SE5024	0.25	0.37	0.5	pF	$I_E = 0$, V_{CB} = 10 V, f = 1.0 MHz (Emitter and can guarded)
h_{FE}	DC Pulse Current Gain (Note 4)	SE5020 through SE5024	20	40	200		I_C = 4.0 mA, V_{CE} = 5.0 V

Additional Electrical Characteristics on page 2

(See notes on back page)

*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

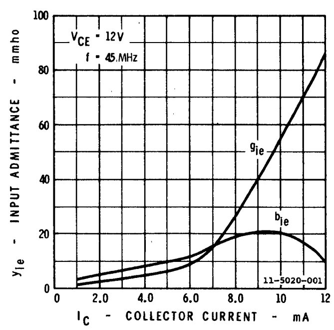
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Characteristic		Min.	Typ.	Max.	Units	Test Conditions
I_{CBO}	Collector Cutoff Current	SE5020 through SE5024			50	nA	I_E = 0 V_{CB} = 10 V
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 3 and 4)	SE5020 through SE5024	20			Volts	I_C = 1.0 mA I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	SE5020 through SE5024	20			Volts	I_C = 100 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	SE5020 through SE5024	3.0			Volts	I_C = 0 I_E = 100 μA
V_{CE}(sat)	Collector Saturation Voltage	SE5020 through SE5024			3.0	Volts	I_C = 10 mA I_B = 5.0 mA
V_{BE}(sat)	Base Saturation Voltage	SE5020 through SE5024			0.96	Volts	I_C = 10 mA I_B = 5.0 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	SE5020 · SE5021	3.75	5.0	8.0		I_C = 4.0 mA V_{CE} = 10 V
		SE5022 through SE5024	3.0	4.5	8.0		

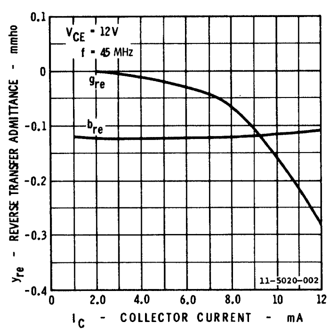
(See notes on back page)

TYPICAL SMALL SIGNAL "Y" PARAMETERS COMMON EMITTER

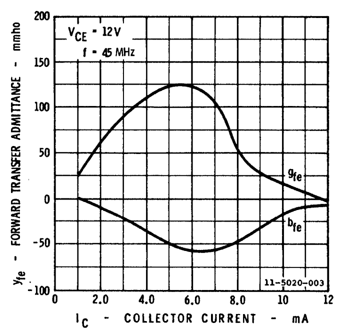
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



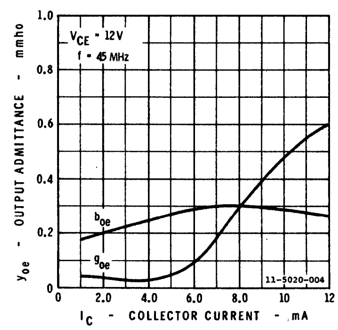
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



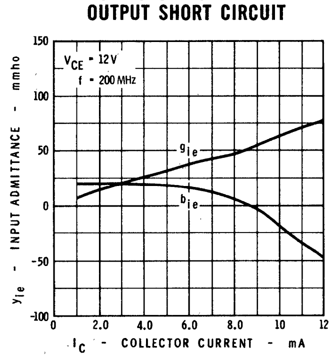
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



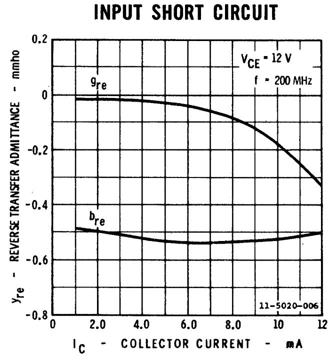
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



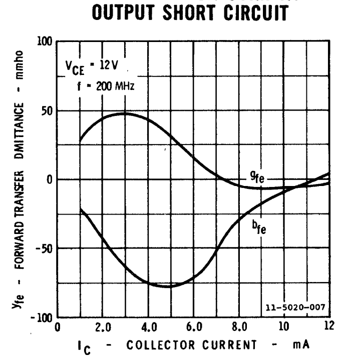
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



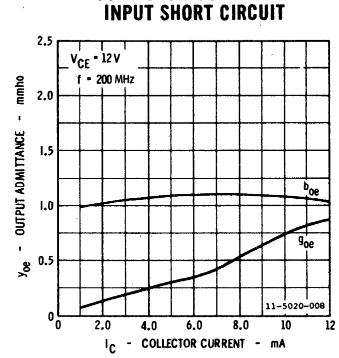
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT

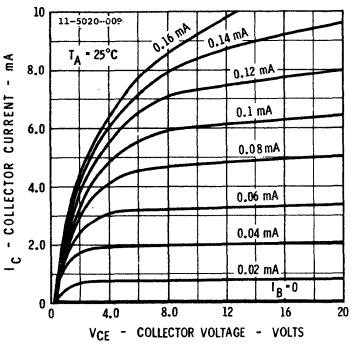


OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT

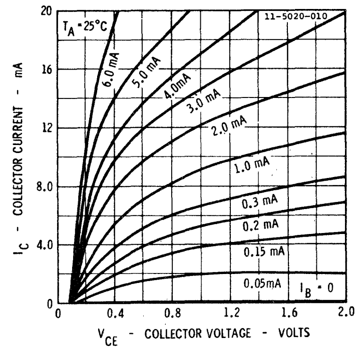


TYPICAL ELECTRICAL CHARACTERISTICS

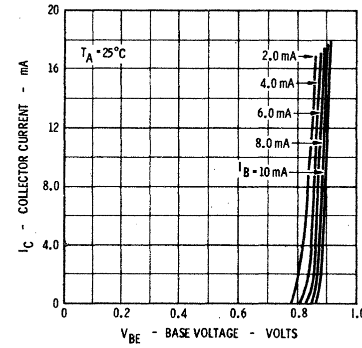
COLLECTOR CHARACTERISTICS*



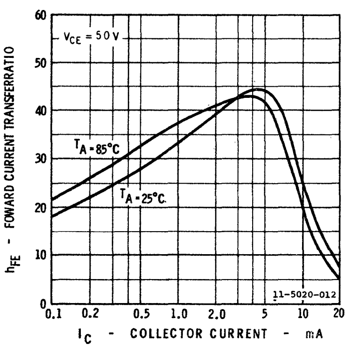
COLLECTOR CHARACTERISTICS*



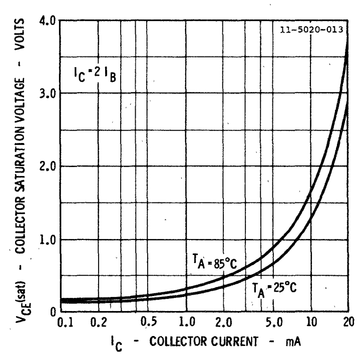
BASE CHARACTERISTICS*



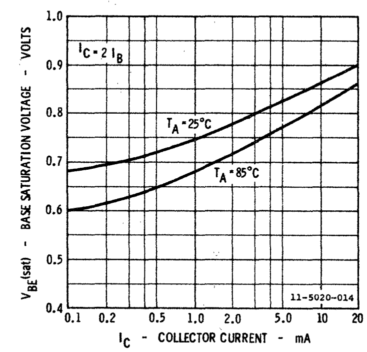
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



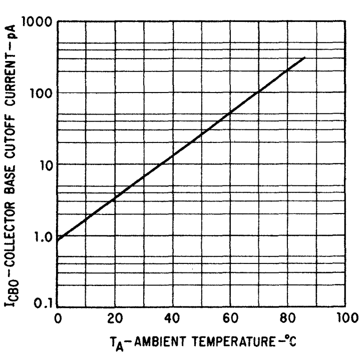
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



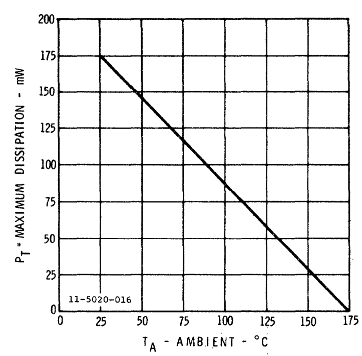
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



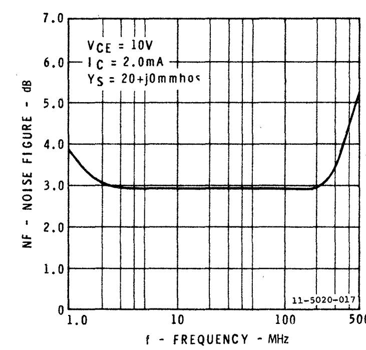
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



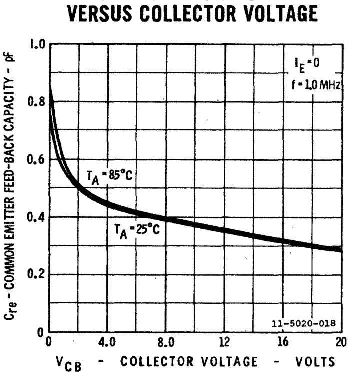
MAXIMUM DISSIPATION VERSUS TEMPERATURE



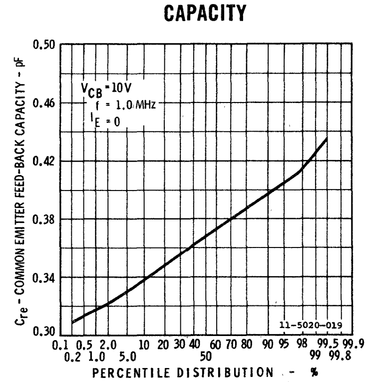
NOISE FIGURE VERSUS FREQUENCY



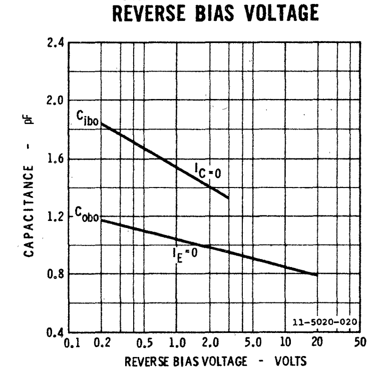
COMMON EMITTER FEED-BACK CAPACITY VERSUS COLLECTOR VOLTAGE



DISTRIBUTION OF COMMON EMITTER FEED-BACK CAPACITY



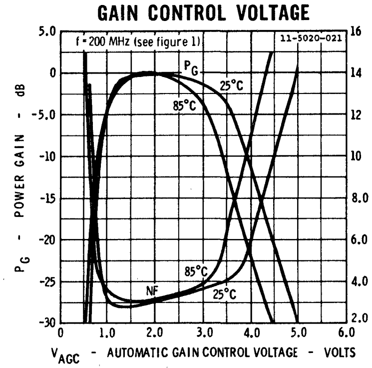
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



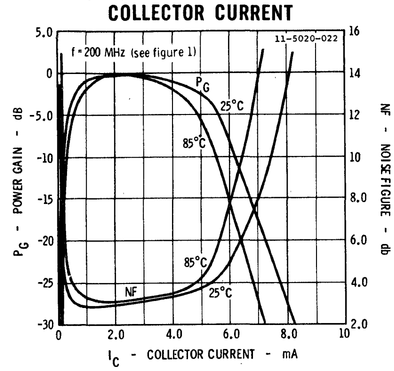
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

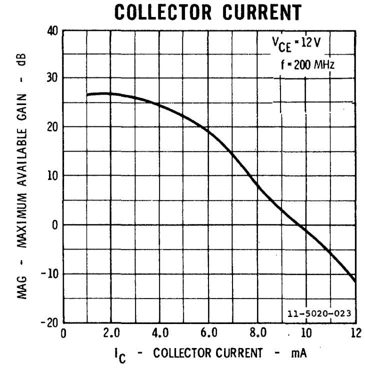
POWER GAIN AND NOISE FIGURE VERSUS AUTOMATIC GAIN CONTROL VOLTAGE



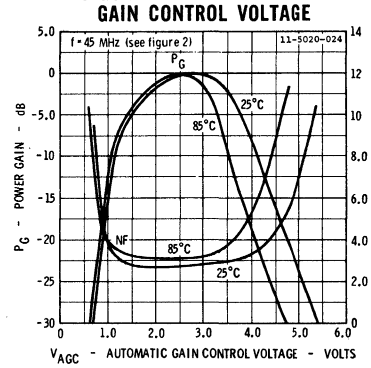
POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT



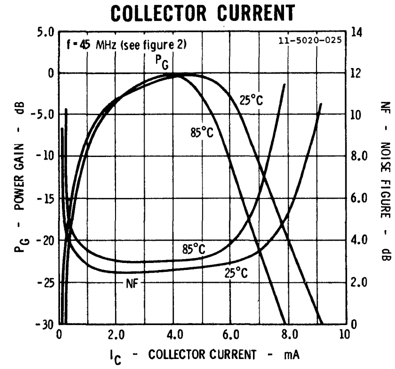
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



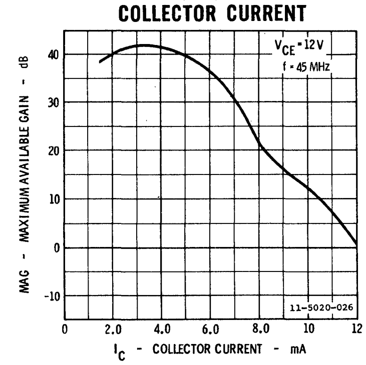
POWER GAIN AND NOISE FIGURE VERSUS AUTOMATIC GAIN CONTROL VOLTAGE



POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT



MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



200 MHz AGC, POWER GAIN AND NOISE FIGURE TEST JIG

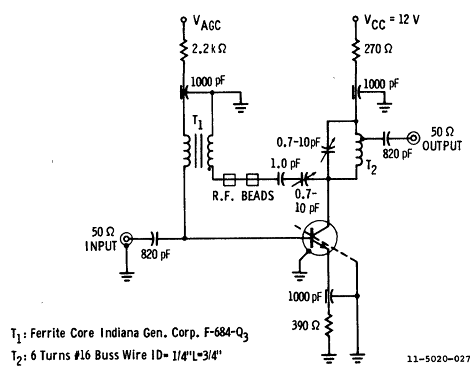


FIGURE 1

45 MHz, AGC, POWER GAIN AND NOISE FIGURE TEST JIG

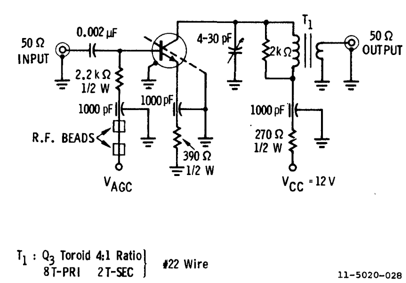


FIGURE 2

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 175°C and junction-to-case thermal resistance of 583°C/Watt (derating factor of 1.73 mW/°C); junction-to-ambient thermal resistance of 850°C/Watt (derating factor of 1.17 mW/°C).

(3) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

(5) Test conditions are as shown on Fig. 1 with fixed neutralization. Neutralization is optimum for a typical device with $C_{re} \cong 0.37$ pF.

(6) Test conditions are as shown on Fig. 2. This test assures gain variations $\leq$ 3 dB around a typical 25.5 dB nominal for the unneutralized case. For the neutralized case (MAG) typical gains of 40 dB are obtainable with the SE5023 and SE5024 at 45 MHz.

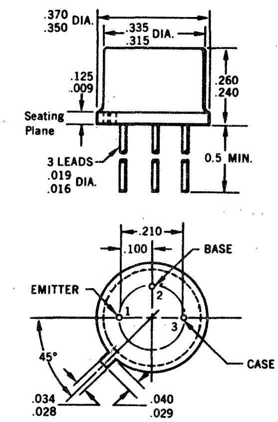
2N5022 · 2N5023

PNP HIGH VOLTAGE, HIGH CURRENT SWITCHES

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTORS

- **FAST SWITCHING . . . . $t_{on} = 25$ ns (TYP) @ 500 mA**
  . . . . $t_{off} = 65$ ns (TYP) @ 500 mA
- **LOW SATURATION VOLTAGE . . . $V_{CE}(sat) = 0.7$ V (MAX) @ 1.0 A**
- **HIGH FREQUENCY . . . . $f_T = 200$ MHz (MIN) @ 50 mA**
- **HIGH BETA . . . . $h_{FE} = 40 - 100$ @ 500 mA**
  . . . . $h_{FE} = 40$ (MIN) @ 1.0 A

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold-plated KOVAR
Lead No. 3 internally connected to case
Package weight is 1.23 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, 60 second time limit)	+300°C

Maximum Power Dissipation (Note 2 and 3)

Total Dissipation at 25°C Case Temperature	4.0 Watts
Total Dissipation at 25°C Ambient Temperature	1.0 Watt

Maximum Voltages and Current		**2N5022**	**2N5023**
V_{CBO}	Collector to Base Voltage	−50 Volts	−30 Volts
V_{CES}	Collector to Emitter Voltage	−50 Volts	−30 Volts
V_{CEO}	Collector to Emitter Voltage	−50 Volts	−30 Volts
V_{EBO}	Emitter to Base Voltage (Note 4)	−5.0 Volts	−5.0 Volts
I_C	Maximum Collector Current (Note 5)	1.0 Amp	1.0 Amp

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

SYMBOL	CHARACTERISTIC	2N5022 MIN.	2N5022 TYP.	2N5022 MAX.	2N5023 MIN.	2N5023 TYP.	2N5023 MAX.	UNITS	TEST CONDITIONS	
t_{on}	**Turn On Time** (Note 6)		25	40		**25**	**40**	**ns**	**$I_C \approx 500$ mA**	**$I_{B1} \approx 50$ mA**
t_{off}	**Turn Off Time** (Note 6)		65	90		**65**	**90**	**ns**	**$I_C \approx 500$ mA**	**$I_{B1} \approx 50$ mA** **$I_{B2} \approx -50$ mA**
h_{FE}	DC Pulse Current Gain (Note 5)	15	40		30	50			$I_C = 100$ mA	$V_{CE} = -1.0$ V
h_{FE}	**DC Pulse Current Gain** (Note 5)	25	45	100	**40**	**60**	**100**		**$I_C = 500$ mA**	**$V_{CE} = -1.0$ V**
h_{FE}	**DC Pulse Current Gain** (Note 5)	25	45		**40**	**60**			**$I_C = 1000$ mA**	**$V_{CE} = -5.0$ V**
$h_{FE}(-55°C)$	DC Pulse Current Gain (Note 5)	10	25		20	45			$I_C = 500$ mA	$V_{CE} = -1.0$ V
$V_{CE}(sat)$	Pulsed Collector Saturation Voltage (Note 5)		−0.1	−0.2		−0.09	−0.17	Volts	$I_C = 100$ mA	$I_B = 10$ mA
$V_{CE}(sat)$	Pulsed Collector Saturation Voltage (Note 5)		−0.24	−0.4		−0.19	−0.35	Volts	$I_C = 500$ mA	$I_B = 50$ mA
$V_{CE}(sat)$	**Pulsed Collector Saturation Voltage** (Note 5)		−0.41	−0.8		**−0.3**	**−0.7**	**Volts**	**$I_C = 1000$ mA**	**$I_B = 100$ mA**
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	1.7	2.3		**2.0**	**2.8**			**$I_C = 50$ mA**	**$V_{CE} = -10$ V**
C_{cb}	Collector to Base Capacitance		18	25		20	25	pF	$V_{CB} = -10$ V	$I_E = 0$
C_{eb}	Emitter to Base Capacitance		80	100		80	100	pF	$V_{BE} = 0.5$ V	$I_C = 0$

*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 43.8°C/Watt (derating factor of 22.8 mW/°C); junction to ambient thermal resistance of 175°C/Watt (derating factor of 5.72 mW/°C).
(4) 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.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_B, and I_{B2}.

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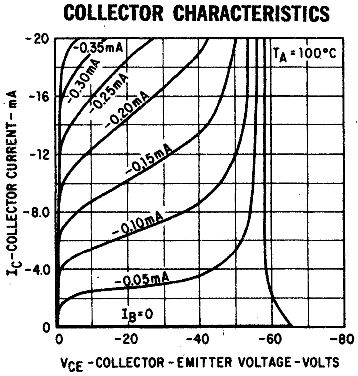
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

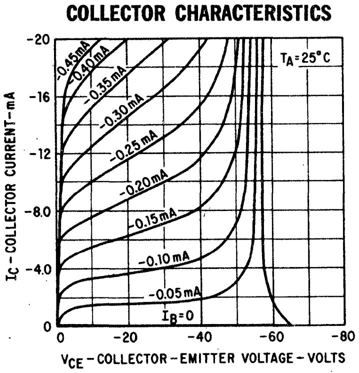
SYMBOL	CHARACTERISTIC	2N5022 MIN.	2N5022 TYP.	2N5022 MAX.	2N5023 MIN.	2N5023 TYP.	2N5023 MAX.	UNITS	TEST CONDITIONS	
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 4 and 5)	−50			−30			Volts	$I_C = 10$ mA	$I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−50			−30			Volts	$I_C = 100\ \mu A$	$I_E = 0$
BV_{CES}	Collector to Base Breakdown Voltage	−50			−30			Volts	$I_C = 100\ \mu A$	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0			−5.0			Volts	$I_E = 100\ \mu A$	$I_C = 0$
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		−0.8	−1.0		−0.8	−1.0	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	−0.9	−1.02	−1.4	−0.9	−1.02	−1.4	Volts	$I_C = 500$ mA	$I_B = 50$ mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)		−1.2	−1.75		−1.2	−1.75	Volts	$I_C = 1000$ mA	$I_B = 100$ mA
I_{CES}	Collector Reverse Current		10	100				nA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES}	Collector Reverse Current					8.0	100	nA	$V_{CE} = -20$ V	$V_{BE} = 0$
I_{CES}(100°C)	Collector Reverse Current		1.5	15				μA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES}(100°C)	Collector Reverse Current					1.0	15	μA	$V_{CE} = -20$ V	$V_{BE} = 0$

2N5022

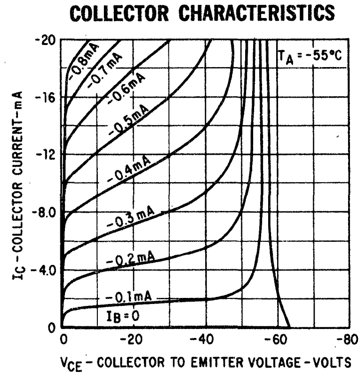
COLLECTOR CHARACTERISTICS



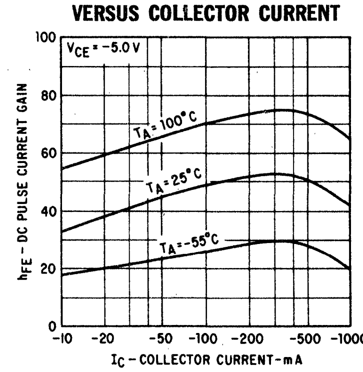
COLLECTOR CHARACTERISTICS



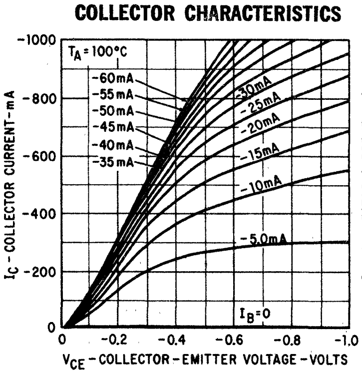
COLLECTOR CHARACTERISTICS



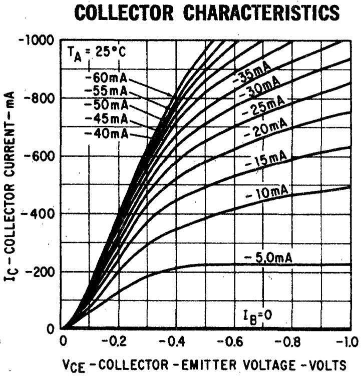
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



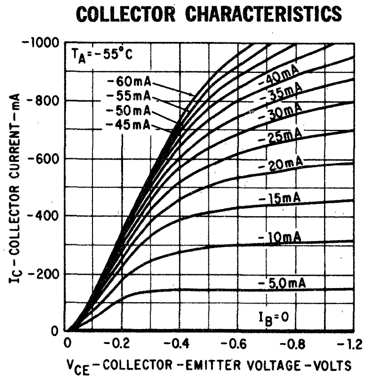
COLLECTOR CHARACTERISTICS



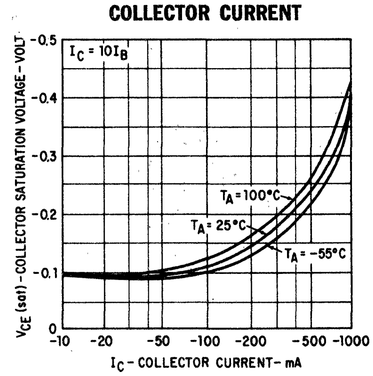
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



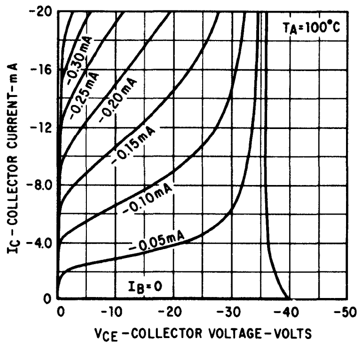
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



TYPICAL ELECTRICAL CHARACTERISTICS

2N5023

COLLECTOR CHARACTERISTICS*



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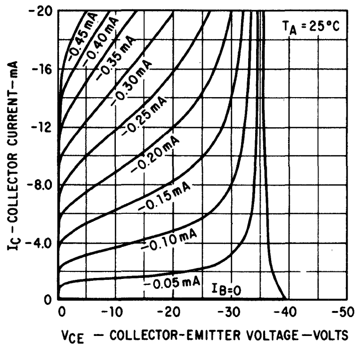

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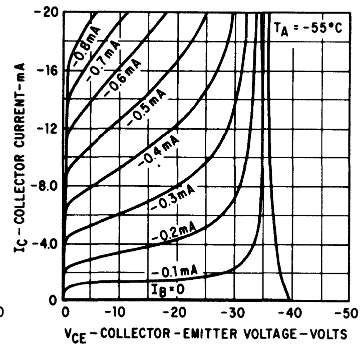
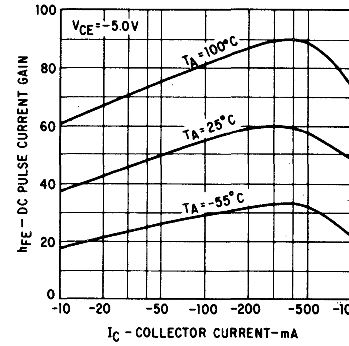


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



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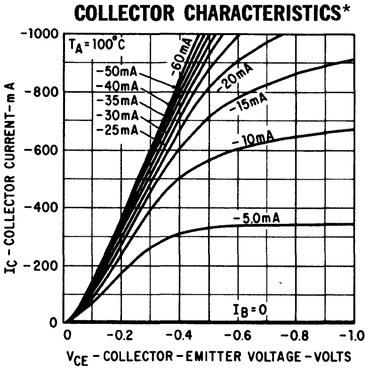

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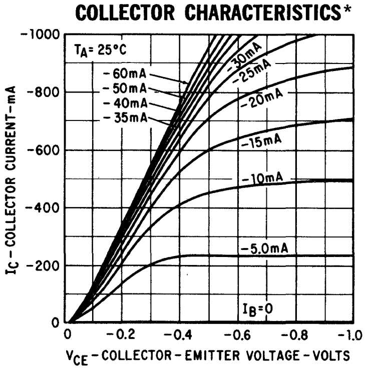

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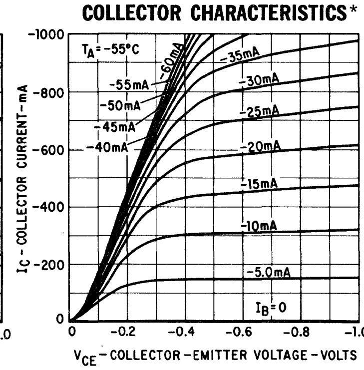
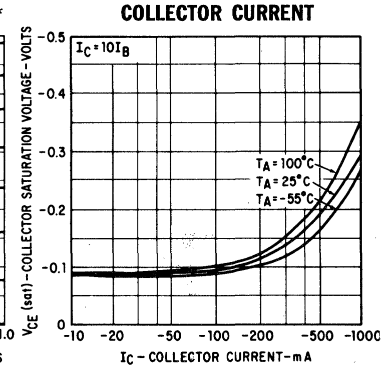
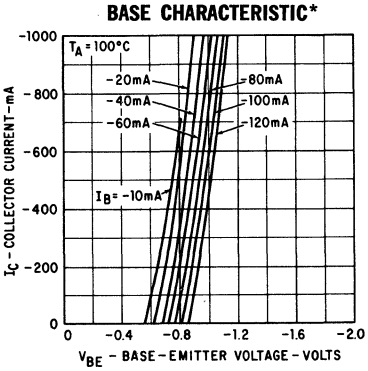


COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

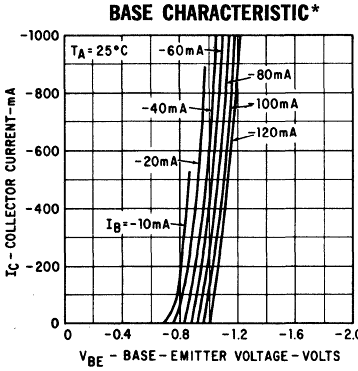


2N5022 • 2N5023

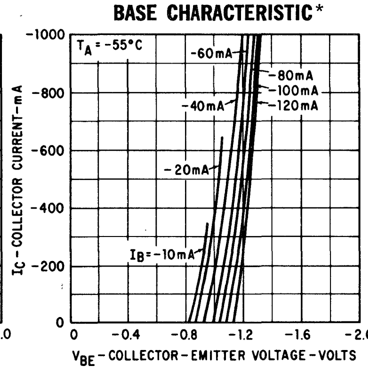
BASE CHARACTERISTIC*



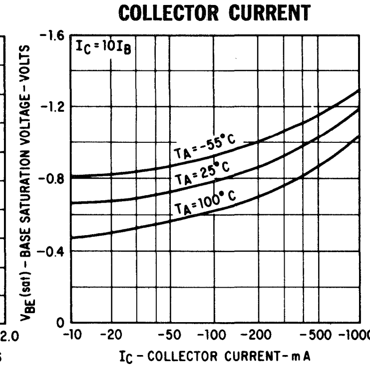
BASE CHARACTERISTIC*



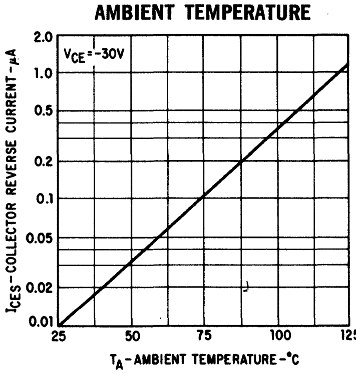
BASE CHARACTERISTIC*



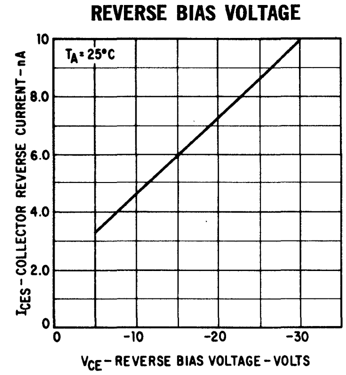
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



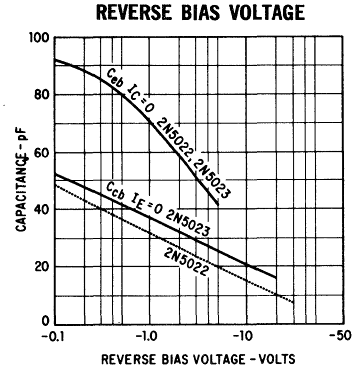
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



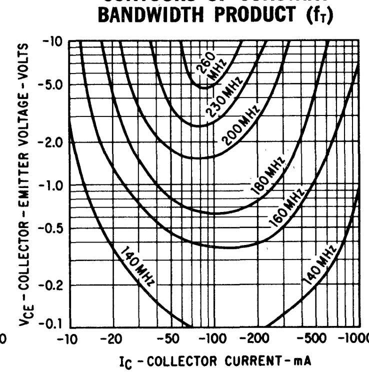
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

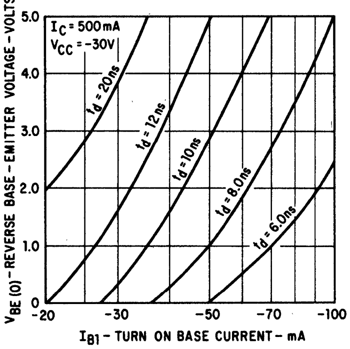


CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)

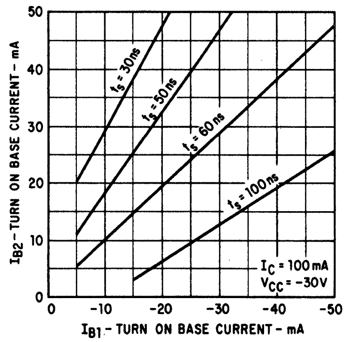


* Single family characteristic on Transistor Curve Tracer.

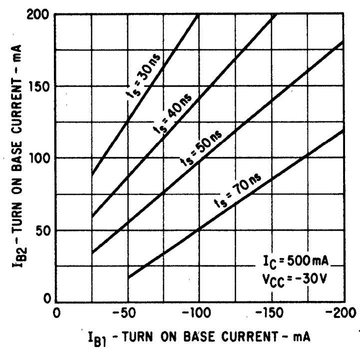
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



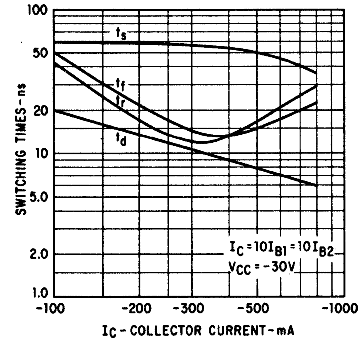
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



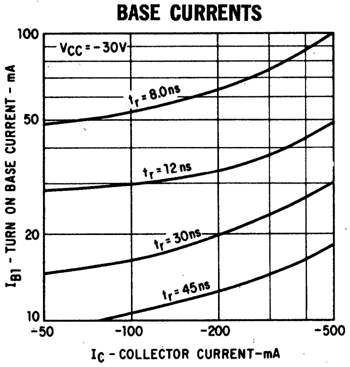
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



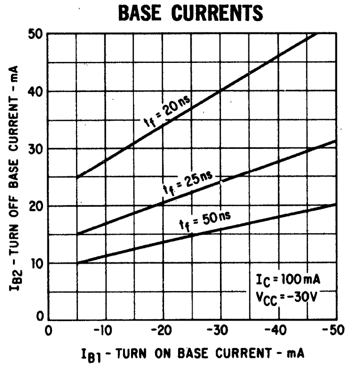
SWITCHING TIMES VERSUS COLLECTOR CURRENT



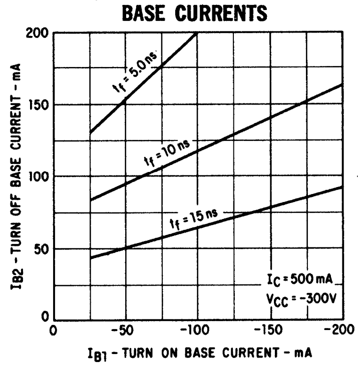
RISE TIME VERSUS COLLECTOR CURRENT AND TURN-ON BASE CURRENTS



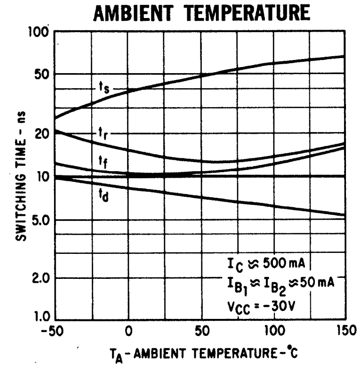
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



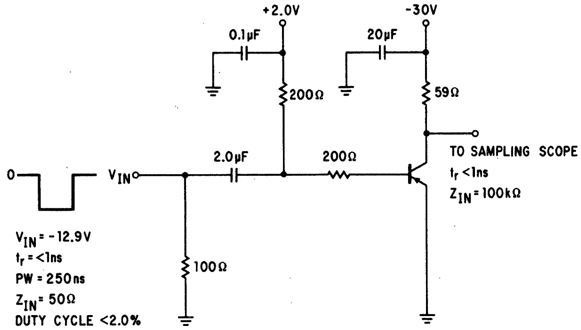
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



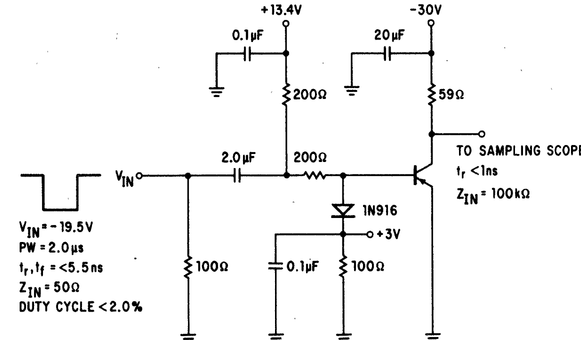
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



TURN-ON CIRCUIT

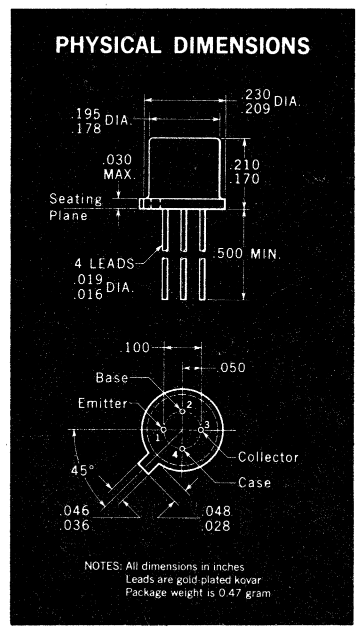


TURN-OFF CIRCUIT



SE5050 • SE5051
NPN RF AMPLIFIERS
DIFFUSED SILICON PLANAR* TRANSISTORS

- **LOW FEEDBACK (Cre) -- 0.25–0.50 pF (Guaranteed Min. and Max.)**
- **LOW NOISE FIGURE -- 4 dB (Max.) at 100 MHz**
- **HIGH POWER GAIN -- 20 dB (Min.) at 100 MHz**
- **FORWARD AGC**



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		−55°C to +175°C
Operating Junction Temperature		175°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature	(Note 2)	0.260 Watt
at 25°C Ambient Temperature	(Note 2)	0.175 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		20 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 3)	20 Volts
V_{EBO}	Emitter to Base Voltage		3.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
NF	**Noise Figure (f = 100 MHz) SE5050** (Notes 5 and 6)		**3.0**	**4.0**	**dB**	$V_{AGC} = 2.0$ V $R_G = 75\Omega$
NF	**Noise Figure (f = 100 MHz) SE5051** (Notes 5 and 6)		3.0		dB	$V_{AGC} = 2.0$ V $R_G = 75\Omega$
PG	**Power Gain (f = 100 MHz)** (Notes 5 and 6)	**20**	**27.5**		**dB**	$V_{AGC} = 2.0$ V $R_G = 75\Omega$
$V_{AGC(30)}$	AGC Voltage for 30 db gain reduction (f = 100 MHz)		4.7		Volts	$R_S = 75\Omega$ (Notes 5 and 6)
Cre	**Reverse transfer capacity** Common emitter	**0.25**	**0.37**	**0.50**	**pF**	$I_E = 0$ $V_{CB} = 10$ V f = 1.0 MHz
h_{FE}	DC Pulse Current Gain (Note 4)	20	40	200		$V_{CE} = 5$ V $I_C = 4.0$ mA
V_{CEO} (sust)	**Collector to Emitter sustaining Voltage** (Notes 3 and 4)	**20**			**Volts**	$I_C = 1.0$ mA $I_B = 0$
I_{CBO}	Collector Cutoff Current			50	nA	$I_E = 0$ $V_{CB} = 10$V
BV_{CBO}	Collector to Base Breakdown Voltage	20			Volts	$I_C = 100\ \mu$A $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0			Volts	$I_C = 0$ $I_E = 100\ \mu$A
V_{CE} (sat)	Collector Saturation Voltage			3.0	Volts	$I_C = 10$ mA $I_B = 5$ mA
V_{BE} (sat)	Base Saturation Voltage			0.96	Volt	$I_C = 10$ mA $I_B = 5$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0				$I_C = 4.0$ 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 ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 583°C/Watt (derating factor of 1.73 mW/°C); junction-to-ambient thermal resistance of 850°C/Watt (derating factor of 1.17 mW/°C).

(3) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

(5) Test conditions are as shown on Fig. 1 with fixed neutralization. Neutralization is optimum for a typical device with $C_{re} \cong 0.37$ pF.

(6) 50Ω input is transformed so that the transistor under test sees 75Ω.

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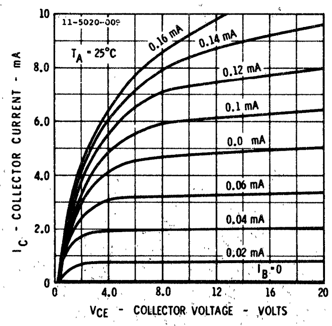
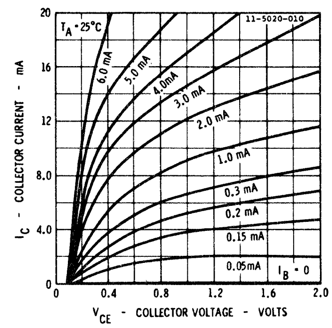
TYPICAL ELECTRICAL CHARACTERISTICS

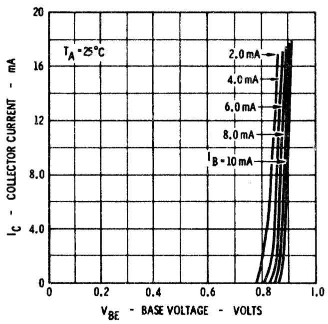
COLLECTOR CHARACTERISTICS



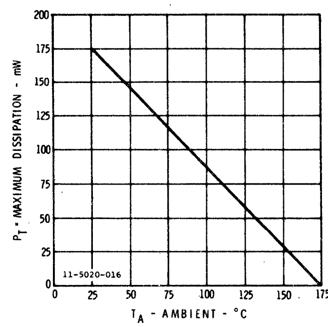
COLLECTOR CHARACTERISTICS



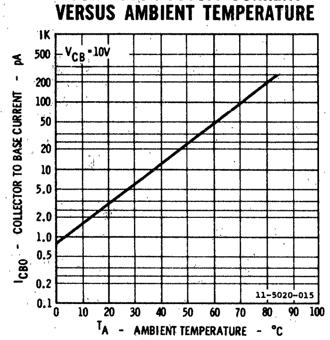
BASE CHARACTERISTICS



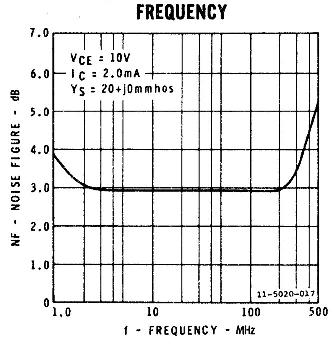
MAXIMUM DISSIPATION VERSUS TEMPERATURE



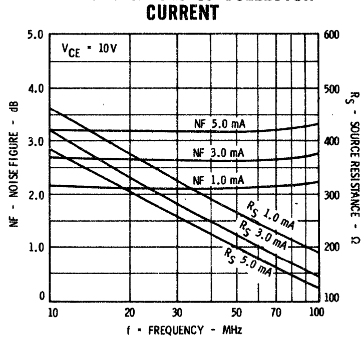
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



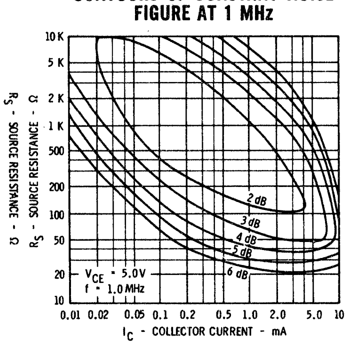
NOISE FIGURE VERSUS FREQUENCY



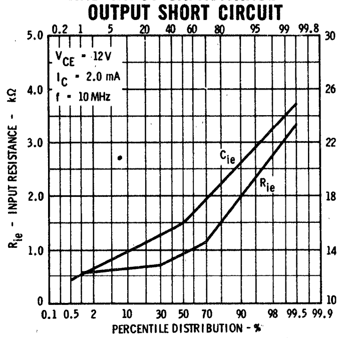
SOURCE RESISTANCE AND NOISE FIGURE VERSUS FREQUENCY AT VARIOUS VALUES OF COLLECTOR CURRENT



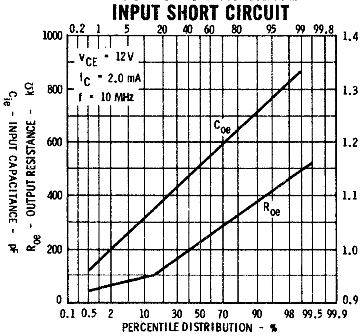
CONTOURS OF CONSTANT NOISE FIGURE AT 1 MHz



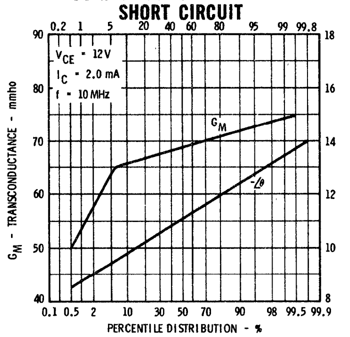
DISTRIBUTION OF COMMON EMITTER INPUT RESISTANCE AND INPUT CAPACITANCE — OUTPUT SHORT CIRCUIT



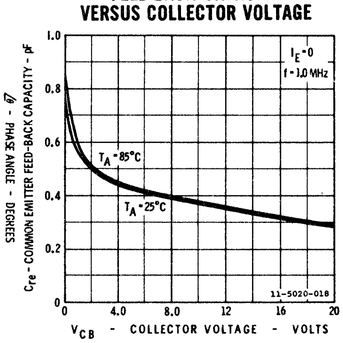
DISTRIBUTION OF COMMON EMITTER OUTPUT RESISTANCE AND OUTPUT CAPACITANCE — INPUT SHORT CIRCUIT



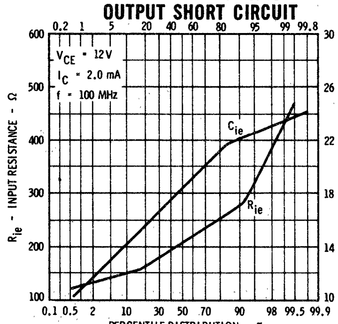
DISTRIBUTION OF PHASE ANGLE AND TRANSCONDUCTANCE — COMMON EMITTER CONFIGURATION — OUTPUT SHORT CIRCUIT



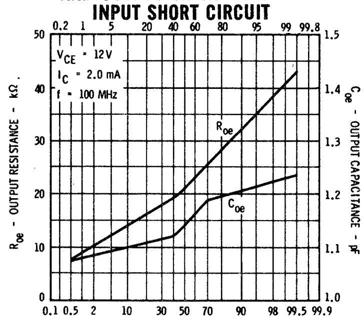
COMMON EMITTER FEED-BACK CAPACITY VERSUS COLLECTOR VOLTAGE



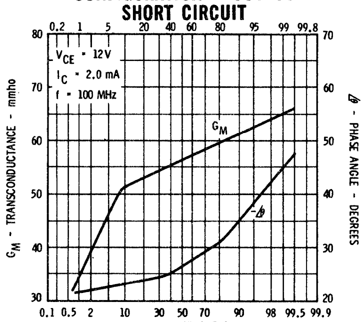
DISTRIBUTION OF COMMON EMITTER INPUT RESISTANCE AND INPUT CAPACITANCE — OUTPUT SHORT CIRCUIT



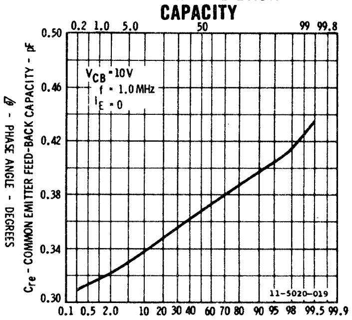
DISTRIBUTION OF COMMON EMITTER OUTPUT RESISTANCE AND OUTPUT CAPACITANCE — INPUT SHORT CIRCUIT



DISTRIBUTION OF PHASE ANGLE AND TRANSCONDUCTANCE — COMMON EMITTER CONFIGURATION — OUTPUT SHORT CIRCUIT

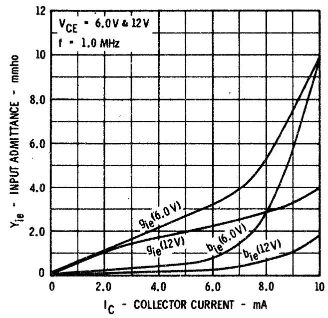


DISTRIBUTION OF COMMON EMITTER FEED-BACK CAPACITY

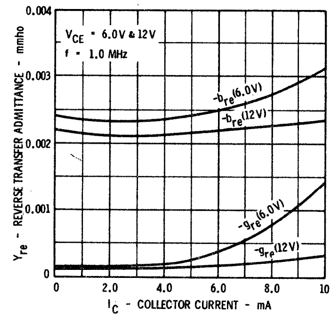


TYPICAL SMALL SIGNAL "Y" PARAMETERS - COMMON EMITTER

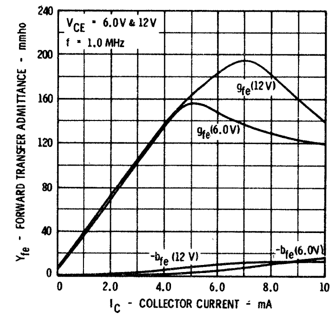
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



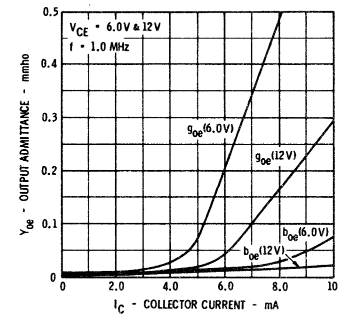
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



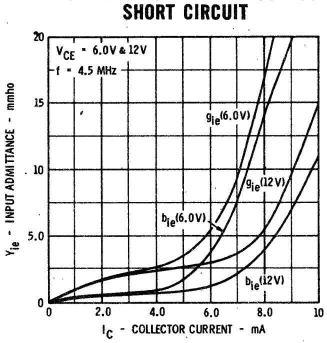
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



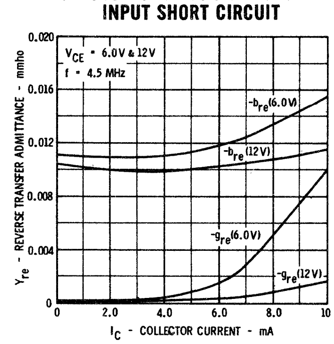
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



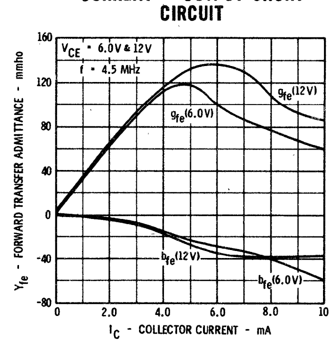
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



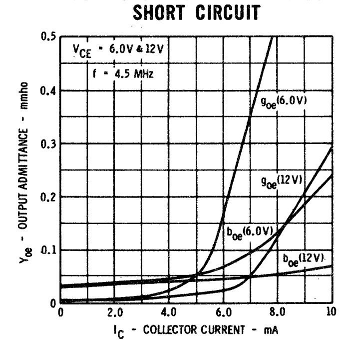
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



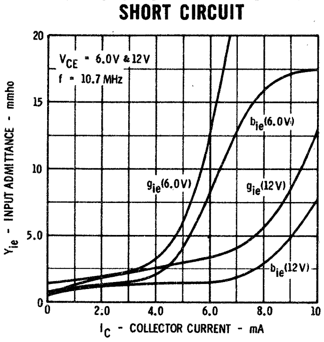
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



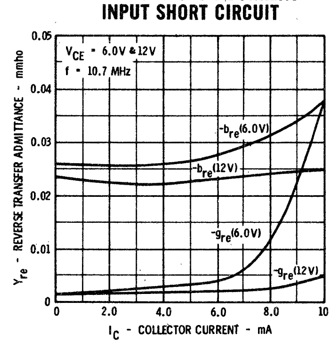
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



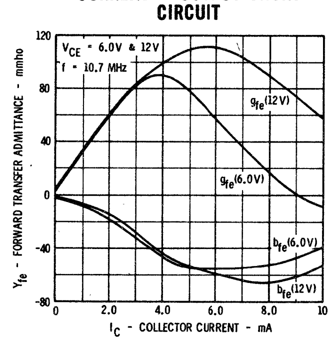
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



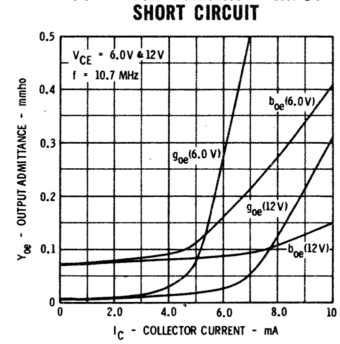
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



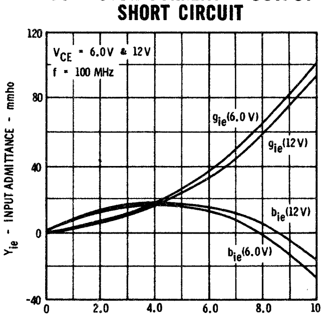
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



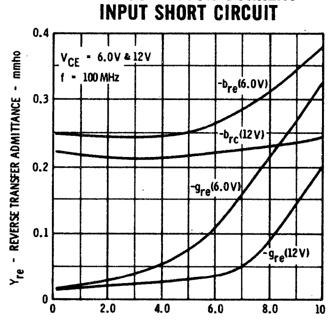
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



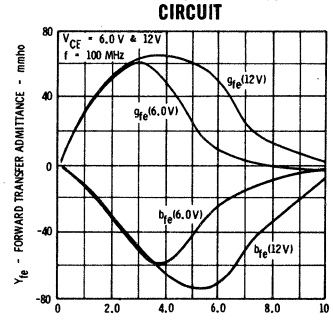
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



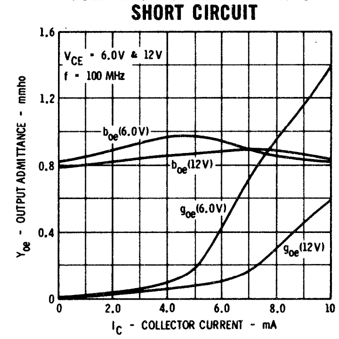
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT

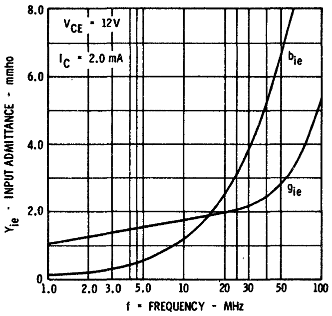


OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT

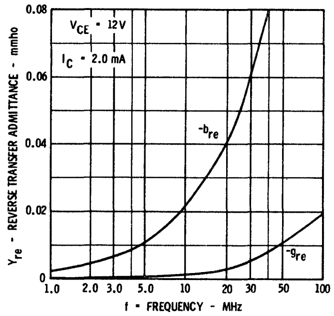


TYPICAL ELECTRICAL CHARACTERISTICS

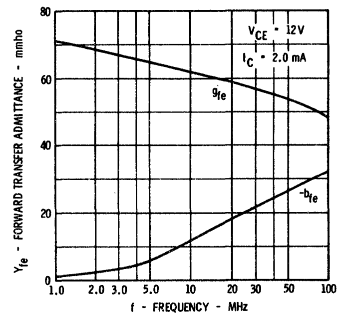
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



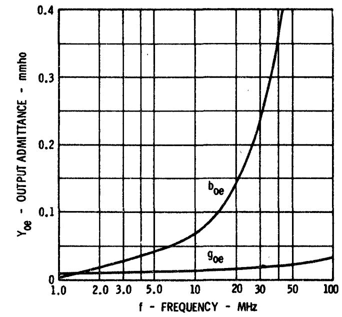
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



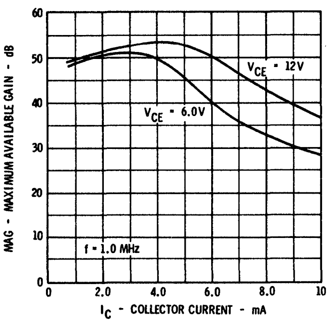
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



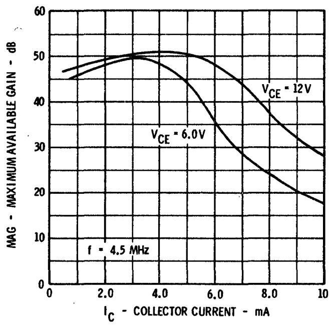
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



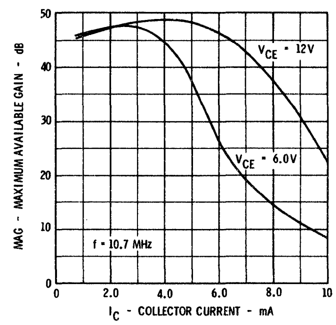
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



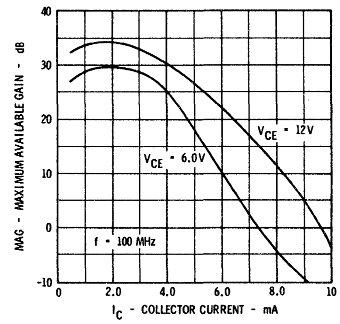
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



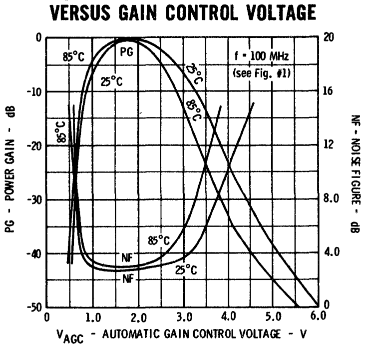
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



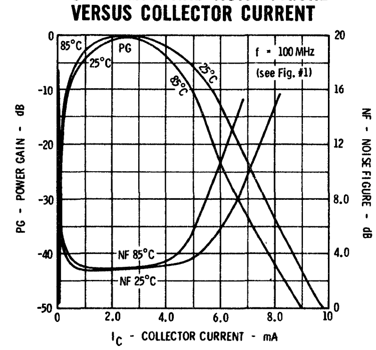
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



POWER GAIN AND NOISE FIGURE VERSUS GAIN CONTROL VOLTAGE



POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT



PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

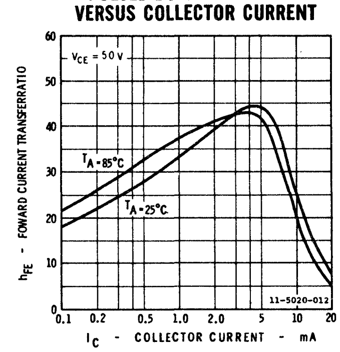
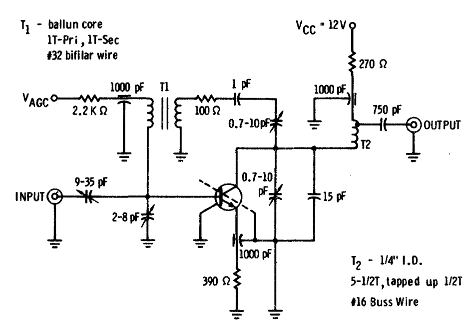


FIG. 1-100 MHz AGC, POWER GAIN, AND NOISE FIGURE TEST JIG



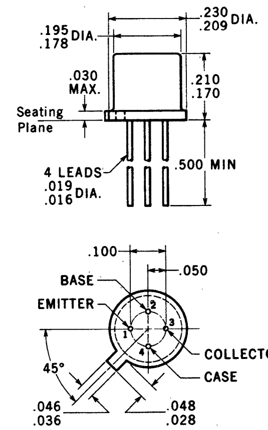
SE5052

NPN RF—AGC AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTOR

- OPTIMIZED FOR COMMON-BASE VHF OPERATION
- FORWARD AGC CAPABILITY TO —30 dB
- LOW NOISE FIGURE . . . 4.0 dB MAX. AT 200 MHz, $R_S = 50\ \Omega$
- HIGH UNNEUTRALIZED GAIN . . . 16 dB MIN. AT 200 MHz, $R_S = 50\ \Omega$
- OFFERS IMPROVED CROSS-MODULATION PERFORMANCE OVER COMMON EMITTER CONFIGURATION

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.47 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

MAXIMUM TEMPERATURES

Storage Temperature	−55°C to +175°C
Operating Junction Temperature	+175°C

MAXIMUM POWER DISSIPATION

Total dissipation at	
25°C Case Temperature (Note 2)	0.260 Watt
25°C Ambient Temperature (Note 2)	0.175 Watt

MAXIMUM VOLTAGES

V_{CBO} Collector to Base Voltage	20 Volts
V_{CEO} Collector to Emitter Voltage (Note 3)	20 Volts
V_{EBO} Emitter to Base Voltage	3.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
N.F.	**Noise figure, f = 200 MHz, $R_S = 50\ \Omega$ Common base configuration**		**3.0**	**4.0**	**dB**	**$V_{CC} = 10$ V see fig. 1**	**$I_C = 3.0$ mA**
P.G.	**Power gain, f = 200 MHz, $R_S = 50\ \Omega$ Unneutralized common-base**	**16**	**18**		**dB**	**$V_{CC} = 10$ V see fig. 1**	**$I_C = 3.0$ mA**
I_{AGC} —30 dB	**Collector current required for 30 dB gain reduction**		**10.0**		**mA**	**$V_{CC} = 10$ V**	**see fig. 1**
C_{ce}	Collector to emitter capacitance (f = 1.0 MHz)		0.17		pF	$V_{CE} = 10$ V	$I_B = 0$
I_B	Base current		80	200	μA	$V_{CB} = 5.0$ V	$I_C = 4.0$ mA
h_{fe}	High frequency current gain (f = 100 MHz)	3.75	5.0			$V_{CE} = 10$ V	$I_C = 4.0$ mA
I_{CBO}	Collector to base reverse leakage current			50	nA	$V_{CB} = 10$ V	$I_E = 0$
$V_{CEO(sus)}$	Collector to emitter sustaining voltage	20			V	$I_C = 1.0$ mA	$I_B = 0$
BV_{CBO}	Collector to base breakdown voltage	20			V	$I_C = 100$ μA	$I_E = 0$
BV_{EBO}	Emitter to base breakdown voltage	3.0			V	$I_C = 0$	$I_E = 100$ μA
$V_{CE(sat)}$	Collector to emitter saturation voltage			3.0	V	$I_C = 10$ mA	$I_B = 5.0$ mA

*Planar is a patented Fairchild process.

NOTES:

1) These ratings are limiting values above which the serviceability of any individual semiconductor may be impaired.
2) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 583°C/Watt (derating factor of 1.73 mW/°C); junction-to-ambient thermal resistance of 850°C/Watt (derating factor of 1.17 mW/°C).
3) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

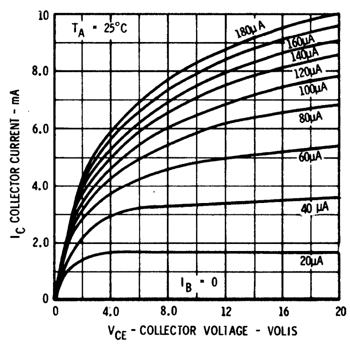
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL COMMON-BASE "Y" PARAMETERS - $T_A = 25°C$
$V_{CB} = 10$ V, $I_C = 3.0$ mA, f = 200 MHz

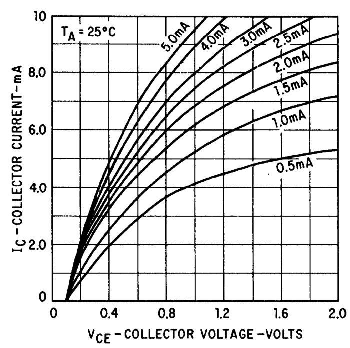
SYMBOL	PARAMETER	MAGNITUDE
$\lvert Y_{ib} \rvert$	INPUT ADMITTANCE OUTPUT SHORT CIRCUIT	50 — j40 mmhos
$\lvert Y_{rb} \rvert$	REVERSE TRANSADMITTANCE INPUT SHORT CIRCUIT	210 μmhos at $\angle -95°$
$\lvert Y_{fb} \rvert$	FORWARD TRANSADMITTANCE OUTPUT SHORT CIRCUIT	70 mmhos at $\angle 120°$
$\lvert Y_{ob} \rvert$	OUTPUT ADMITTANCE INPUT SHORT CIRCUIT	0.2 + j1.45 mmhos

TYPICAL ELECTRICAL CHARACTERISTICS

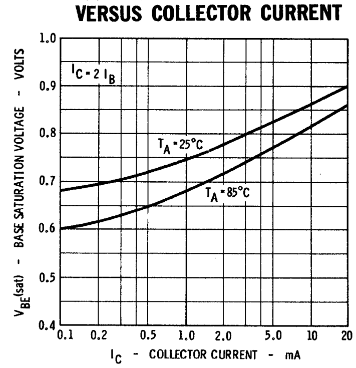
COLLECTOR CHARACTERISTICS*



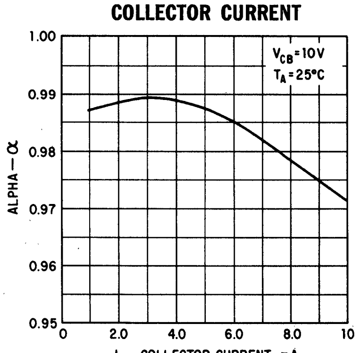
COLLECTOR CHARACTERISTICS*



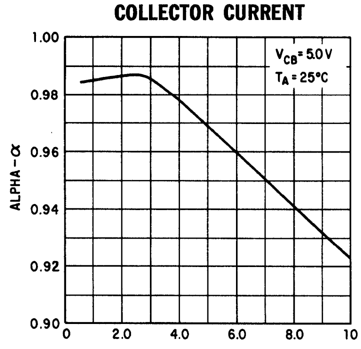
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



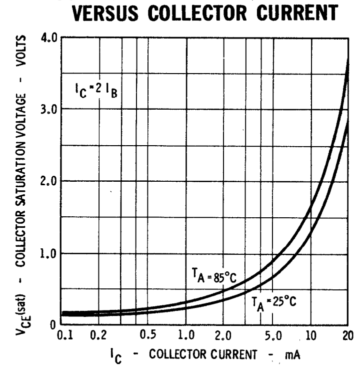
ALPHA VERSUS COLLECTOR CURRENT



ALPHA VERSUS COLLECTOR CURRENT



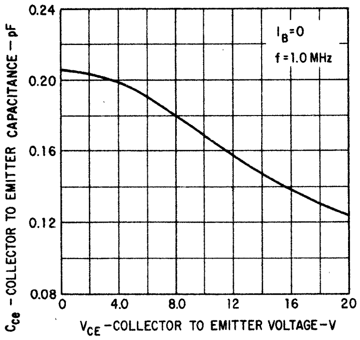
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



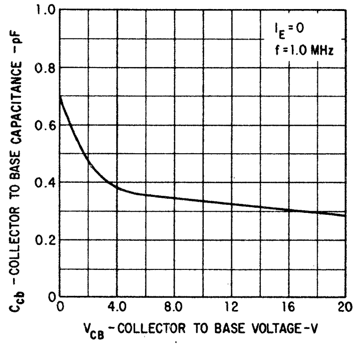
* Single family characteristic on Transistor Curve Tracer

TYPICAL ELECTRICAL CHARACTERISTICS

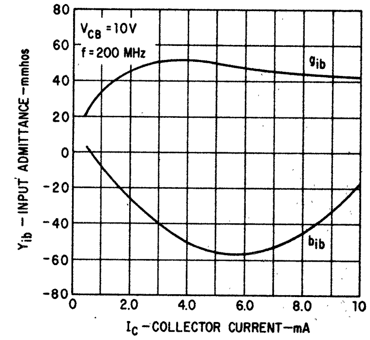
COLLECTOR TO EMITTER CAPACITANCE VERSUS COLLECTOR TO EMITTER VOLTAGE



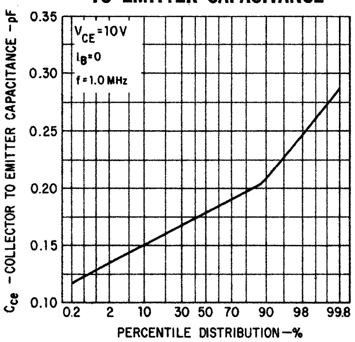
COLLECTOR TO BASE CAPACITANCE VERSUS COLLECTOR TO BASE VOLTAGE



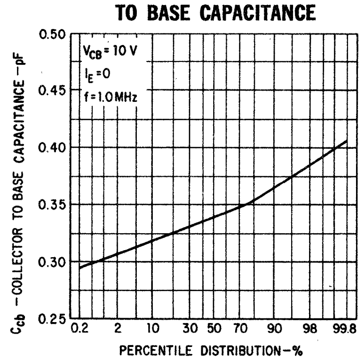
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



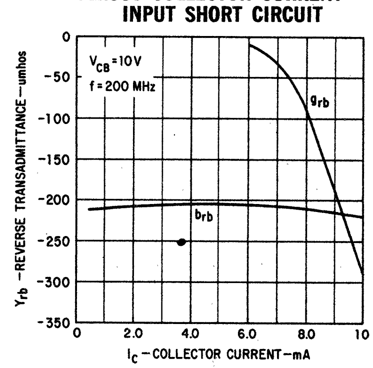
DISTRIBUTION OF COLLECTOR* TO EMITTER CAPACITANCE



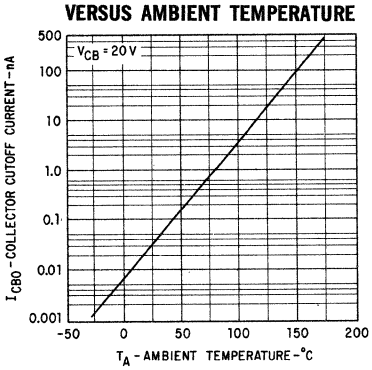
DISTRIBUTION OF COLLECTOR* TO BASE CAPACITANCE



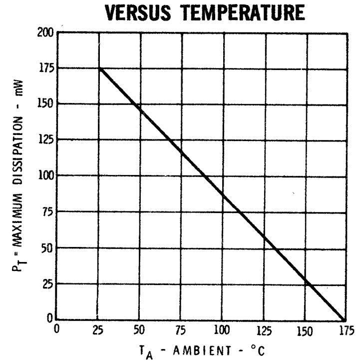
REVERSE TRANSADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



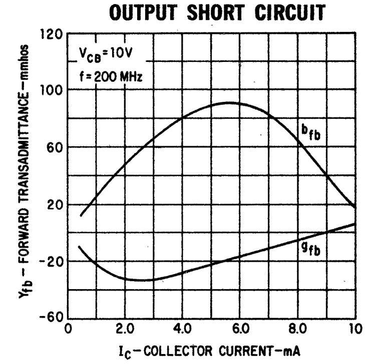
COLLECTOR CUT OFF CURRENT VERSUS AMBIENT TEMPERATURE



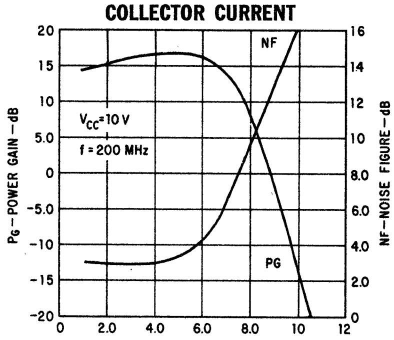
MAXIMUM DISSIPATION VERSUS TEMPERATURE



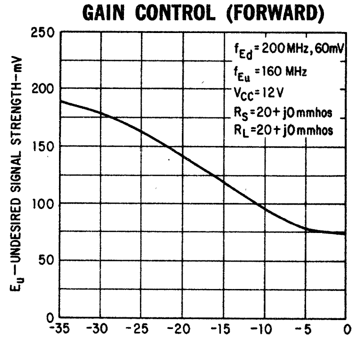
FORWARD TRANSADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



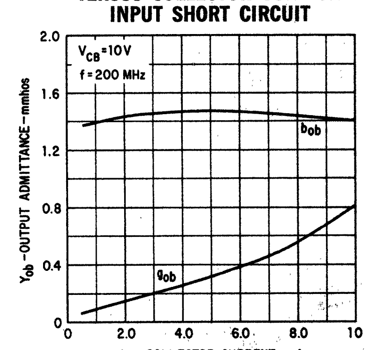
POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT



UNDESIRED SIGNAL STRENGTH FOR 1.0% CROSS MODULATION VERSUS AUTOMATIC GAIN CONTROL (FORWARD)

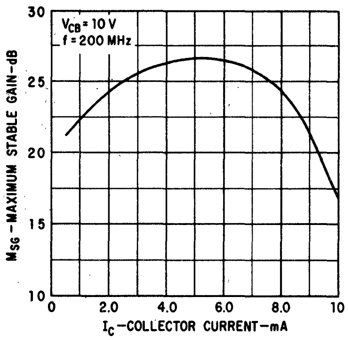


OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT INPUT SHORT CIRCUIT

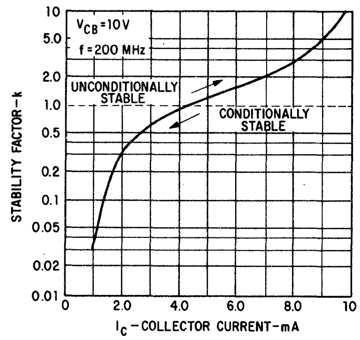


* These distributions derived from a random sample of 200 units.

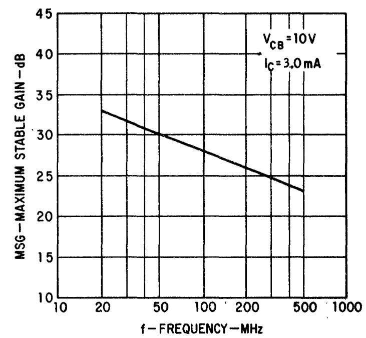
MAXIMUM STABLE GAIN VERSUS COLLECTOR CURRENT COMMON BASE CONFIGURATION



COMMON BASE CONFIGURATION STABILITY FACTOR - k VERSUS COLLECTOR CURRENT

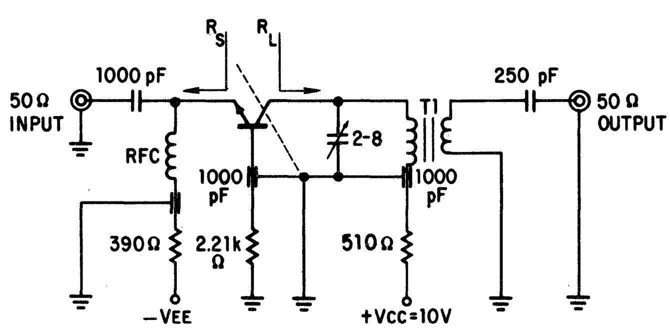


MAXIMUM STABLE GAIN VERSUS FREQUENCY COMMON BASE CONFIGURATION



Rollett stability factor 'k' is defined as: $k = \frac{2g_ig_o - Re(Y_fY_r)}{|Y_fY_r|}$

FIG. 1 200 MHz COMMON BASE POWER GAIN, NOISE FIGURE, AUTOMATIC GAIN CONTROL TEST CIRCUIT



T1—3:1 RATIO NO. 22 BIFILAR ON MICROMETALS TOROID, P/N T30-12
$R_S = 50\ \Omega$, $R_L = 2.5\ k\Omega$
f_{bw} - 8.0 MHz

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

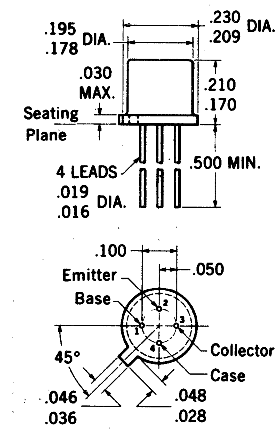
SE5055

NPN RF-AGC AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTOR

- **LOW FEEDBACK CAPACITY (C_{CB}) —0.13 pF TYPICAL, 0.22 pF MAX.**
- **HIGH UNNEUTRALIZED POWER GAIN —27 dB MIN. at 45 MHz.**
- **V_{AGC} GUARANTEED FOR —30 dB and —50 dB at 45 MHz.**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-72)



NOTES: All dimensions in inches
Leads are gold-plated Kovar
Collector electrically isolated from case
Package weight is 0.36 gram

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature		−55°C to +175°C
Operating Junction Temperature		+175°C

Maximum Power Dissipation

Total dissipation at 25°C Case Temperature [Note 2]	0.260 Watt
at 25°C Ambient Temperature [Note 2]	0.175 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	20 Volts
V_{CEO}	Collector to Emitter Voltage [Note 3]	20 Volts
V_{EBO}	Emitter to Base Voltage	3.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
P.G.	**Power Gain (f = 45 MHz)**	**27**	**29**		**dB**	**V_{BE} = 2.0 V**, See Figure 1
N.F.	Noise Figure (f = 45 MHz)		2.7	5.0	dB	V_{BE} = 2.0 V, See Figure 1
V_{AGC}	**AGC Voltage for 30 dB Gain Reduction (f = 45 MHz)**	**3.3**	**4.15**	**5.0**	**Volts**	**V_{CC} = 12 V**, See Figure 1
I_{AGC}	Collector Current for 30 dB Gain Reduction (f = 45 MHz)		7.2		mA	V_{CC} = 12 V, See Figure 1
V_{AGC}	**AGC Voltage for 50 dB Gain Reduction (f = 45 MHz)**		**6.15**	**7.5**	**Volts**	**V_{CC} = 12 V**, See Figure 1
C_{cb}	**Collector to Base Capacitance (f = 1.0 MHz)**		0.13	0.22	pF	I_E = 0, V_{CB} = 10 V
h_{FE}	DC Current Gain	20	80	220		I_C = 2.0 mA, V_{CE} = 10 V
V_{CEO} (Sust)	Collector to Emitter Sustaining Voltage [Note 3]	20			Volts	I_C = 1.0 mA, I_B = 0
I_{CBO}	Collector Cutoff Current			50	nA	I_E = 0, V_{CB} = 20 V
BV_{CBO}	Collector to Base Breakdown Voltage	20			Volts	I_C = 100 μA, I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0			Volts	I_C = 0, I_E = 100 μA
V_{CE} (Sat)	Collector Saturation Voltage			2.75	Volts	I_C = 10 mA, I_B = 5.0 mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0	5.0			I_C = 2.0 mA, V_{CE} = 10 V
R_{iep}	Input Resistance, Common Emitter (f = 45 MHz)		400		Ohms	I_C = 2.0 mA, V_{CE} = 10 V
C_{iep}	Input Capacitance, Common Emitter (f = 45 MHz)		16		pF	I_C = 2.0 mA, V_{CE} = 10 V
R_{oep}	Output Resistance, Common Emitter (f = 45 MHz)		67		kohms	I_C = 2.0 mA, V_{CE} = 10 V
C_{oep}	Output Capacitance, Common Emitter (f = 45 MHz)		1.2		pF	I_C = 2.0 mA, V_{CE} = 10 V

NOTES:

* Planar is a patented Fairchild process.

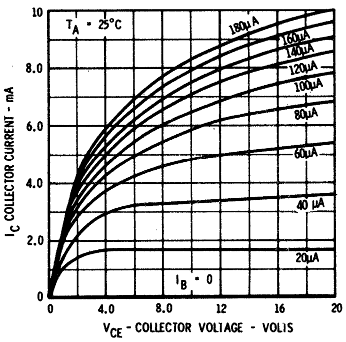
1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2) These ratings give a maximum junction temperature of 175°C and junction-to-case thermal resistance of 583°C/Watt (derating factor of 1.73 mW/°C); junction-to-ambient thermal resistance of 850°C/Watt (derating factor of 1.17 mW/°C).
3) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.

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

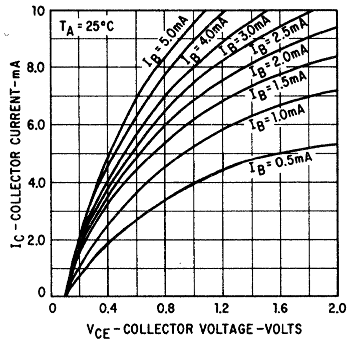
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

FAIRCHILD TRANSISTOR SE5055

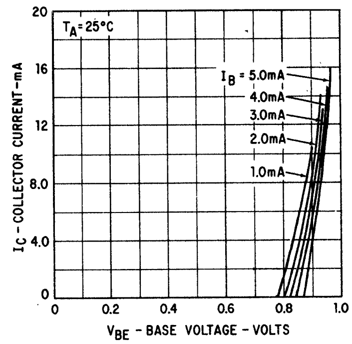
COLLECTOR CHARACTERISTICS*



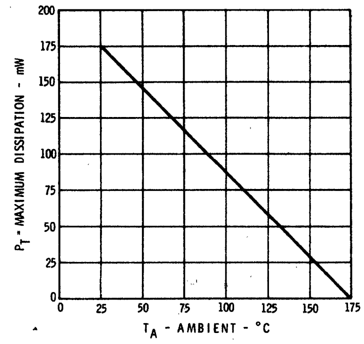
COLLECTOR CHARACTERISTICS*



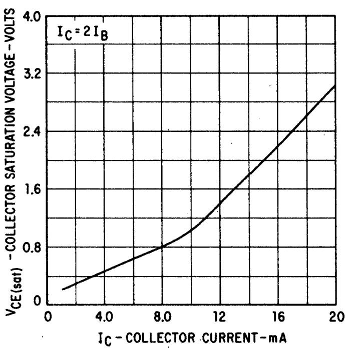
BASE CHARACTERISTICS*



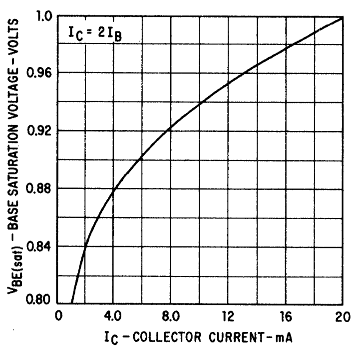
MAXIMUM DISSIPATION VERSUS TEMPERATURE



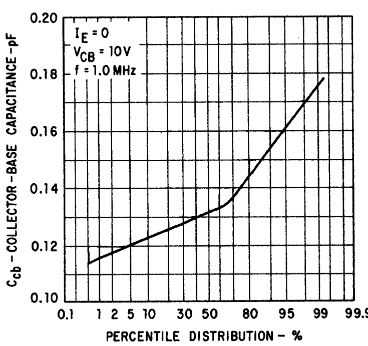
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



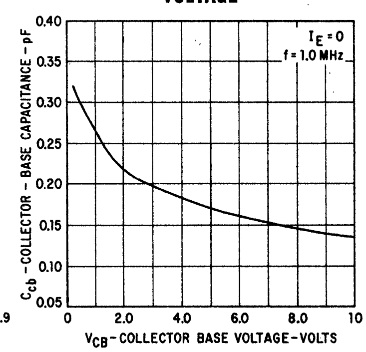
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



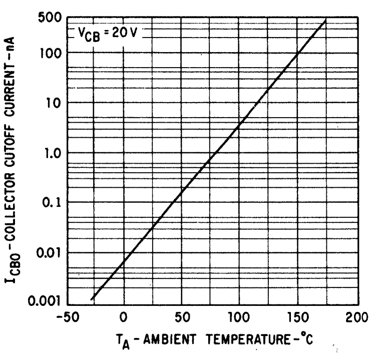
DISTRIBUTION OF COLLECTOR-BASE CAPACITANCE



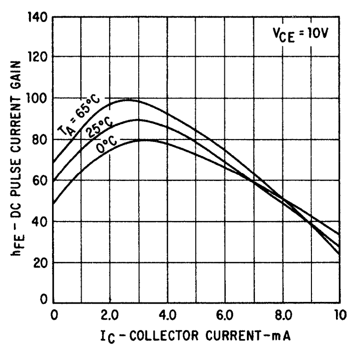
COLLECTOR-BASE CAPACITANCE VERSUS COLLECTOR-BASE VOLTAGE



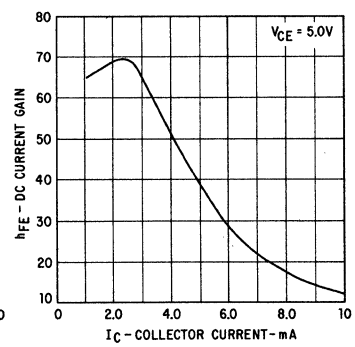
COLLECTOR CUT OFF CURRENT VERSUS AMBIENT TEMPERATURE



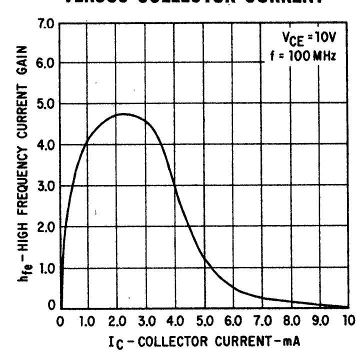
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



DC CURRENT GAIN VERSUS COLLECTOR CURRENT



HIGH FREQUENCY CURRENT GAIN VERSUS COLLECTOR CURRENT

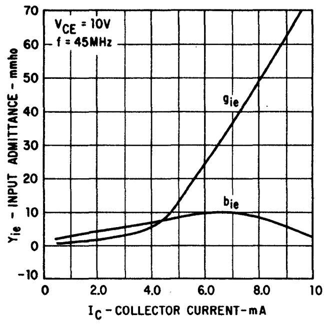


* Single family characteristic on Transistor Curve Tracer.

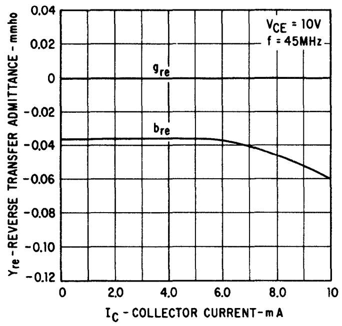
FAIRCHILD TRANSISTOR SE5055

TYPICAL SMALL SIGNAL COMMON EMITTER "Y" PARAMETERS

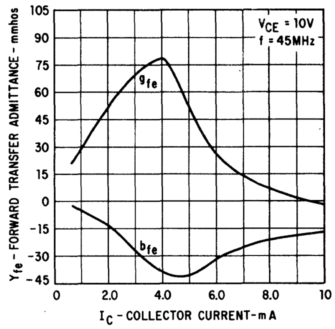
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



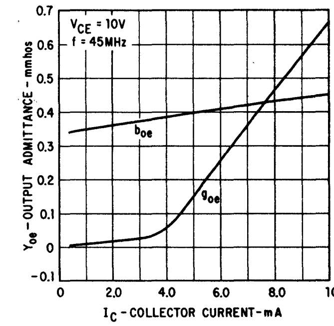
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



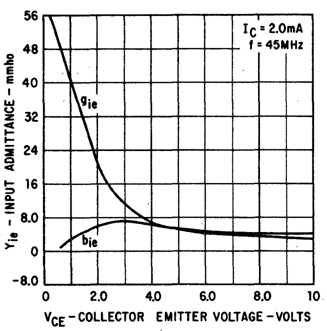
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHOT CIRCUIT



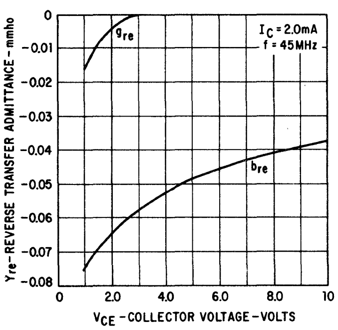
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT — INPUT SHORT CIRCUIT



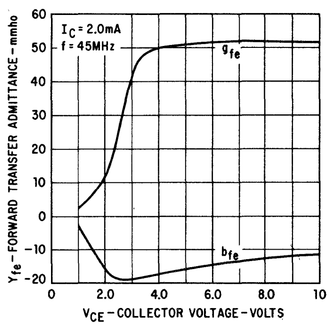
INPUT ADMITTANCE VERSUS COLLECTOR VOLTAGE — OUTPUT SHORT CIRCUIT



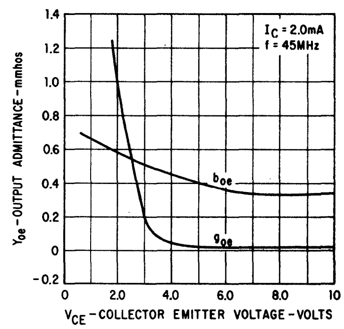
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR VOLTAGE — INPUT SHORT CIRCUIT



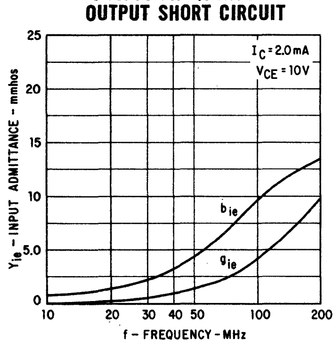
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR VOLTAGE — OUTPUT SHORT CIRCUIT



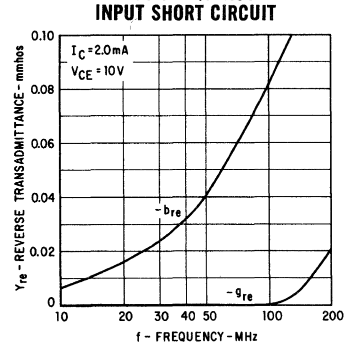
OUTPUT ADMITTANCE VERSUS COLLECTOR VOLTAGE — INPUT SHORT CIRCUIT



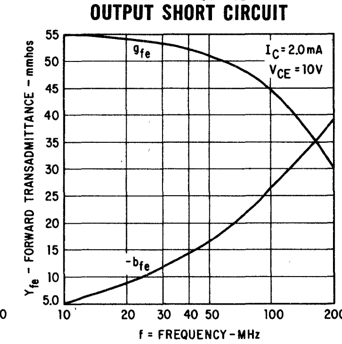
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



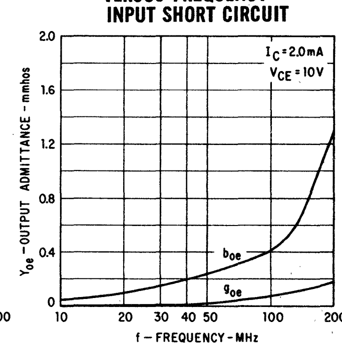
REVERSE TRANSADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



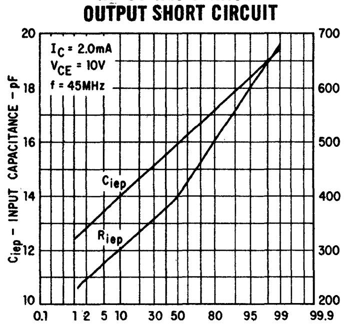
FORWARD TRANSADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



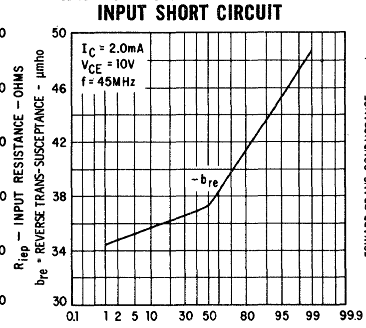
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



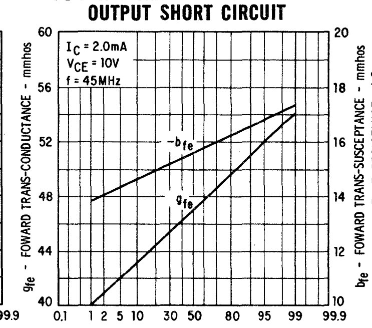
DISTRIBUTION OF INPUT CAPACITANCE AND INPUT RESISTANCE — OUTPUT SHORT CIRCUIT



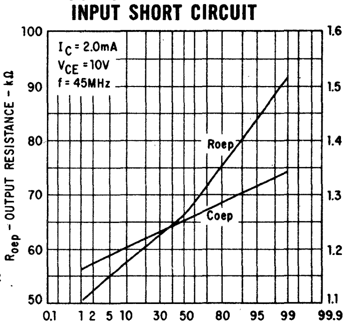
DISTRIBUTION OF REVERSE TRANSADMITTANCE — INPUT SHORT CIRCUIT



DISTRIBUTION OF FORWARD TRANSFER ADMITTANCE OUTPUT SHORT CIRCUIT

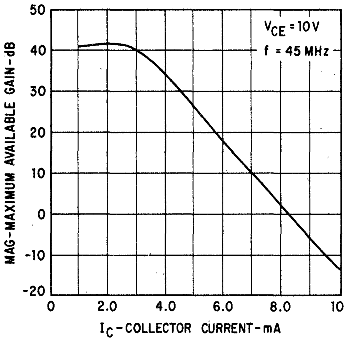


DISTRIBUTION OF OUTPUT CAPACITANCE AND OUTPUT RESISTANCE — INPUT SHORT CIRCUIT

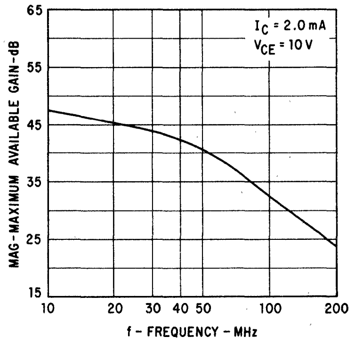


* These distributions derived from a random sample of 100 units.

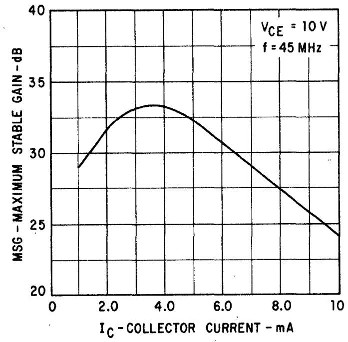
MAXIMUM AVAILABLE GAIN VERSUS COLLECTOR CURRENT



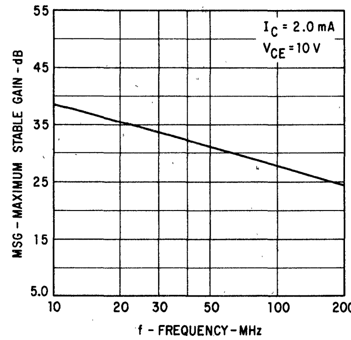
MAXIMUM AVAILABLE GAIN VERSUS FREQUENCY



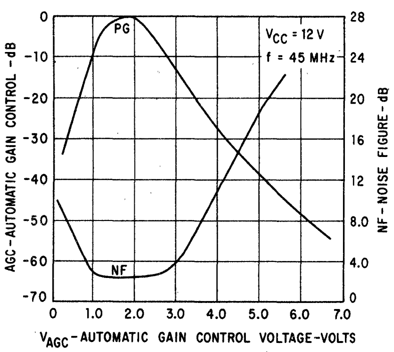
MAXIMUM STABLE GAIN VERSUS COLLECTOR CURRENT



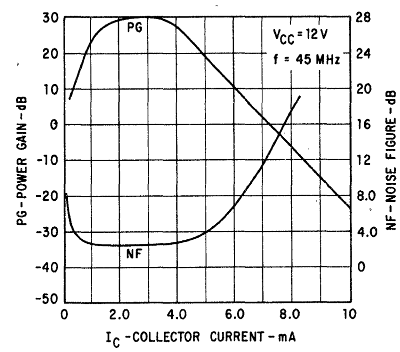
MAXIMUM STABLE GAIN VERSUS FREQUENCY



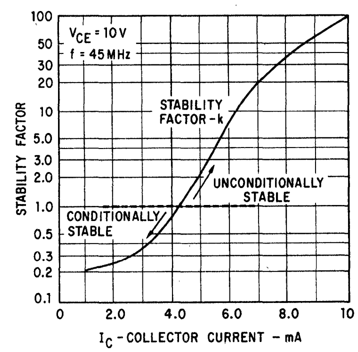
AUTOMATIC GAIN CONTROL AND NOISE FIGURE VERSUS AUTOMATIC GAIN CONTROL VOLTAGE



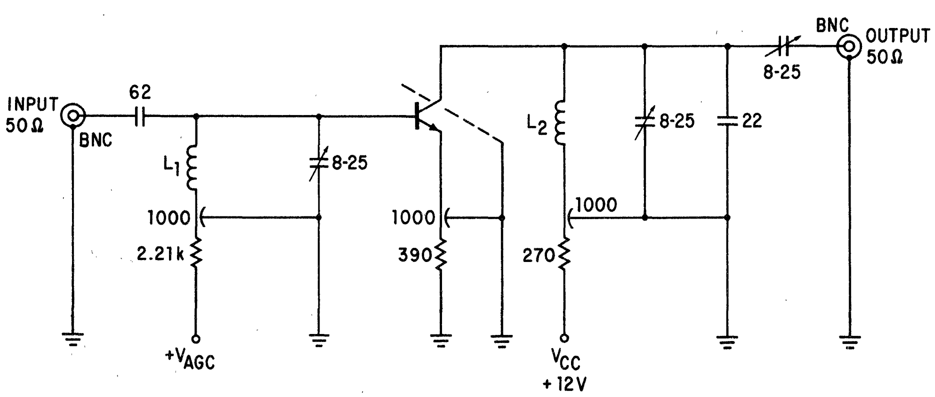
POWER GAIN AND NOISE FIGURE VERSUS COLLECTOR CURRENT



STABILITY FACTOR* VERSUS COLLECTOR CURRENT



SE5055 45 MHz GAIN, NOISE FIGURE, AGC CIRCUIT



L_1—7 TURNS No.16 BUSS WIRE 5/8" L X 5/16" I.D.
L_2—4 TURNS No.16 BUSS WIRE 1/2" L X 1/2" I.D.
ALL CAPACITIES IN pF.
ALL RESISTANCE IN Ω, 1/2W, 1% TOL.
ERIE TUNEABLES P/N N300
ERIE FEEDTHRU P/N 370CB102J
R_g = 120 Ω
R_L = 750 Ω

FIGURE 1

* Rollett stability factor k, where $k = \frac{2\,g_i g_o - \mathrm{Re}(Y_f Y_r)}{|Y_r Y_f|}$

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

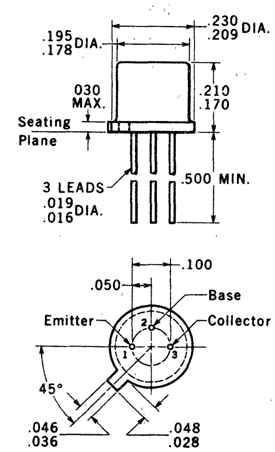
2N5056 • 2N5057

PNP HIGH SPEED SATURATED SWITCHES

DIFFUSED SILICON PLANAR*II EPITAXIAL TRANSISTORS

- **FAST SWITCHING** . . . . **t_{on} = 20 ns (MAX) AT 30 mA**
  t_{off} = 35 ns (MAX) AT 30 mA
  τ_s = 30 ns (MAX) AT 10 mA
- **HIGH FREQUENCY** . . . . **f_T = 800 MHz (MIN) AT 30 mA**
- **LOW CAPACITANCE** . . . . **C_{cb} = 4.5 pF (MAX) AT 5 V**
- **LOW SATURATION VOLTAGE** . . . **V_{CE}(sat) = 0.19 V (MAX) AT I_C = 30 mA**

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 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, 60 second time limit)	+300°C

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.2 Watts
at 100°C Case Temperature	0.72 Watt
at 25°C Ambient Temperature	0.36 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	−15 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	−15 Volts
V_{EBO}	Emitter to Base Voltage	−4.5 Volts

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

SYMBOL	CHARACTERISTICS	2N5056 MIN.	2N5056 TYP.	2N5056 MAX.	2N5057 MIN.	2N5057 TYP.	2N5057 MAX.	UNITS	TEST CONDITIONS	
t_{on}	**Turn On Time** (Note 6, Figure 1)		10	20		**10**	**20**	**ns**	**$I_C \approx$ 30 mA**	**$I_{B1} \approx$ 3.0 mA**
t_{off}	**Turn Off Time** (Note 6, Figure 1)		15	35		**15**	**35**	**ns**	**$I_C \approx$ 30 mA**	**$I_{B1} = I_{B2} \approx$ 3.0 mA**
τ_s	**Charge Storage Time** (Note 6, Figure 1)		15	30		**15**	**30**	**ns**	**$I_C \approx$ 10 mA**	**$I_{B1} \approx$ 10 mA $I_{B2} \approx$ −10 mA**
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		−0.08	−0.13		−0.08	−0.13	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{CE}(sat)	**Pulsed Collector Saturation Voltage** (Note 5)		−0.12	−0.19		**−0.12**	**−0.19**	**Volts**	**I_C = 30 mA**	**I_B = 3.0 mA**
V_{CE}(sat)	**Pulsed Collector Saturation Voltage** (Note 5)		−0.28	−0.45		**−0.28**	**−0.45**	**Volts**	**I_C = 100 mA**	**I_B = 10 mA**
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	−0.72	−0.82	−0.92	−0.72	−0.82	−0.92	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)	−0.80	−0.93	−1.15	−0.80	−0.93	−1.15	Volts	I_C = 30 mA	I_B = 3.0 mA
V_{BE}(sat)	Pulsed Base Saturation Voltage	−0.95	−1.14	−1.5	−0.95	−1.14	−1.5	Volts	I_C = 100 mA	I_B = 10 mA
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	6.0	9.0		**8.0**	**12**			**I_C = 30 mA**	**V_{CE} = −10 V**
C_{cb}	**Collector to Base Capacitance**		3.3	4.5		**3.3**	**4.5**	**pF**	**I_E = 0**	**V_{CB} = −5.0 V**
C_{eb}	Emitter to Base Capacitance		4.7	6.0		4.7	6.0	pF	I_C = 0	V_{EB} = −0.5 V
I_{CES}	Collector Reverse Current		0.3	50		0.3	50	nA	V_{CE} = −10 V	V_{BE} = 0
I_{CES}(+125°C)	Collector Reverse Current		0.05	10		0.05	10	μA	V_{CE} = −10 V	V_{BE} = 0
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	−15			**−15**			**Volts**	**I_C = 10 mA**	**I_E = 0**
BV_{CBO}	Collector to Base Breakdown Voltage	−15			−15			Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	−15			−15			Volts	I_C = 10 μA	V_{BE} = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.5			−4.5			Volts	I_C = 0	I_E = 100 μA
h_{FE}	DC Pulse Current Gain (Note 5)	12	25		20	44			I_C = 1.0 mA	V_{CE} = −0.5 V
h_{FE}	DC Pulse Current Gain (Note 5)	20	33		30	53			I_C = 10 mA	V_{CE} = −0.3 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	48	100	40	63	100		I_C = 30 mA	V_{CE} = −0.5 V
h_{FE}	**DC Pulse Current Gain** (Note 5)	20	45		**30**	**55**			**I_C = 100 mA**	**V_{CE} = −1.0 V**
h_{FE}(−55°C)	**DC Pulse Current Gain** (Note 5)	12	25		**20**	**38**			**I_C = 30 mA**	**V_{CE} = −0.5 V**

Notes on page 4

* Planar is a patented Fairchild process.

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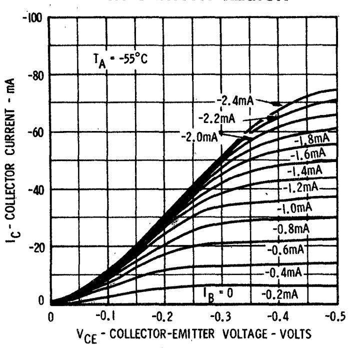
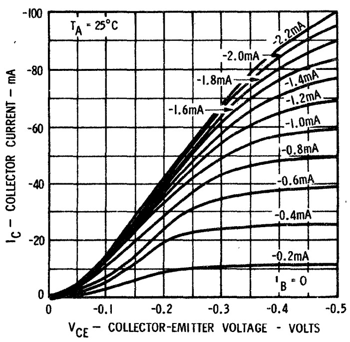
TYPICAL ELECTRICAL CHARACTERISTICS

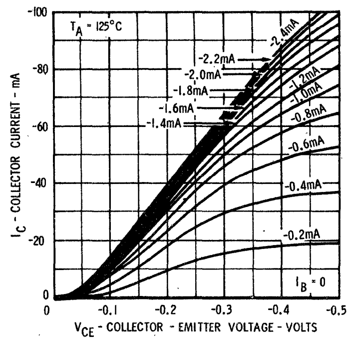
COLLECTOR CHARACTERISTICS* SATURATION REGION



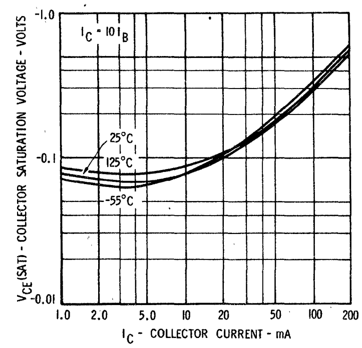
COLLECTOR CHARACTERISTICS* SATURATION REGION



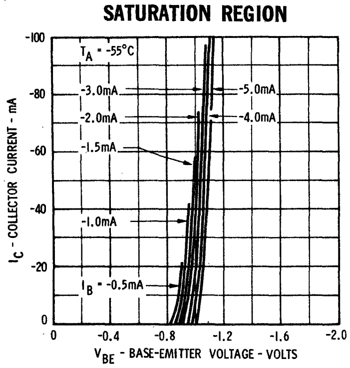
COLLECTOR CHARACTERISTICS* SATURATION REGION



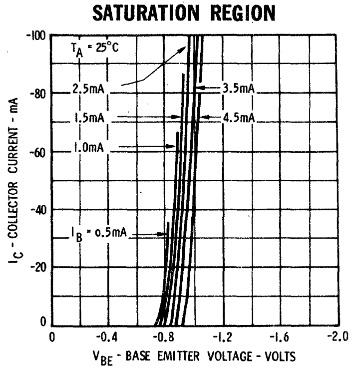
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



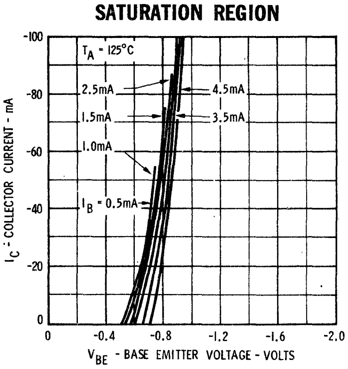
BASE CHARACTERISTICS* SATURATION REGION



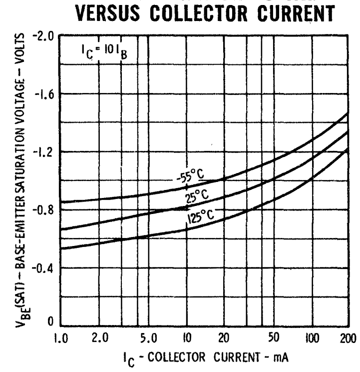
BASE CHARACTERISTICS* SATURATION REGION



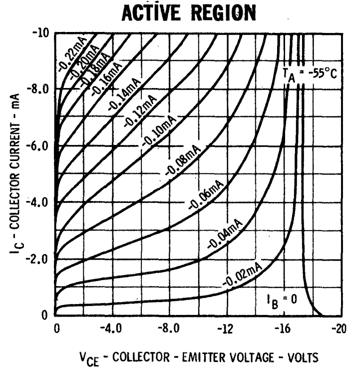
BASE CHARACTERISTICS* SATURATION REGION



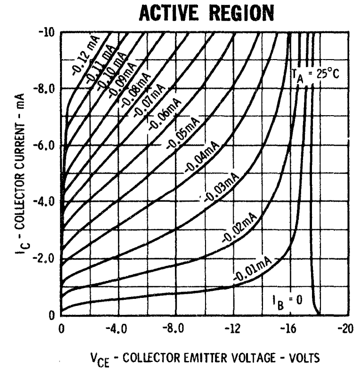
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



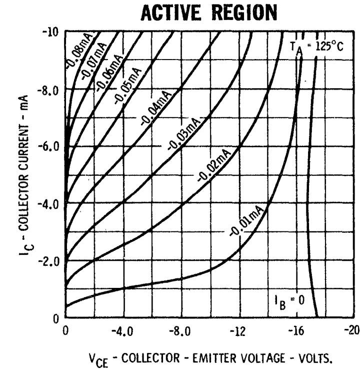
COLLECTOR CHARACTERISTICS ACTIVE REGION



COLLECTOR CHARACTERISTICS ACTIVE REGION



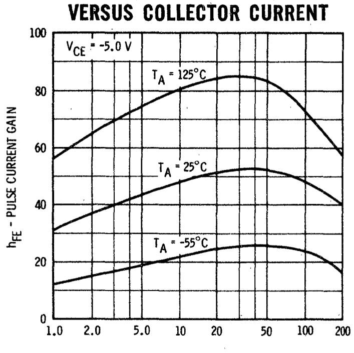
COLLECTOR CHARACTERISTICS ACTIVE REGION



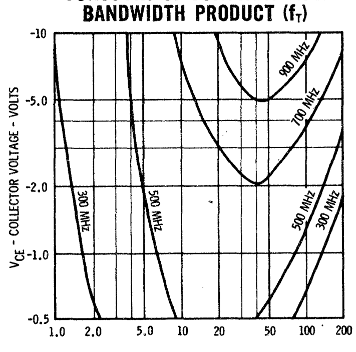
*Single family characteristics on Transistor Curve Tracer.

2N5056

DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

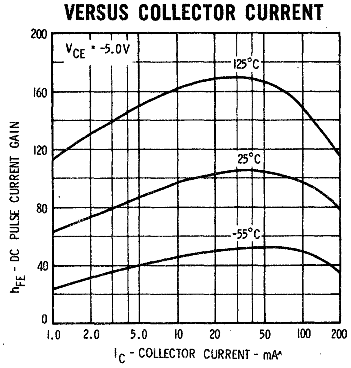


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

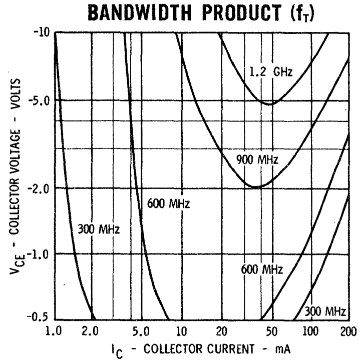


2N5057

DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

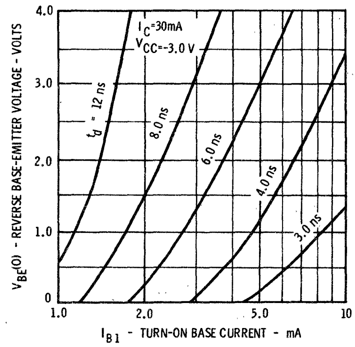


CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

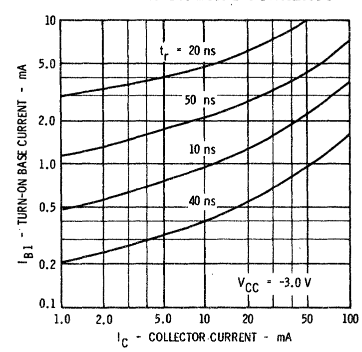


TYPICAL ELECTRICAL CHARACTERISTICS

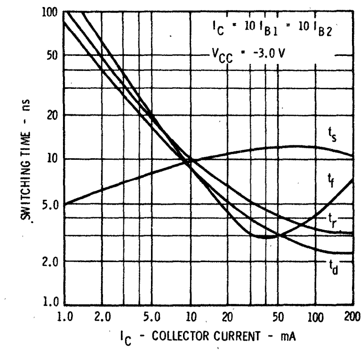
DELAY TIME VERSUS ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



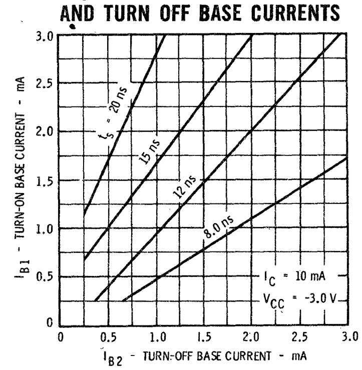
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



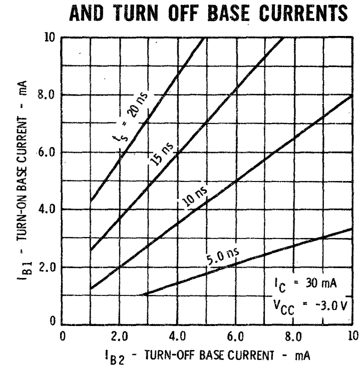
SWITCHING TIMES VERSUS COLLECTOR CURRENT



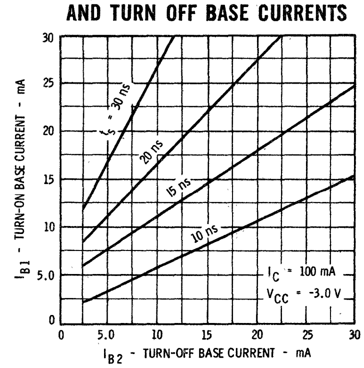
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



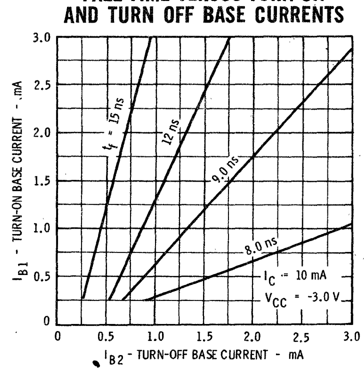
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



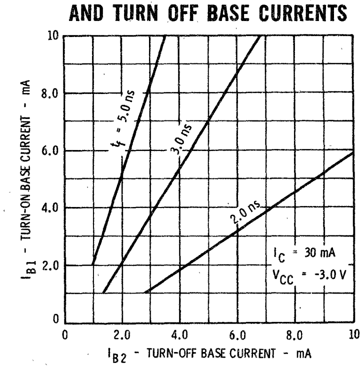
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



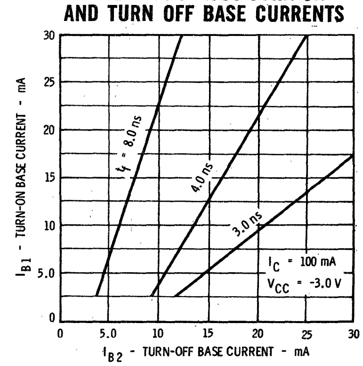
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



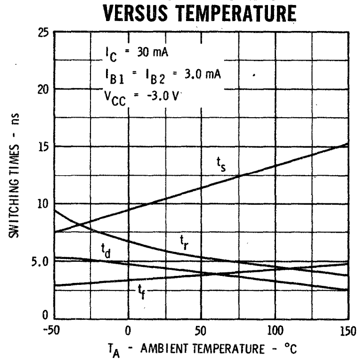
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



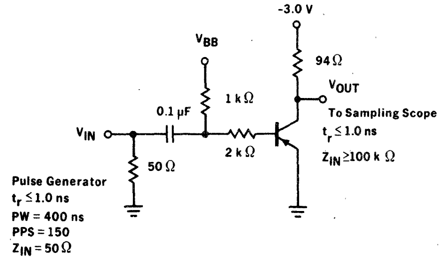
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



SWITCHING TIMES VERSUS TEMPERATURE



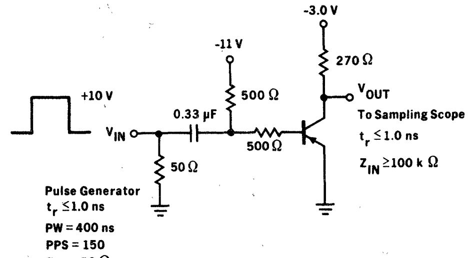
SWITCHING TIME TEST CIRCUIT FIGURE 1



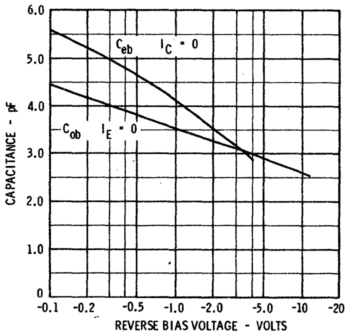
t_{on} V_{BB} = 0, V_{IN} = -6.85 V

t_{off} V_{BB} = -9.85 V, V_{IN} = +11.7 V

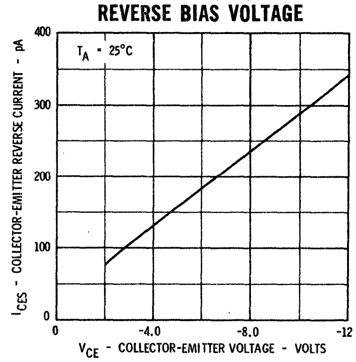
SWITCHING TIME TEST CIRCUIT FIGURE 2



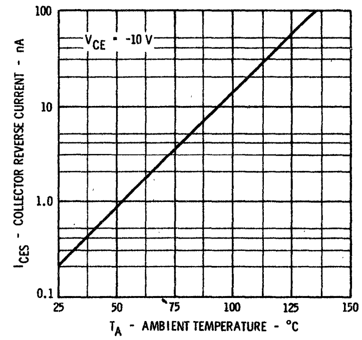
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



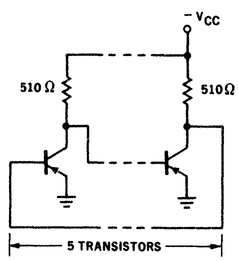
COLLECTOR-EMITTER REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR REVERSE CURRENT VERSUS TEMPERATURE

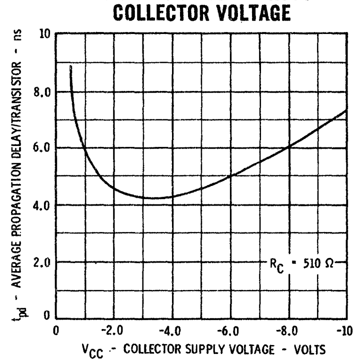


FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY

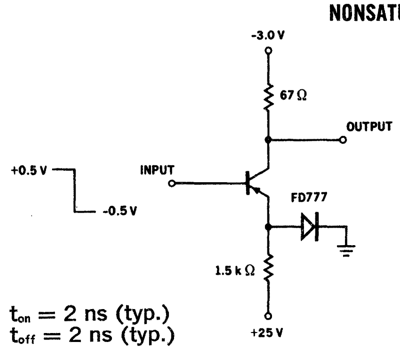


$$tpd = \frac{1}{10\ fosc.}$$

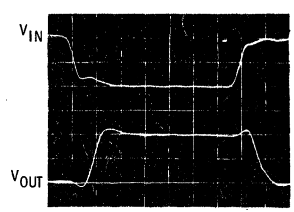
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



NONSATURATED SWITCHING PERFORMANCE



t_{on} = 2 ns (typ.)
t_{off} = 2 ns (typ.)



2 ns/div

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. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.

FAIRCHILD
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2N5065

NPN HIGH SPEED HIGH CURRENT RADIATION RESISTANT SWITCH

SILICON PLANAR* EPITAXIAL TRANSISTOR

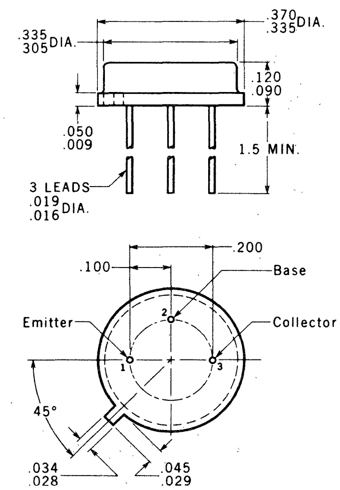
FEATURES

- **GUARANTEED PERFORMANCE AFTER 3 × 10^{14} nvt > 10 keV (INTEGRATED FAST NEUTRON DOSE)**
- **15 ns MAX. t_{on}; 35 ns MAX. t_{off}; 16 ns MAX. τ_s**
- **0.95 V MAX. V_{CE} (sat) @ 1.0 Amp.**
- **500 MHz MIN. f_T**
- **h_{FE} — 10 MIN. POST-IRRADIATION; 50 MIN. PRE-IRRADIATION @ 300 mA**

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures	
Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (soldering, 60 second time limit)	+300°C
Maximum Power Dissipation [Notes 2 and 3]	
Total Dissipation at 25°C Case Temperature	2.5 Watts
25°C Ambient Temperature	0.6 Watt
Maximum Voltages and Current	
V_{CBO} Collector to Base Voltage	25 Volts
V_{CES} Collector to Emitter Voltage	25 Volts
V_{CEO} Collector to Emitter Voltage [Note 5]	15 Volts
V_{EBO} Emitter to Base Voltage	4.0 Volts
I_C Collector Current	1.0 Amp.

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Collector internally connected to case
Leads are gold-plated kovar
Package weight is 0.98 gram

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	
t_{on}	**Turn On Time** [Note 6]		11	**15**		11	**15**	**ns**	**$I_C \approx 1.0$ A**	**$I_{B1} \approx 200$ mA**
t_{off}	**Turn Off Time** [Note 6]		20	**35**		15	**35**	**ns**	**$I_C \approx 1.0$ A**	**$I_{B1} = I_{B2} \approx 200$ mA**
τ_s	**Charge Storage Time** [Note 6]		**13**	**16**		**8.0**	**16**	**ns**	**$I_C \approx 100$ mA**	**$I_{B1} \approx 100$ mA, $I_{B2} \approx -100$ mA**
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	5.5	7.0		**5.0**	6.8			**$I_C = 100$ mA**	**$V_{CE} = 5.0$V**
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.15	0.23		0.21	0.30	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{CE} (sat)	Pulsed Collector Saturation Voltage [Note 5]		0.20	0.33		0.29	0.42	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{CE} (sat)	**Pulsed Collector Saturation Voltage** [Note 5]		0.45	**0.70**		0.59	**0.95**	**Volts**	**$I_C = 1.0$A**	**$I_B = 200$ mA**
V_{CE} (sat) (125°C)	Pulsed Collector Saturation Voltage [Note 5]		0.3	0.5		0.4	0.6	Volts	$I_C = 300$ mA	$I_B = 30$ mA
h_{FE}	DC Pulse Current Gain [Note 5]	50	88	120	10	19			$I_C = 300$ mA	$V_{CE} = 0.5$ V
h_{FE}	DC Pulse Current Gain [Note 5]	50	96		11	20			$I_C = 100$ mA	$V_{CE} = 0.5$ V
h_{FE} (−35°C)	DC Pulse Current Gain [Note 5]	20	40		5.0	7.0			$I_C = 300$ mA	$V_{CE} = 0.5$ V
h_{FE} (−55°C)	DC Pulse Current Gain [Note 5]	15	36		3.0	5.0			$I_C = 300$ mA	$V_{CE} = 0.5$ V
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]		0.79	1.1		0.81	1.1	Volts	$I_C = 100$ mA	$I_B = 10$ mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]		0.9	1.3		0.91	1.3	Volts	$I_C = 300$ mA	$I_B = 30$ mA
V_{BE} (sat)	Pulsed Base Saturation Voltage [Note 5]	1.0	1.17	2.4	1.0	1.24	2.4	Volts	$I_C = 1.0$ A	$I_B = 200$ mA
I_{CES}	Collector Reverse Current		8.5	100		8.5	100	μA	$V_{CE} = 15$ V	$V_{EB} = 0$
I_{CES} (125°C)	Collector Reverse Current			150			150	μA	$V_{CE} = 15$ V	$V_{EB} = 0$
C_{cb}	Collector to Base Capacitance		6.0	15		6.0	15	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{eb}	Emitter to Base Capacitance		15	25		15	25	pF	$I_C = 0$	$V_{EB} = 0.5$ V
BV_{CES}	Collector to Emitter Breakdown Voltage	25	46		25	54		Volts	$I_C = 0.5$ mA	$I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	25			25			Volts	$I_C = 0.5$ mA	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 5]	15	17.5		15	23		Volts	$I_C = 30$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0	5.7		4.0	5.8		Volts	$I_C = 0$	$I_E = 0.1$ mA

* Planar is a patented Fairchild process.

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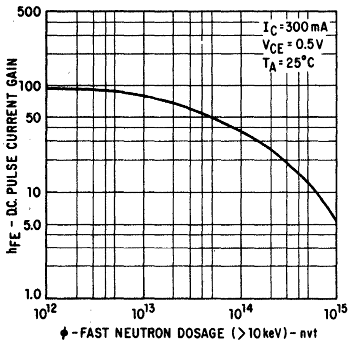
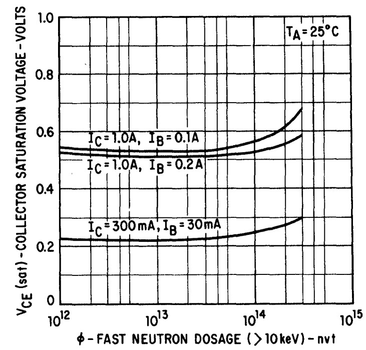
TYPICAL ELECTRICAL CHARACTERISTICS

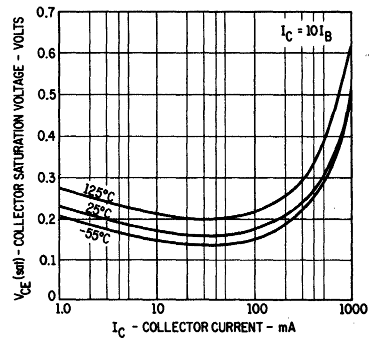
DC CURRENT GAIN VERSUS NEUTRON DOSAGE



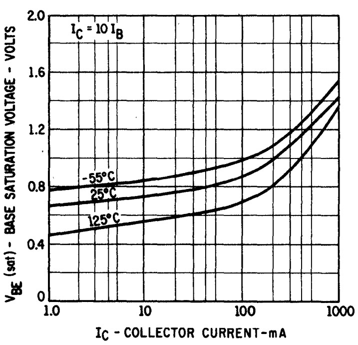
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



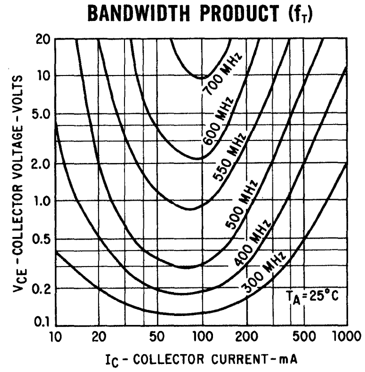
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



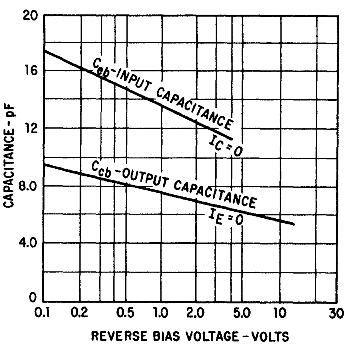
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



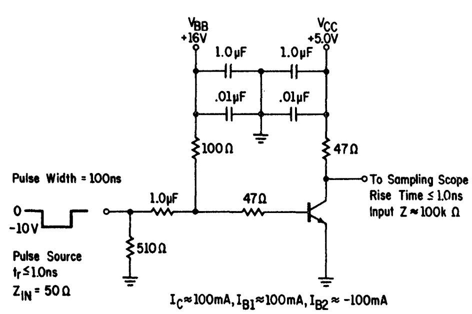
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



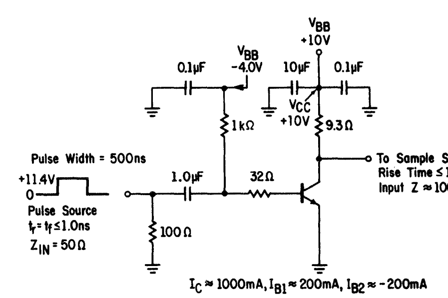
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



CHARGE STORAGE TIME MEASUREMENT CIRCUIT



t_{on} AND t_{off} MEASUREMENT 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 give a maximum junction temperature of 200°C and junction to case thermal resistance of 58.3°C/Watt (derating factor of 17.2 mW/°C); junction to ambient thermal resistance of 291.7°C/Watt (derating factor of 3.43 mW/°C).
(4) 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.
(5) Pulse Conditions: length = 300 µs; duty cycle = 1%.
(6) See switching circuit for exact values of I_C, I_{B1} and I_{B2}.

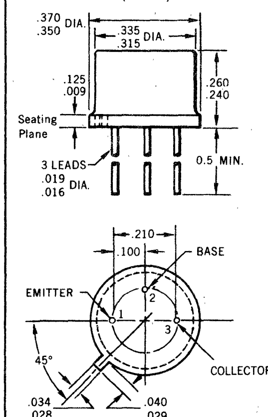
2N5106 • 2N5107

NPN RADIATION RESISTANT GENERAL PURPOSE AMPLIFIERS AND SWITCHES

DOUBLE DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **GUARANTEED PERFORMANCE AFTER NEUTRON IRRADIATION OF 3 x 10^{14} nvt > 10 keV**
- **GAIN . . . . h_{FE} = 8.0 (MIN), 13 (TYP) AT 150 mA**
  h_{FE} = 100 (MIN) AT 150 mA PREIRRADIATION
  f_T = 200 MHz (MIN) AT 50 mA
- **BREAKDOWN VOLTAGE . . . LV_{CEO} = 30 V (MIN)**

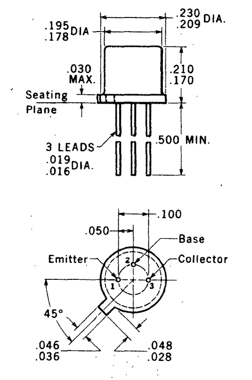
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES All dimensions in inches
Leads are gold-plated KOVAR
Lead No 3 internally connected to case
Package weight is 1 23 grams

2N5106

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

2N5107

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature		−65°C to +200°C	
Operating Junction Temperature		+200°C	
Lead Temperature (Soldering, 60 second time limit)		+300°C	
Maximum Power Dissipation (Notes 2 and 3)		**2N5106**	**2N5107**
Total Dissipation at 25°C Case Temperature		3.0 Watts	1.8 Watts
at 25°C Ambient Temperature		0.8 Watt	0.36 Watt
Maximum Voltages and Current			
V_{CBO}	Collector to Base Voltage	60 Volts	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	30 Volts	30 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts	5.0 Volts
I_C	Collector Current	500 mA	500 mA

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

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	TYP.	MAX.	POST-IRRADIATION (3×10^{14} nvt > 10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**30**	**42**		**30**	**56**		**Volts**	**I_C = 10 mA**	**I_B = 0**
BV_{CES}	Collector to Emitter Breakdown Voltage	60	80		60	87		Volts	I_C = 10 μA	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	60			60			Volts	I_C = 10 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0	7.0		5.0	7.0		Volts	I_C = 0	I_E = 10 μA
h_{FE}	DC Pulse Current Gain (Note 5)	50	100		5.0	9.0			I_C = 1.0 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	75	205		8.0	16			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50			5.0				I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	**DC Pulse Current Gain** (Note 5)	**100**	**220**	**300**	**8.0**	**13**			**I_C = 150 mA**	**V_{CE} = 10 V**
h_{FE}(−35°C)	DC Pulse Current Gain (Note 5)	50			5.0				I_C = 150 mA	V_{CE} = 10 V
h_{FE}(−55°C)	DC Pulse Current Gain (Note 5)	35			3.0				I_C = 150 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	50	100		5.0	9.0			I_C = 500 mA	V_{CE} = 10 V
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	**2.5**	**4.5**	**9.0**	**2.0**	**4.0**			**I_C = 50 mA**	**V_{CE} = 10 V**

Additional Electrical Characteristics on page 2
Notes on page 2

*Planar is a patented Fairchild process.

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

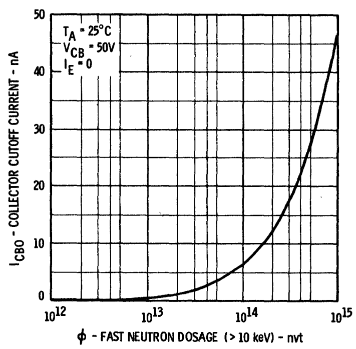
SYMBOL	CHARACTERISTIC	PRE-IRRADIATION MIN.	TYP.	MAX.	POST-IRRADIATION (3×10^{14} nvt > 10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
I_{CBO}	Collector Cutoff Current		0.2	10		18	100	nA	$I_E = 0$	$V_{CB} = 50$ V
I_{CBO}(150°C)	Collector Cutoff Current			10			100	μA	$I_E = 0$	$V_{CB} = 50$ V
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)		0.11	0.22		0.33	0.5	Volts	$I_C = 150$ mA	$I_B = 50$ mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)			1.5			1.5	Volts	$I_C = 150$ mA	$I_B = 50$ mA
V_{BE}(on)	Pulsed Base Emitter On Voltage (Note 5)			1.2			1.2	Volts	$I_C = 150$ mA	$V_{CE} = 10$ V
I_{EBO}	Emitter Cutoff Current		0.1	10			100	nA	$I_C = 0$	$V_{EB} = 3.0$ V
V_{CE}(sat)	Pulsed Collector Saturation Voltage (Note 5)			0.45			1.6	Volts	$I_C = 300$ mA	$I_B = 100$ mA
V_{BE}(sat)	Pulsed Base Saturation Voltage (Note 5)			1.5			1.6	Volts	$I_C = 300$ mA	$I_B = 100$ mA
C_{cb}	Collector to Base Capacitance		6.0	8.0			8.0	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{eb}	Emitter to Base Capacitance		14	20			20	pF	$I_C = 0$	$V_{EB} = 2.0$ V
t_{on}	Turn On Time (Note 6)			65			65	ns	$I_C \approx 300$ mA	$I_{B1} \approx 100$ mA
t_{off}	Turn Off Time (Note 6)			550			550	ns	$I_C \approx 300$ mA	$I_{B1} \approx 100$ mA, $I_{B2} \approx -100$ mA

NOTES:

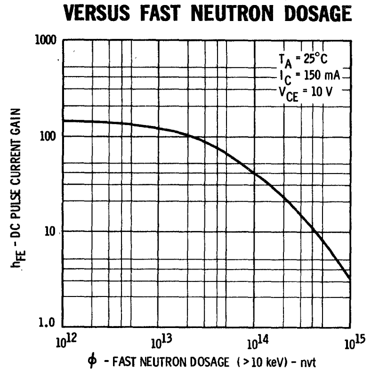
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 58.3°C/Watt (derating factor of 17.2 mW/°C) for the 2N5106 and 140°C/Watt (derating factor of 7.1 mW/°C) for the 2N5107. Junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.57 mW/°C) for the 2N5106 and 486°C/Watt (derating factor of 2.06 mW/°C) for the 2N5107.
(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(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

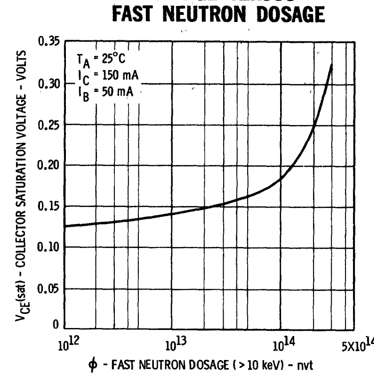
COLLECTOR CUTOFF CURRENT VERSUS FAST NEUTRON DOSAGE



DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE

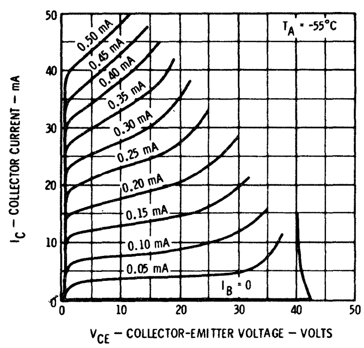


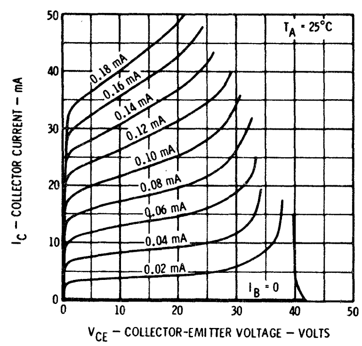
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE

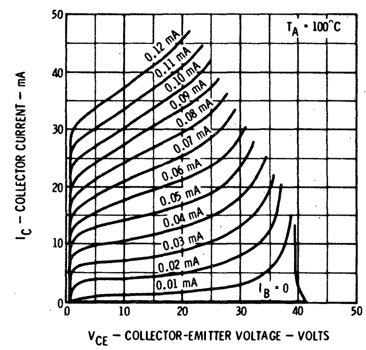


TYPICAL COLLECTOR CHARACTERISTICS*

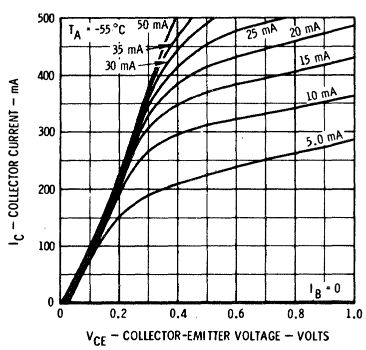
ACTIVE REGION*

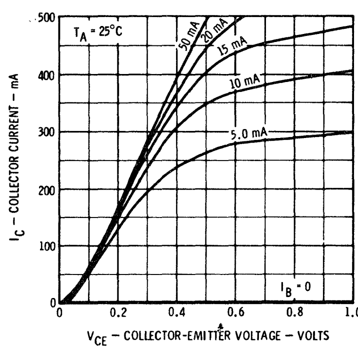


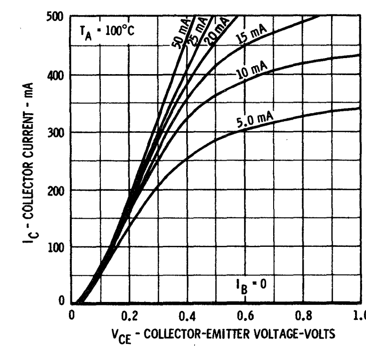




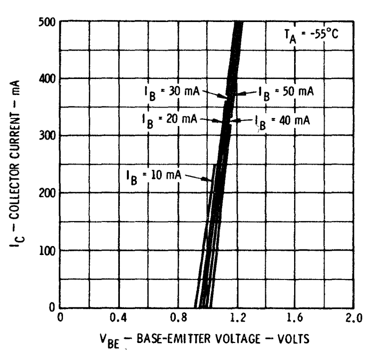
SATURATION REGION*

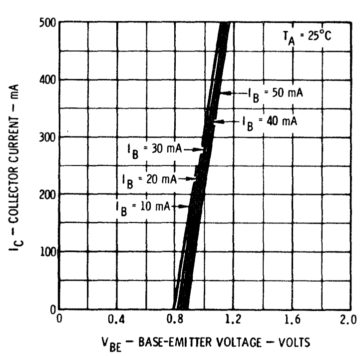


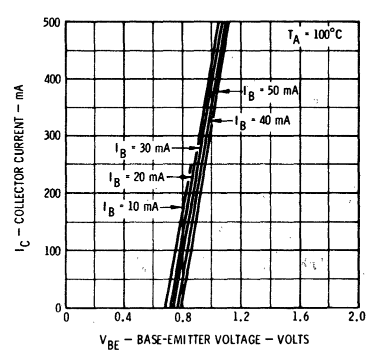




TYPICAL BASE CHARACTERISTICS*



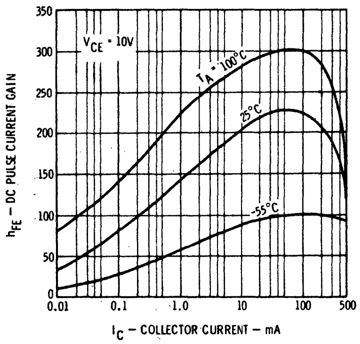




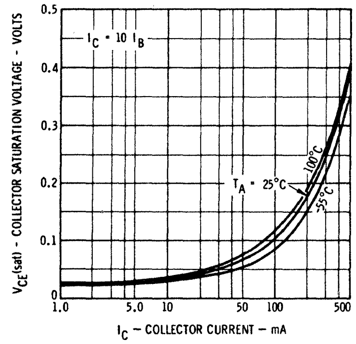
*Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

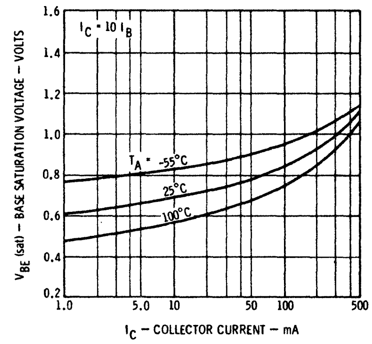
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



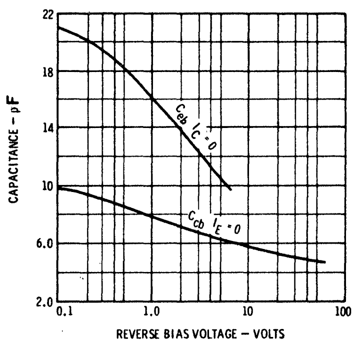
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



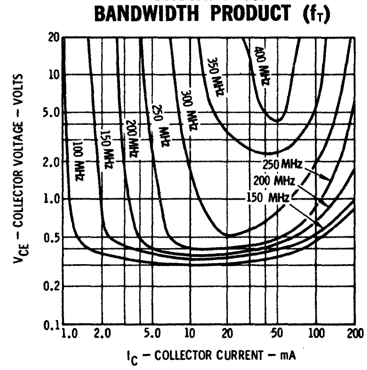
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



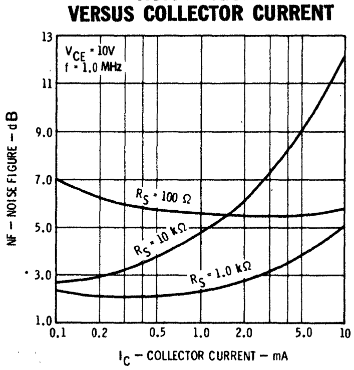
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



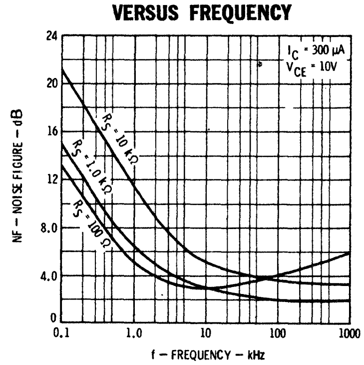
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



NOISE FIGURE VERSUS COLLECTOR CURRENT



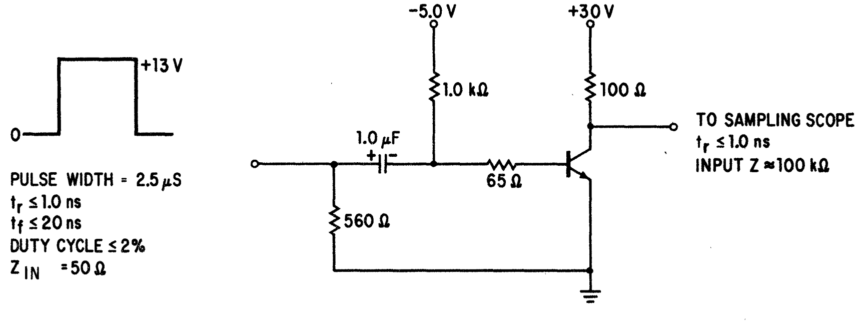
NOISE FIGURE VERSUS FREQUENCY



SWITCHING CIRCUIT

FIGURE 1

t_{on} AND t_{off} TEST CIRCUIT



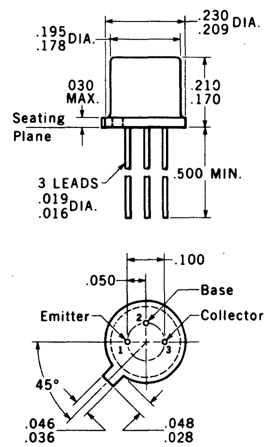
2N5144 • 2N5145

NPN RADIATION RESISTANT HIGH-VOLTAGE, HIGH-SPEED SWITCHES

DOUBLE DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **GUARANTEED PERFORMANCE AFTER NEUTRON IRRADIATION OF 3 x 10[14] nvt > 10 keV**
- **FAST SWITCHING . . . . t_{on} = 35 ns (MAX) AT 500 mA**
  t_{off} = 60 ns (MAX) AT 500 mA
- **HIGH BREAKDOWN VOLTAGE . . . LV_{CEO} = 30 V (MIN)**
- **HIGH GAIN . . . . h_{FE} = 9.0 (MIN) AT 100 mA, 1.0 V**
  h_{FE} = 5.0 (MIN) AT 500 mA, 1.0 V

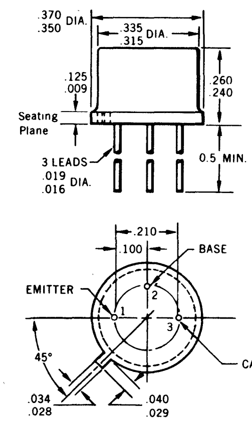
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-18) outline



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

2N5144

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES All dimensions in inches
Leads are gold plated KOVAR
Lead No. 3 internally connected to case
Package weight is 1.23 grams

2N5145

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	+200°C
Lead Temperature (Soldering, 60 second time limit)	+300°C

Maximum Power Dissipation (Notes 2 and 3)	**2N5144**	**2N5145**
Total Dissipation at 25°C Case Temperature	1.2 Watts	3.5 Watts
at 25°C Ambient Temperature	0.36 Watt	0.8 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	50 Volts
V_{CES}	Collector to Emitter Voltage	50 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	30 Volts
V_{EBO}	Emitter to Base Voltage	6.0 Volts
I_C	Collector Current	500 mA

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

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	TYP.	MAX.	POST IRRADIATION 3x10[14] nvt (>10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain (Note 5)	30	60		5.0	7.0			I_C = 10 mA	V_{CE} = 1.0 V
h_{FE}	**DC Pulse Current Gain** (Note 5)	**60**	**90**	**150**	**9.0**	**12**			**I_C = 100 mA**	**V_{CE} = 1.0 V**
h_{FE}	**DC Pulse Current Gain** (Note 5)	**35**	**50**		**5.0**	**6.0**			**I_C = 500 mA**	**V_{CE} = 1.0 V**
h_{FE}(−55°C)	DC Pulse Current Gain (Note 5)	30			5.0				I_C = 100 mA	V_{CE} = 1.0 V
$V_{BE(sat)}$	Base Saturation Voltage (Note 5)		0.75	0.86		0.79	0.90	Volts	I_C = 100 mA	I_B = 10 mA
$V_{BE(sat)}$	Base Saturation Voltage (Note 5)		0.78	0.90		0.82	0.95	Volts	I_C = 100 mA	I_B = 20 mA
$V_{BE(sat)}$	Base Saturation Voltage (Note 5)	0.9	0.95	1.2	0.8	0.99	1.3	Volts	I_C = 500 mA	I_B = 50 mA
$V_{BE(sat)}$	Base Saturation Voltage (Note 5)	0.9	1.0	1.3	0.9	1.1	1.5	Volts	I_C = 500 mA	I_B = 100 mA
I_{CBO}	Collector Cutoff Current		0.25	1.7			1.7	μA	I_E = 0	V_{CB} = 40 V
I_{CBO}(+100°C)	Collector Cutoff Current		25	120			120	μA	I_E = 0	V_{CB} = 40 V
BV_{CBO}	Collector to Base Breakdown Voltage	50			50			Volts	I_C = 10 μA	I_E = 0
BV_{CES}	Collector to Emitter Breakdown Voltage	50			50			Volts	I_C = 10 μA	V_{BE} = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			6.0			Volts	I_C = 0	I_E = 10 μA

Additional Electrical Characteristics on page 2

*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 50°C/Watt (derating factor of 20 mW/°C) for the 2N5144 and 146°C/Watt (derating factor of 6.85 mW/°C) for the 2N5145. Junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the 2N5144 and 485°C/Watt (derating factor of 2.06 mW/°C) for the 2N5145.
4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
5) Pulse Conditions: length = 300 μs; duty cycle = 1%.

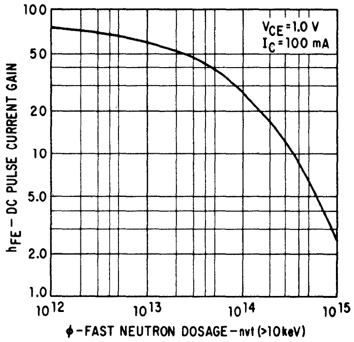
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

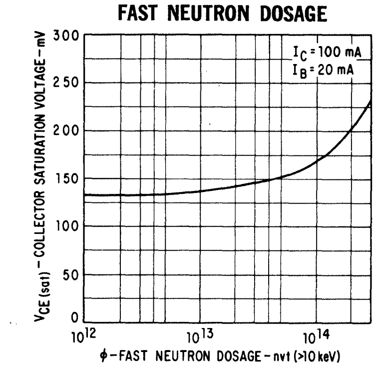
SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST IRRADIATION $3x10^{14}$ nvt (>10 keV) MIN.	POST IRRADIATION TYP.	POST IRRADIATION MAX.	UNITS	TEST CONDITIONS	
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**30**			**30**			**Volts**	$I_C = 10$ mA	$I_B = 0$
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.13	0.2				Volts	$I_C = 100$ mA	$I_B = 10$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.11	0.18		0.23	0.4	Volts	$I_C = 100$ mA	$I_B = 20$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.3	0.42				Volts	$I_C = 500$ mA	$I_B = 50$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.27	0.4		0.56	1.1	Volts	$I_C = 500$ mA	$I_B = 100$ mA
t_{on}	**Turn On Time** (See circuit below)			**35**			**35**	**ns**	$I_C \approx 500$ mA	$I_{B1} \approx 100$ mA
t_{off}	**Turn Off Time** (See circuit below)			**60**			**60**	**ns**	$I_C \approx 500$ mA	$I_{B1} \approx 100$ mA, $I_{B2} \approx -100$ mA
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0	4.5		2.5	4.0			$I_C = 50$ mA	$V_{CE} = 10$ V
C_{cb}	Collector to Base Capacitance			12			12	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{eb}	Emitter to Base Capacitance			55			55	pF	$I_C = 0$	$V_{EB} = 0.5$ V

TYPICAL ELECTRICAL CHARACTERISTICS

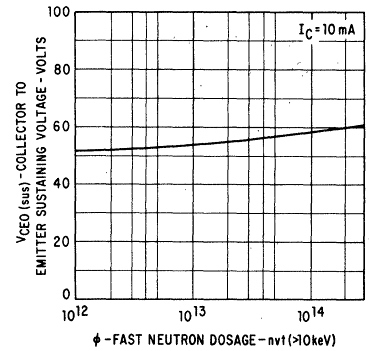
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



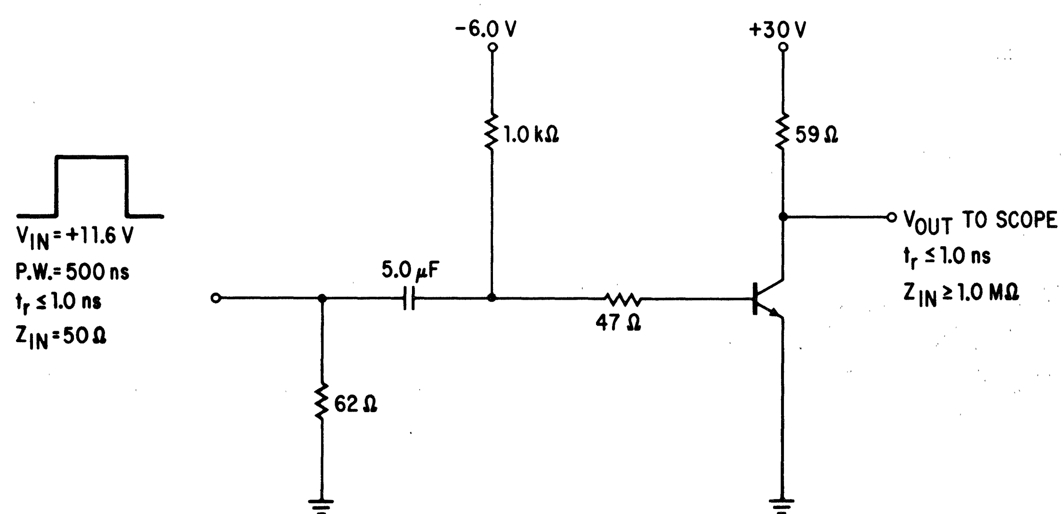
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



COLLECTOR TO EMITTER SUSTAINING VOLTAGE VERSUS FAST NEUTRON DOSAGE

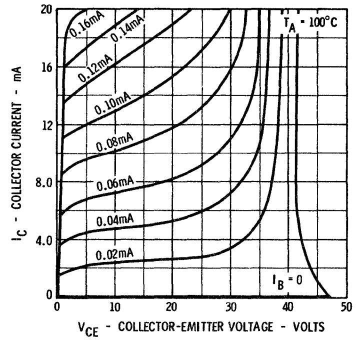


t_{on}, t_{off} TEST CIRCUIT

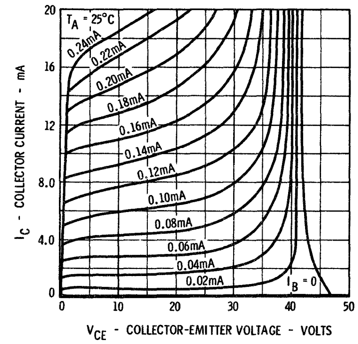


TYPICAL ELECTRICAL CHARACTERISTICS

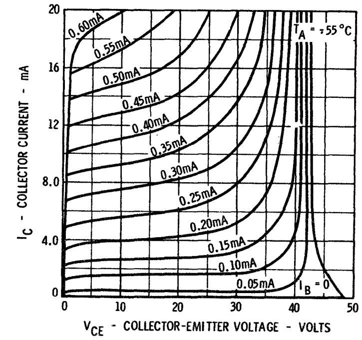
COLLECTOR CHARACTERISTICS*



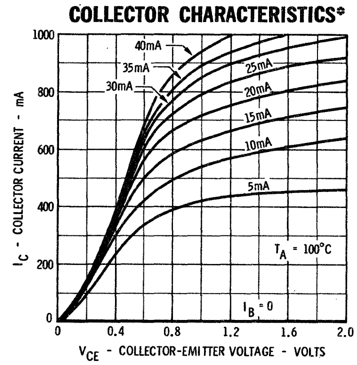
COLLECTOR CHARACTERISTICS*



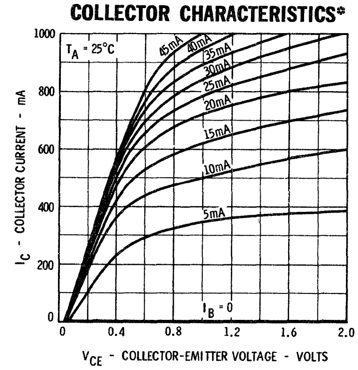
COLLECTOR CHARACTERISTICS*



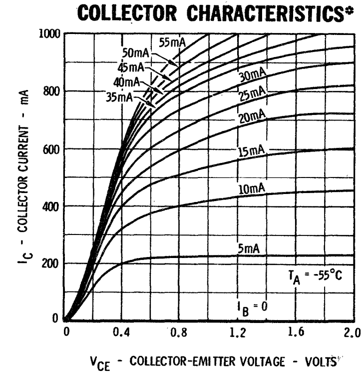
COLLECTOR CHARACTERISTICS*



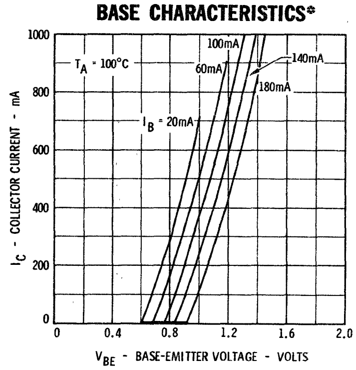
COLLECTOR CHARACTERISTICS*



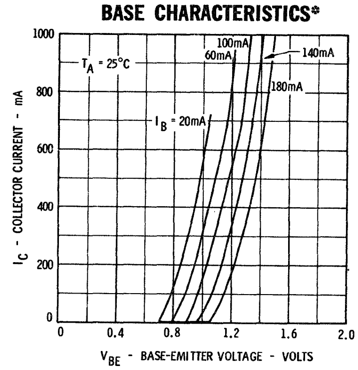
COLLECTOR CHARACTERISTICS*



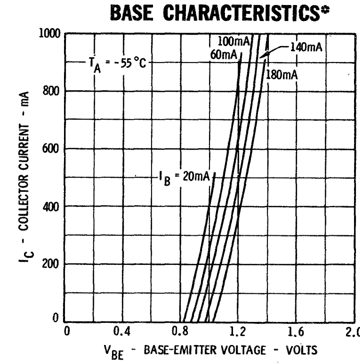
BASE CHARACTERISTICS*



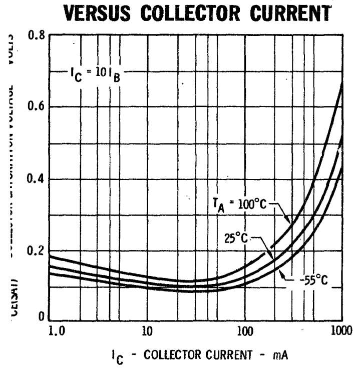
BASE CHARACTERISTICS*



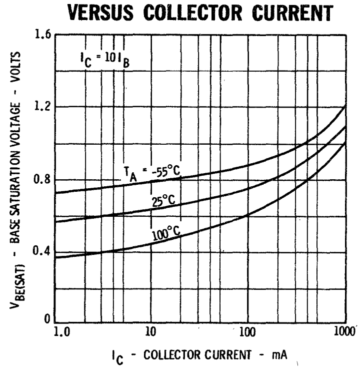
BASE CHARACTERISTICS*



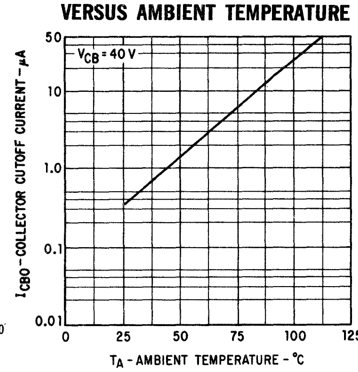
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



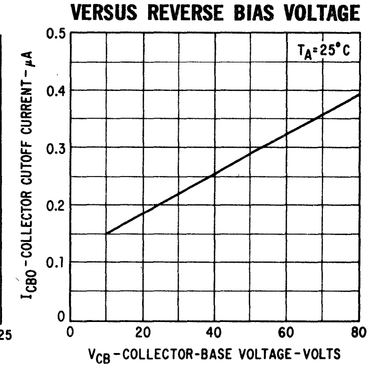
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



*Single family characteristics on Transistor Curve Tracer.

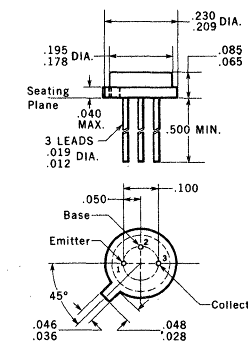
2N5200 • 2N5201

NPN RADIATION RESISTANT GENERAL PURPOSE AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **GUARANTEED PERFORMANCE AFTER FAST NEUTRON DOSAGE ($3x10^{14}$ AND 10^{15} nvt > 10 keV)**
- **HIGH GAIN . . . . . $h_{FE} = 23$ (MIN) AFTER $3x10^{14}$ nvt > 10 keV**
  . . . . . $h_{FE} = 10$ (MIN) AFTER 10^{15} nvt > 10 keV
- **LOW CAPACITY . . . $C_{eb} = 2.0$ pF (MAX)**
  . . . $C_{cb} = 2.5$ pF (MAX)
- **VOLTAGE . . . . . . $V_{CEO(sus)} = 20$ V (MIN)**

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 (Note 1)

Maximum Temperatures

Storage Temperature	−55°C to +200°C
Operating Temperature	+200°C
Lead Temperature (soldering, 10 seconds time limit)	+300°C

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.2 Watts
at 25°C Ambient Temperature	0.3 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	20 Volts
V_{CES}	Collector to Emitter Voltage	20 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	20 Volts
V_{EBO}	Emitter to Base Voltage	4.5 Volts

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

SYMBOL	CHARACTERISTICS		PRE-IRRADIATION MIN.	TYP.	MAX.	POST IRRADIATION ($3x10^{14}$nvt>10 keV) MIN.	TYP.	MAX.	POST IRRADIATION (10^{15}nvt>10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage (Note 4)**		**20**			**20**			**20**			**Volts**	$I_C = 2.0$ mA	$I_B = 0$
h_{FE}	DC Pulse Current Gain	2N5200	45			15			5.0				$I_C = 30$ mA	$V_{CE} = 5.0$ V
	(Note 5)	2N5201	65			20			7.0				$I_C = 30$ mA	$V_{CE} = 5.0$ V
h_{FE}	**DC Pulse Current Gain**	2N5200	50		150	15			5.0				$I_C = 10$ mA	$V_{CE} = 5.0$ V
	(Note 5)	**2N5201**	**75**		**150**	**23**			**10**				$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	2N5200	40			10							$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
		2N5201	70			15			5.0				$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	2N5200	40			10							$I_C = 500$ μA	$V_{CE} = 5.0$ V
		2N5201	65			12							$I_C = 500$ μA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	2N5200	40			5.0							$I_C = 100$ μA	$V_{CE} = 5.0$ V
		2N5201	65			7.0							$I_C = 100$ μA	$V_{CE} = 5.0$ V
$h_{FE}(-55°C)$	Pulsed DC Current Gain	2N5200	25			5.0							$I_C = 10$ mA	$V_{CE} = 5.0$ V
	(Note 5)	2N5201	40			10			5.0				$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{fe}	High Frequency Current Gain	2N5200	9.0			8.0			7.0				$I_C = 10$ mA	$V_{CE} = 5.0$ V
	(f = 100 MHz)	2N5201	11			10			7.0				$I_C = 10$ mA	$V_{CE} = 5.0$ V
C_{cb}	**Collector to Base Capacitance** (f = 1.0 MHz)				2.5			2.5			2.5	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{eb}	**Emitter to Base Capacitance** (f = 1.0 MHz)				2.0			2.0			2.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V

Additional Electrical Characteristics on page 2

*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 583°C/Watt (derating factor of 1.72 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%.

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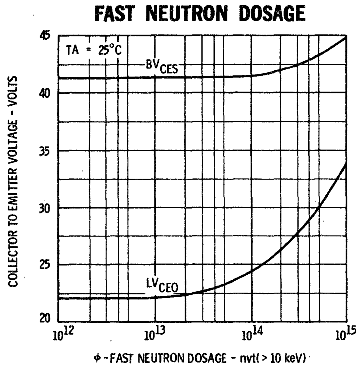
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

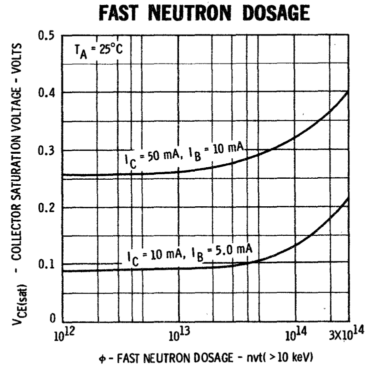
SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST IRRADIATION ($3x10^{14}$nvt>10 keV) MIN.	TYP.	MAX.	POST IRRADIATION (10^{15}nvt>10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)			0.15			0.35			0.7	Volt	$I_C = 10$ mA	$I_B = 2.0$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)			0.5			1.0				Volt	$I_C = 50$ mA	$I_B = 10$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)			0.96			1.0			1.0	Volt	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)			1.42			1.7				Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CES}	Collector Reverse Current			10			50			100	nA	$V_{CE} = 10$ V	$V_{BE} = 0$
I_{CES}(125°C)	Collector Reverse Current			10			20			50	μA	$V_{CE} = 10$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	20			20			20			Volts	$I_C = 10\ \mu$A	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	20			20			20			Volts	$I_C = 10\ \mu$A	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	4.5			4.5			4.5			Volts	$I_C = 0$	$I_E = 10\mu$A
$r_b'C_c$	Collector Base Time Constant (f = 80 MHz)		10								ps	$I_C = 10$ mA	$V_{CE} = 5.0$ V

TYPICAL POST-IRRADIATION ELECTRICAL CHARACTERISTICS

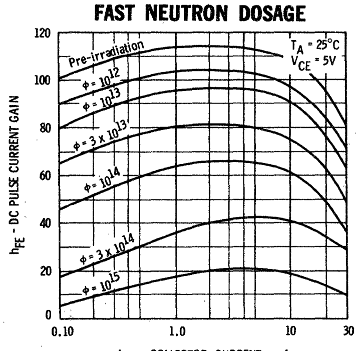
COLLECTOR TO EMITTER VOLTAGES VERSUS FAST NEUTRON DOSAGE



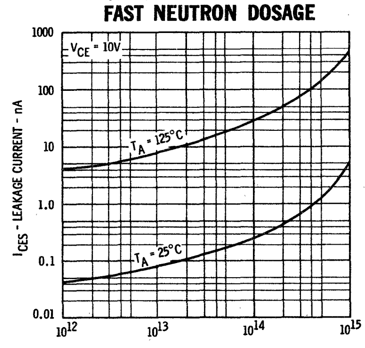
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



DC PULSE CURRENT VERSUS CURRENT AND FAST NEUTRON DOSAGE

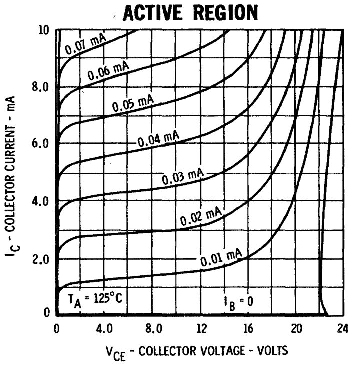


LEAKAGE CURRENT VERSUS FAST NEUTRON DOSAGE

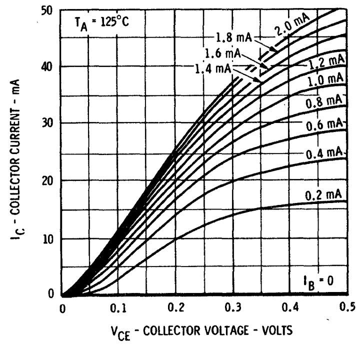


TYPICAL ELECTRICAL CHARACTERISTICS

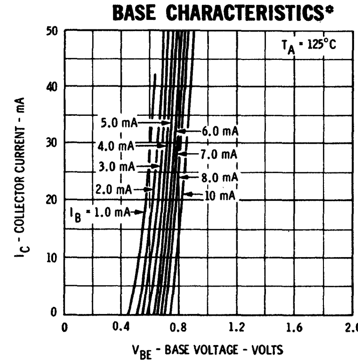
COLLECTOR CHARACTERISTICS* ACTIVE REGION



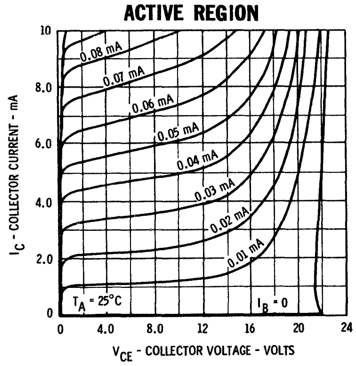
COLLECTOR CHARACTERISTICS* SATURATION REGION



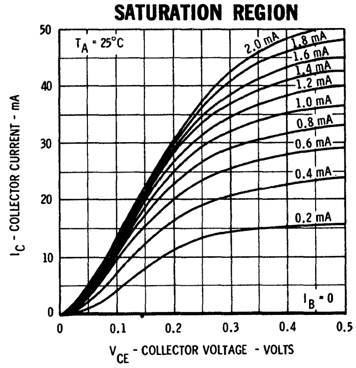
BASE CHARACTERISTICS*



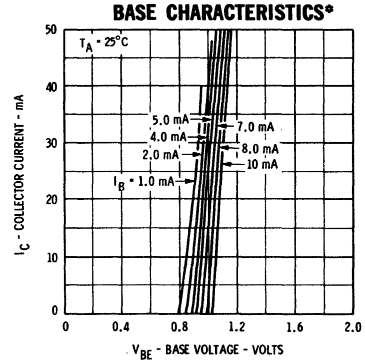
COLLECTOR CHARACTERISTICS* ACTIVE REGION



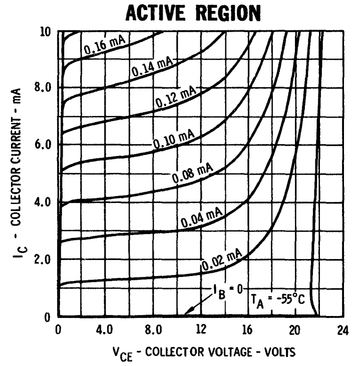
COLLECTOR CHARACTERISTICS* SATURATION REGION



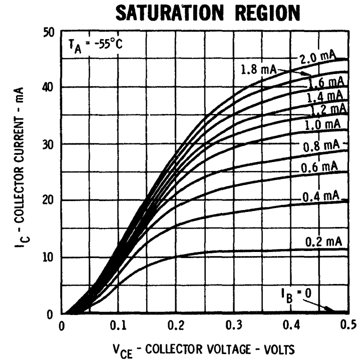
BASE CHARACTERISTICS*



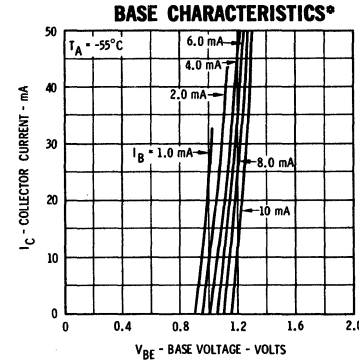
COLLECTOR CHARACTERISTICS* ACTIVE REGION



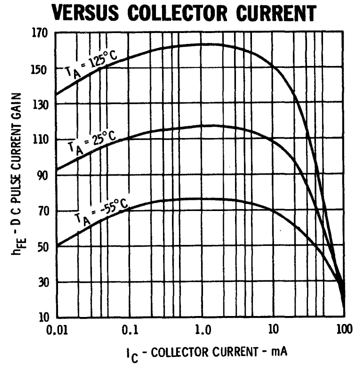
COLLECTOR CHARACTERISTICS* SATURATION REGION



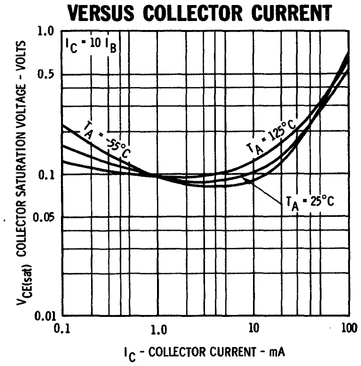
BASE CHARACTERISTICS*



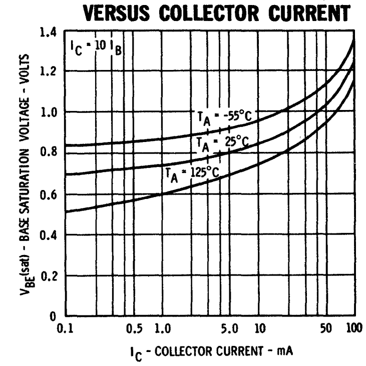
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

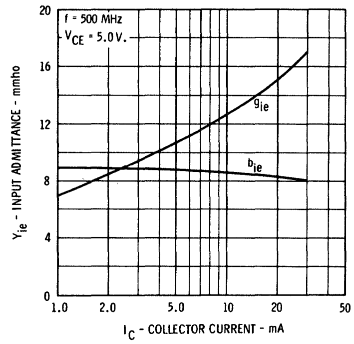


BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

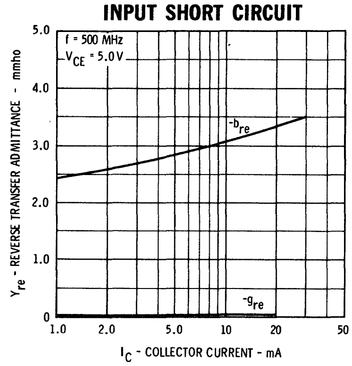


TYPICAL ELECTRICAL CHARACTERISTICS

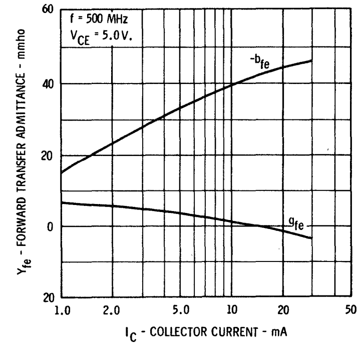
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT OUTPUT SHORT CIRCUIT



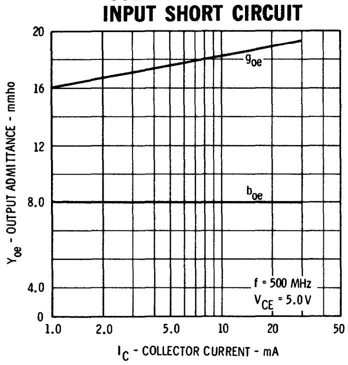
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT INPUT SHORT CIRCUIT



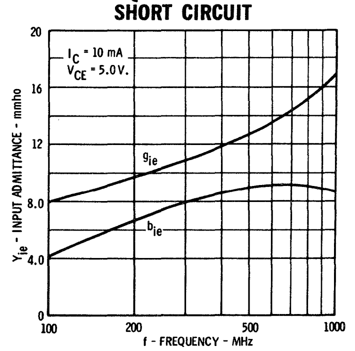
FOWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT OUTPUT SHORT CIRCUIT



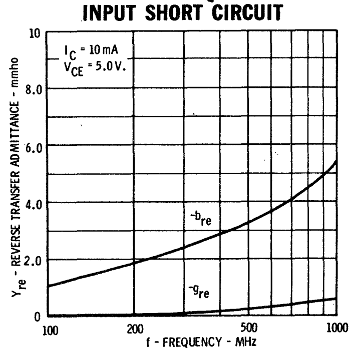
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT INPUT SHORT CIRCUIT



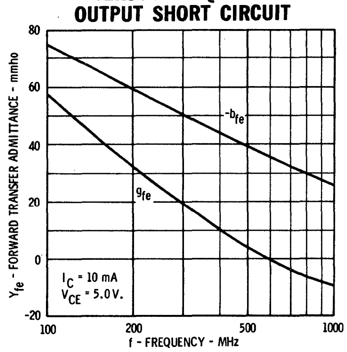
INPUT ADMITTANCE VERSUS FREQUENCY OUTPUT SHORT CIRCUIT



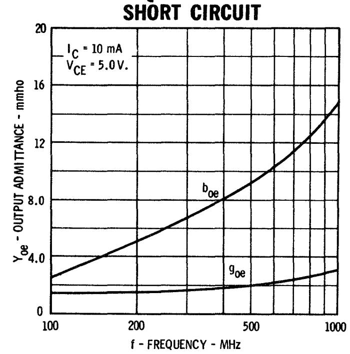
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY INPUT SHORT CIRCUIT



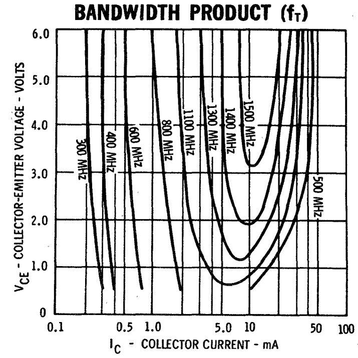
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY OUTPUT SHORT CIRCUIT



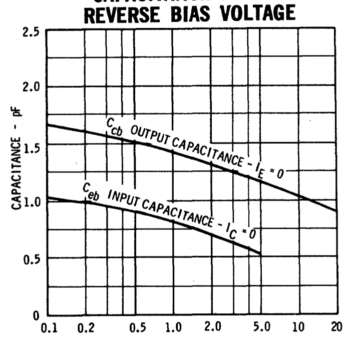
OUTPUT ADMITTANCE VERSUS FREQUENCY INPUT SHORT CIRCUIT



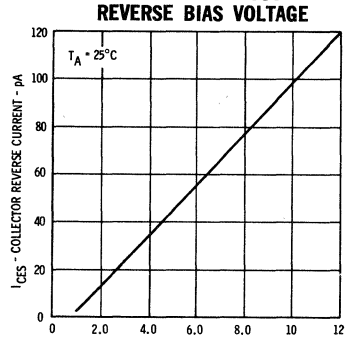
CONTOUR OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



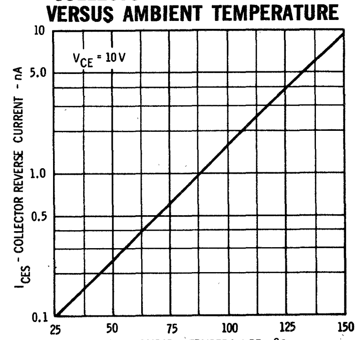
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



COLLECTOR-EMITTER REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



Fairchild cannot assume responsibility for use of any circuitry described. No circuit patent licenses are implied.

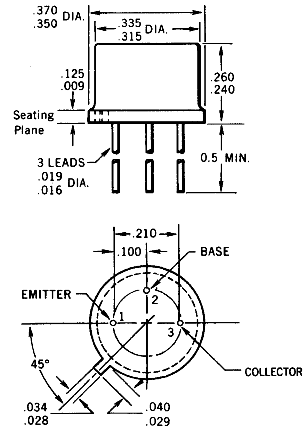
2N5236

RADIATION RESISTANT NPN CLASS-C RF AMPLIFIER

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

- **GUARANTEED PERFORMANCE AFTER FAST NEUTRON DOSAGE ($3x10^{14}$ nvt > 10 keV)**
- **HIGH GAIN . . . . h_{FE} = 10 (MIN), 17 (TYP) AT 50 mA**
- **HIGH POWER OUT . . . . 0.5 WATT (TYP) AT 250 MHz**
- **HIGH GAIN BANDWITH PRODUCT . . . f_T = 400 MHz (MIN) AT 50 mA**
- **LARGE SIGNAL CAPABILITY**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold-plated KOVAR
Lead No. 3 internally connected to case
Package weight is 1.23 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C
Lead Temperature (soldering, 60 second time limit)	300°C

Maximum Power Dissipation (Notes 6 and 7)

Total Dissipation at 25°C Case Temperature	1.0 Watt
at 25°C Ambient Temperature	0.6 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage	40 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	20 Volts
V_{EBO}	Emitter to Base Voltage	4.0 Volts

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

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	TYP.	MAX.	POST-IRRADIATION ($3x10^{14}$nvt >10 keV) MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Pulse Current Gain** (Note 5)	30	50	120	**10**	**17**			**I_C = 50 mA**	**V_{CE} = 5.0 V**
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		0.12	0.2		0.3	0.7	Volts	I_C = 50 mA	I_B = 5.0 mA
I_{CES}	Collector Cutoff Current		0.03	1.0		0.7	20	nA	V_{CE} = 20 V	V_{BE} = 0
I_{CES}(125°C)	Collector Cutoff Current		0.03	1.0		0.7	20	µA	V_{CE} = 20 V	V_{BE} = 0
BV_{CBO}	Collector to Base Breakdown Voltage	40	50		40	50		Volts	I_C = 100 µA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	4.0	5.5		4.0	5.5		Volts	I_C = 0	I_E = 100 µA
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	20	25		20	32		Volts	I_C = 15 mA	I_B = 0
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	5.0	7.5		**4.0**	**6.5**			**I_C = 50 mA**	**V_{CE} = 10 V**
C_{cb}	Collector to Base Capacitance (f = 1.0 MHz)		2.3	3.0			3.0	pF	I_E = 0	V_{CB} = 10 V
G_{PE}	Amplifier Power Gain (f = 250 MHz)	6.0	7.0		5.0	6.5		dB	I_C = 0	V_{CE} = 20 V (Zero Signal)
h_{FE}(—55°C)	DC Pulse Current Gain (Note 5)	15			5.0				I_C = 50 mA	V_{CE} = 5.0 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) RF power-in = 100 mW (see test circuit).
(3) RF power-in = 100 mW. Conduction angle adjusted through R to obtain maximum efficiency with a minimum of 400 mW out. (See test circuit).
(4) Rating refers to a high-current point where collector to emitter voltage is lowest. For more information send for Fairchild Publication APP-4/2.
(5) Pulse Conditions: length = 300 µs; duty cycle = 1%.
(6) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(7) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 175°C/Watt (derating factor of 5.71 mW/°C); junction to ambient thermal resistance of 292°C/Watt (derating factor of 3.42 mW/°C).

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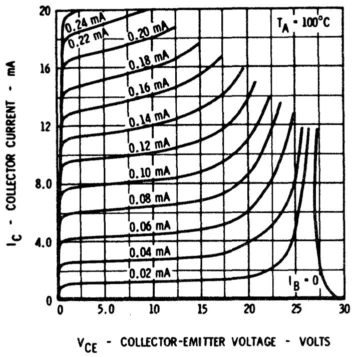
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

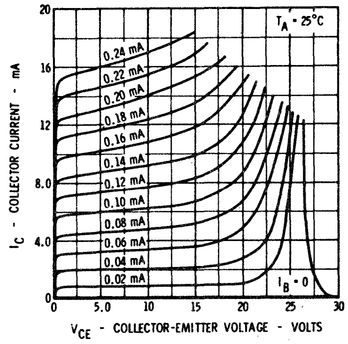
FAIRCHILD TRANSISTOR 2N5236

TYPICAL ELECTRICAL CHARACTERISTICS

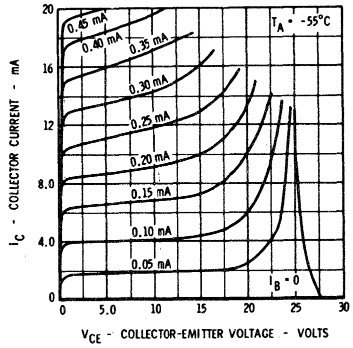
COLLECTOR CHARACTERISTICS



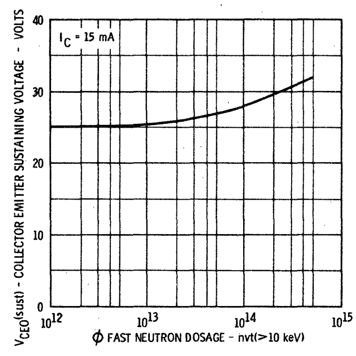
COLLECTOR CHARACTERISTICS



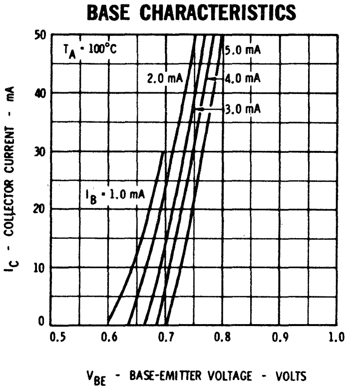
COLLECTOR CHARACTERISTICS



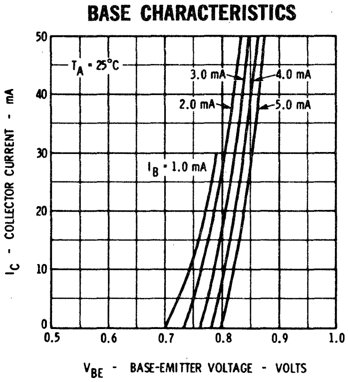
COLLECTOR EMITTER SUSTAINING VOLTAGE VERSUS FAST NEUTRON DOSAGE



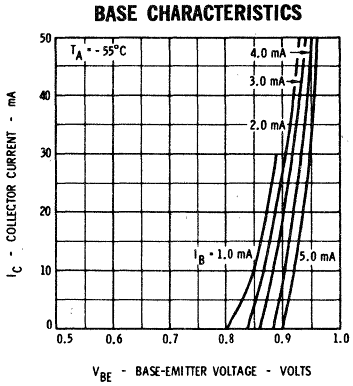
BASE CHARACTERISTICS



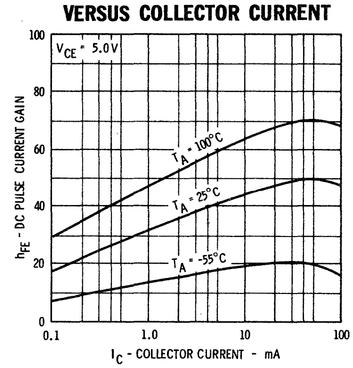
BASE CHARACTERISTICS



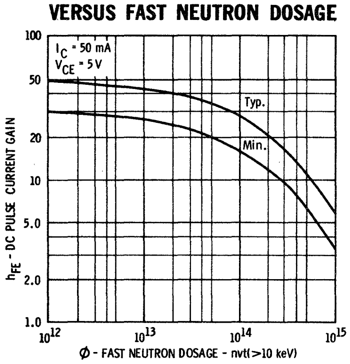
BASE CHARACTERISTICS



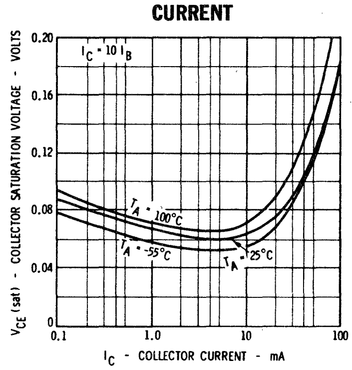
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



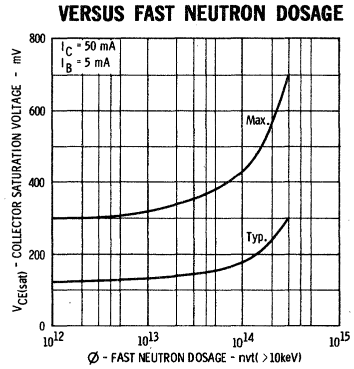
MINIMUM AND TYPICAL DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



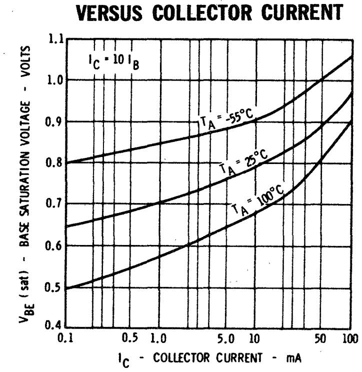
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



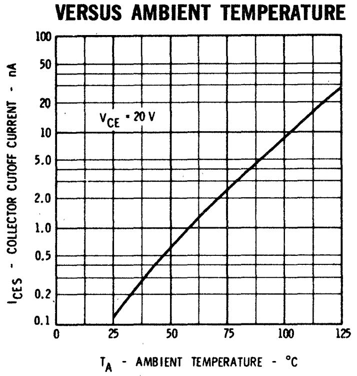
TYPICAL AND MAXIMUM COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



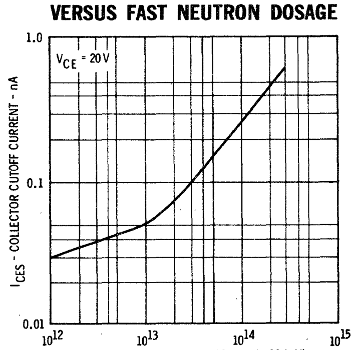
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



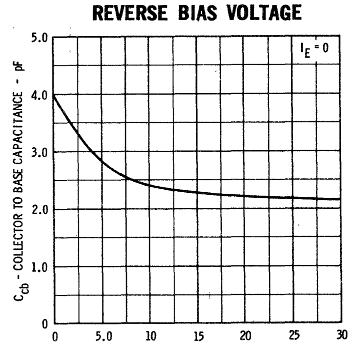
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



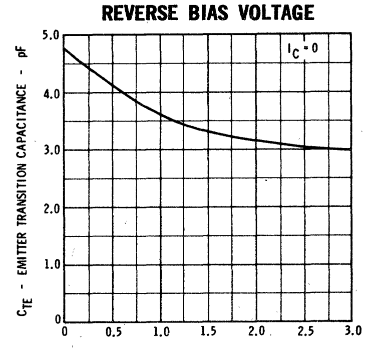
COLLECTOR CUTOFF CURRENT VERSUS FAST NEUTRON DOSAGE



COLLECTOR TO BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



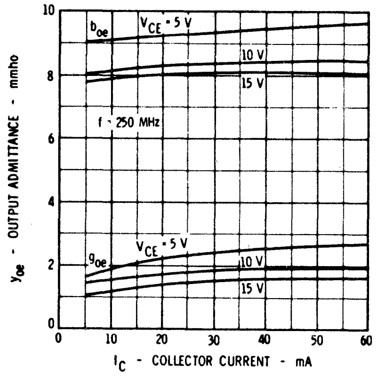
EMITTER TO BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



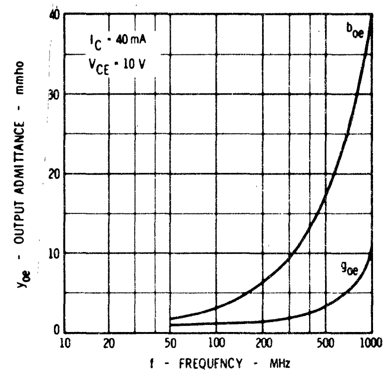
FAIRCHILD TRANSISTOR 2N5236

TYPICAL ELECTRICAL CHARACTERISTICS

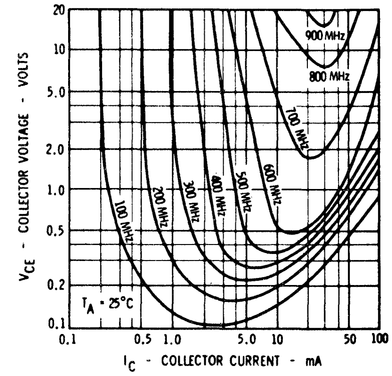
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT-INPUT SHORT CIRCUIT



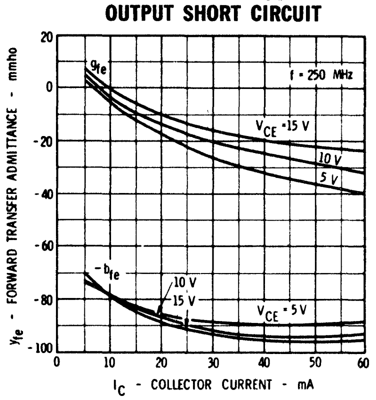
OUTPUT ADMITTANCE VERSUS FREQUENCY INPUT SHORT CIRCUIT



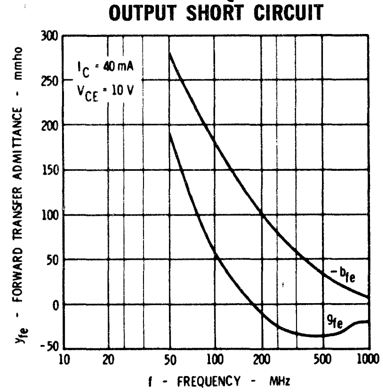
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



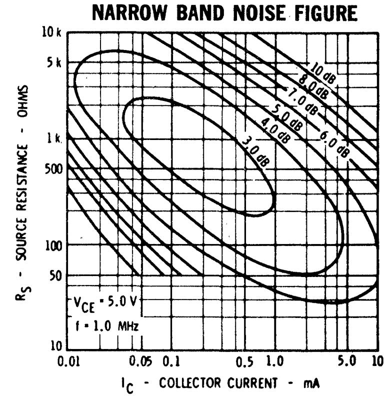
FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT-OUTPUT SHORT CIRCUIT



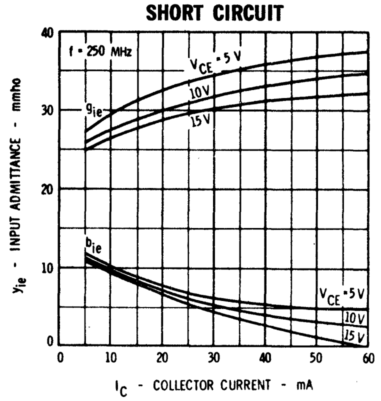
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



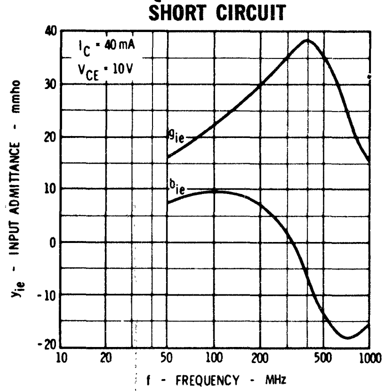
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



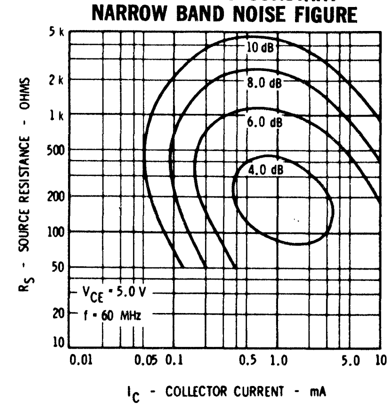
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT-OUTPUT SHORT CIRCUIT



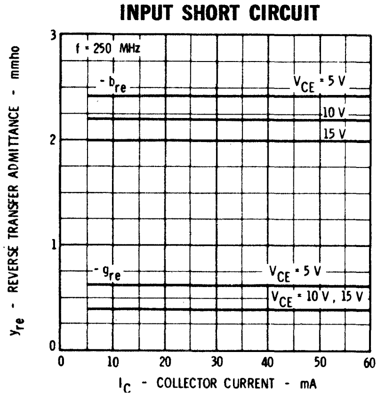
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



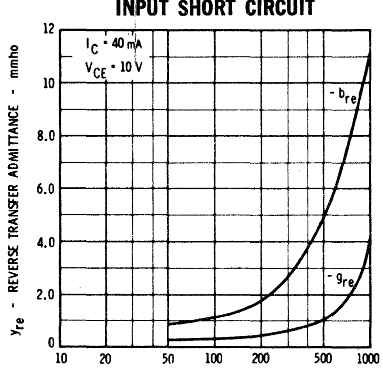
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



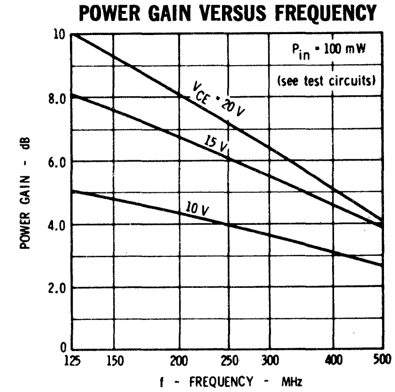
REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT-INPUT SHORT CIRCUIT



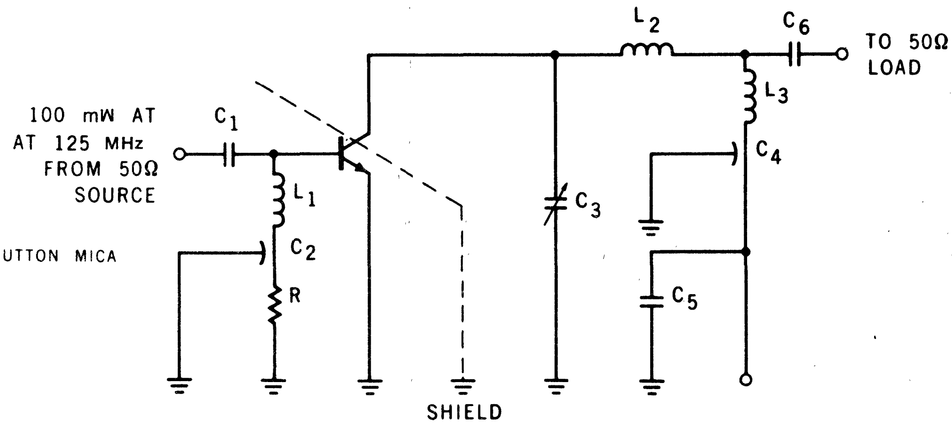
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



POWER GAIN VERSUS FREQUENCY



125 MHz POWER AMPLIFIER



$C_1 . C_2 . C_4 . C_6$ = 1000 pF BUTTON MICA

C_3 = 2 - 8 pF

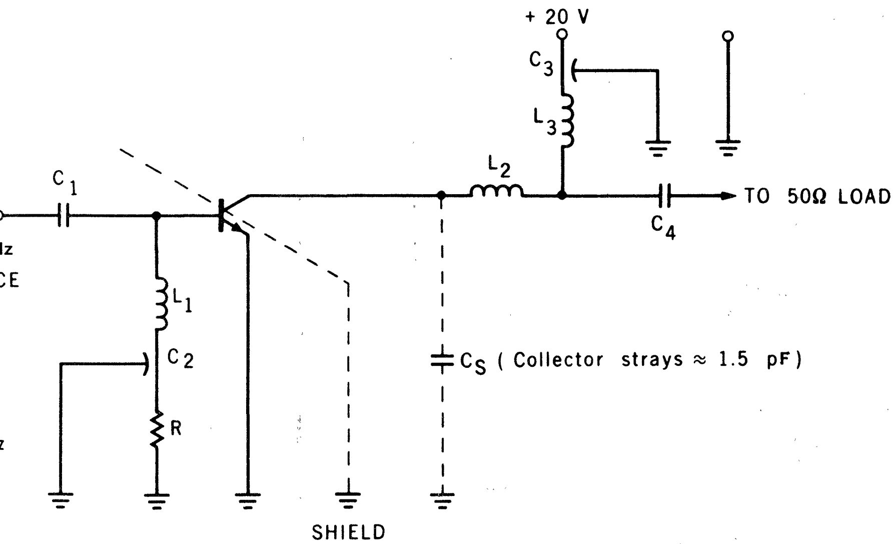
C_5 = 6 µF AT 50 V

L_1 L_3 = RFC fr > 125 MHz

L_2 = - 16 pF

R = 200 Ω

250 MHz POWER AMPLIFIER



C_1 = 120 pF

$C_2 . C_3 . C_4$ = 1000 pF BUTTON MICA

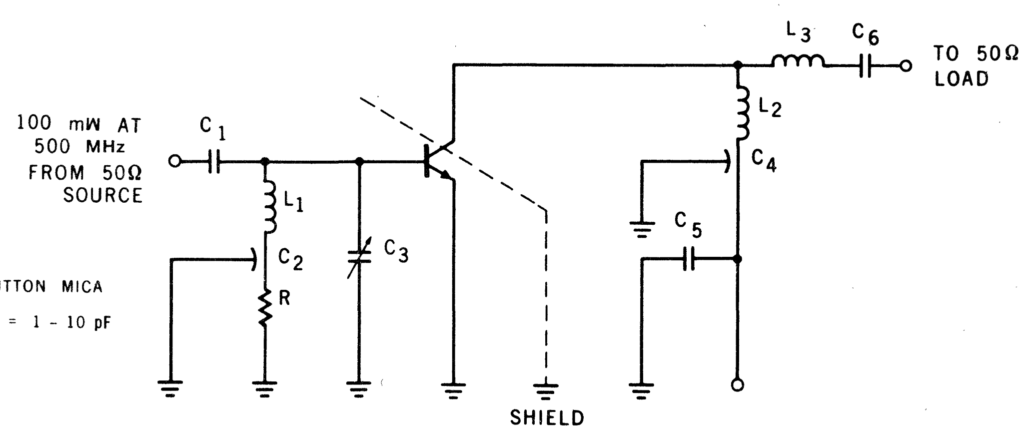
C_S (COLLECTOR STRAYS) ≈ 1.5 pF

$L_1 . L_3$ = .47 µH (RF CHOKE) fr > 250 MHz

L_2 = -5.5 pF

R = 200 Ω

500 MHz POWER AMPLIFER



C_1 = 10 pF

$C_2 . C_4 . C_6$ = 1000 pF BUTTON MICA

C_5 = 6 µF AT 50 V C_3 = 1 - 10 pF

L_1 = - 9 pF

L_2 = - 3.5 pF

L_3 = - 7.5 pF

R = 20 Ω

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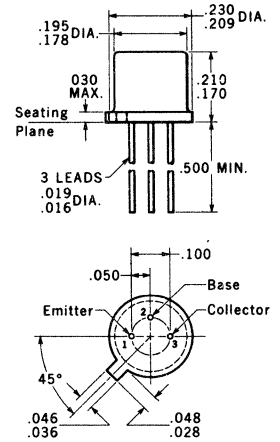
2N5244

PNP RADIATION RESISTANT HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTOR

- **GUARANTEED PERFORMANCE AFTER NEUTRON IRRADIATION OF 3X10[14] nvt > 10 keV**
- **HIGH FREQUENCY . . . . f_T = 400 MHz (MIN) AFTER RADIATION**
- **HIGH VOLTAGE . . . . . . LV_{CEO} = —40 V (MIN) AFTER RADIATION**
- **EXCELLENT BETA . . . . h_{FE} = 14 (MIN) AT I_C = 10 mA AFTER RADIATION**
- **FAST SWITCHING . . . . . t_{on} = 15 ns (TYP) AT $I_C \approx$ 50 mA AFTER RADIATION**
  t_{off} = 60 ns (TYP) AT $I_C \approx$ 50 mA AFTER RADIATION
- **LOW NOISE FIGURE . . . NF = 7.0 dB (TYP) 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 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	−65°C to +200°C
Operating Junction Temperature	200°C
Lead Temperature (Soldering, 60 second time limit)	300°C

Maximum Power Dissipation (Notes 2 and 3)

Total Dissipation at 25°C Case Temperature	1.0 Watt
at 25°C Ambient Temperature	0.36 Watt

Maximum Voltages and Current

V_{CES}	Collector to Base Voltage	−40 Volts
V_{CBO}	Collector to Base Voltage	−40 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	−40 Volts
V_{EBO}	Emitter to Base Voltage	−5.0 Volts
I_C	Collector Current	100 mA

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

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION			POST-IRRADIATION (3x10[14]nvt>10 keV)			UNITS	TEST CONDITIONS	
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.			
h_{FE}	DC Current Gain	140	160		4.0	6.0			I_C = 100 μA	V_{CE} = −5.0 V
h_{FE}	DC Current Gain	150	200		8.0	10.5			I_C = 1.0 mA	V_{CE} = −1.0 V
h_{FE}	**DC Pulse Current Gain** (Note 5)	150	200	300	**14**	**17**			**I_C = 10 mA**	**V_{CE} = −1.0 V**
h_{FE}	DC Pulse Current Gain (Note 5)	30	60		5.0	6.5			I_C = 50 mA	V_{CE} = −1.0 V
h_{FE}(−55°C)	DC Pulse Current Gain (Note 5)	70	100		7.0	8.0			I_C = 10 mA	V_{CE} = −1.0 V
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	4.5	6.0		**4.0**	**5.5**			**I_C = 10 mA**	**V_{CE} = −20 V**
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.1	−0.14		−0.32	−0.55	Volts	I_C = 10 mA	I_B = 1.0 mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.2	−0.3				Volts	I_C = 50 mA	I_B = 5.0 mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.16	−0.28			−1.0	Volts	I_C = 50 mA	I_B = 10 mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)		−0.125	−0.2				Volts	I_C = 50 mA	I_B = 16.67 mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)	−0.7	−0.77	−0.9	−0.7	−0.75	−0.9	Volts	I_C = 10 mA	I_B = 1.0 mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)		−0.88	−1.1		−0.84	−1.1	Volts	I_C = 50 mA	I_B = 5.0 mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 5)		−0.9	−1.2		−0.88	−1.2	Volts	I_C = 50 mA	I_B = 16.67 mA
C_{cb}	Collector to Base Capacitance (f = 1.0 MHz)		2.2	3.5		2.2	3.5	pF	I_E = 0	V_{CB} = −10 V
C_{eb}	Emitter to Base Capacitance (f = 1.0 MHz)		4.0	5.5		4.0	5.5	pF	I_C = 0	V_{EB} = −0.5 V
NF	**Noise Figure** (f = 100 MHz)		3.5			**7.0**		**dB**	**I_C = 1.0 mA**	**V_{CE} = −5.0 V**

Notes on page 2.

*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

FAIRCHILD TRANSISTOR 2N5244

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

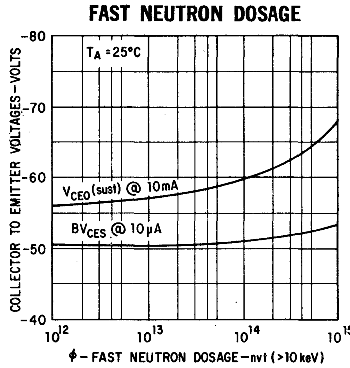
SYMBOL	CHARACTERISTICS	PRE-IRRADIATION MIN.	PRE-IRRADIATION TYP.	PRE-IRRADIATION MAX.	POST-IRRADIATION ($3x10^{14}$nvt>10 keV) MIN.	POST-IRRADIATION TYP.	POST-IRRADIATION MAX.	UNITS	TEST CONDITIONS	
t_{on}	**Turn On Time** (Note 6)		15	40		**15**	**40**	**ns**	**$I_C \approx 50$ mA**	**$I_{B1} \approx 16.67$ mA**
t_{off}	**Turn Off Time** (Note 6)		160	200		**60**	**200**	**ns**	**$I_C \approx 50$ mA**	**$I_{B1} \approx 16.67$ mA $I_{B2} \approx -16.67$ mA**
I_{CES}	Collector Reverse Current		0.15	15		3.3	1000	nA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES}(125°C)	Collector Reverse Current			15				μA	$V_{CE} = -30$ V	$V_{BE} = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−40			−40			Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−40	−56		−40	−58		Volts	$I_C = 10$ μA	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0	−5.4		−5.0	−5.4		Volts	$I_C = 0$	$I_E = 10$ μA
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	−40	−56		**−40**	**−62**		**Volts**	**$I_C = 10$ mA** (pulsed)	**$I_B = 0$**

NOTES:

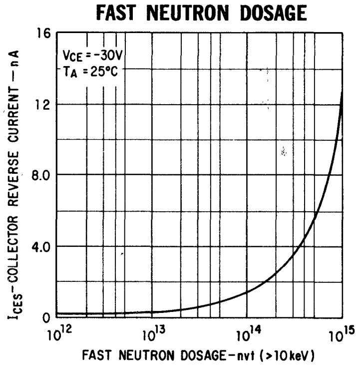
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 175°C/Watt (derating factor of 5.71 mW/°C); junction to ambient thermal resistance of 500°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. For more information send for Fairchild Publication APP-4/2.
(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 (POST IRRADIATION PERFORMANCE)

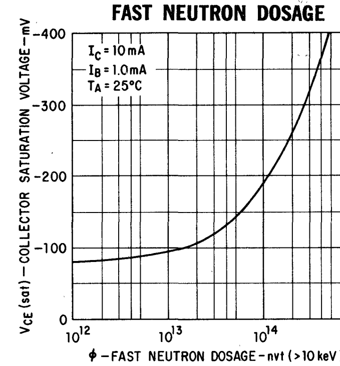
COLLECTOR TO EMITTER VOLTAGES VERSUS FAST NEUTRON DOSAGE



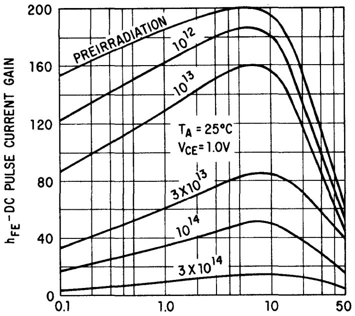
COLLECTOR TO EMITTER CURRENT VERSUS FAST NEUTRON DOSAGE



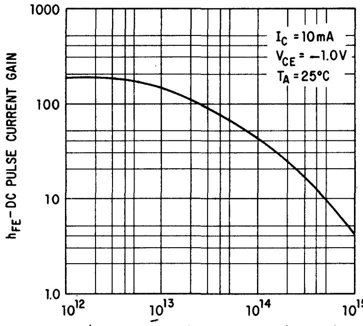
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT AND FAST NEUTRON DOSAGE (nvt > 10 keV)

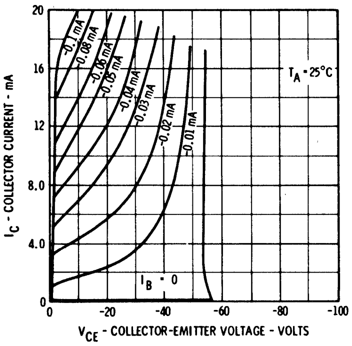


DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE

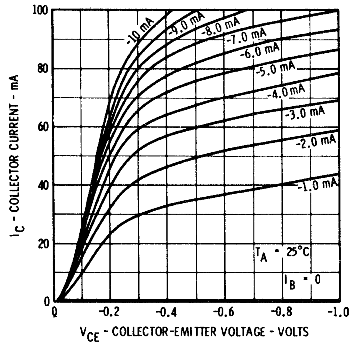


TYPICAL ELECTRICAL CHARACTERISTICS

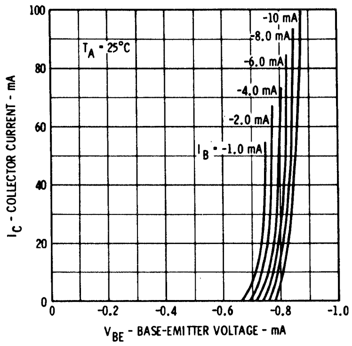
COLLECTOR CHARACTERISTICS ACTIVE REGION



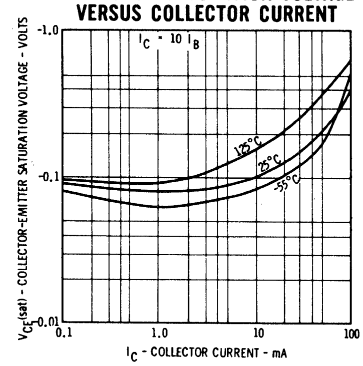
COLLECTOR CHARACTERISTICS SATURATION REGION



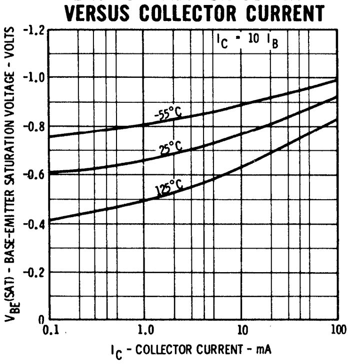
BASE CHARACTERISTICS



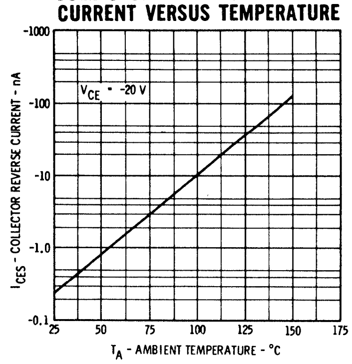
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



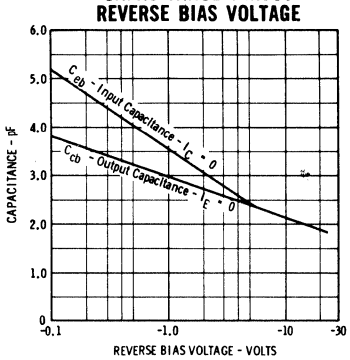
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



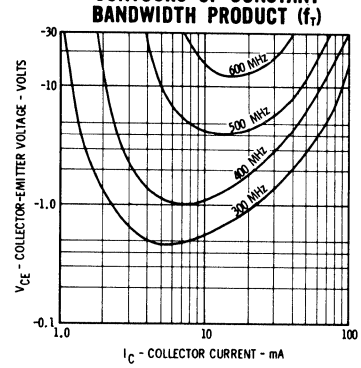
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



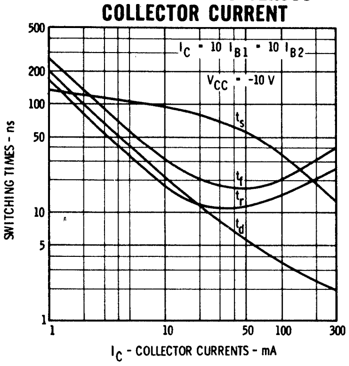
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



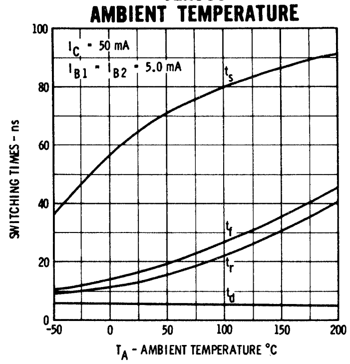
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



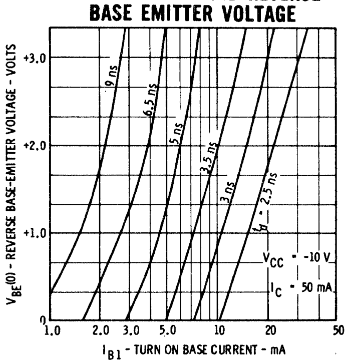
SWITCHING TIMES VERSUS COLLECTOR CURRENT



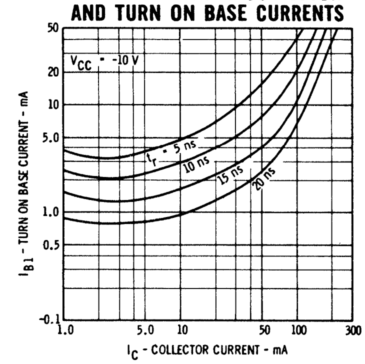
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



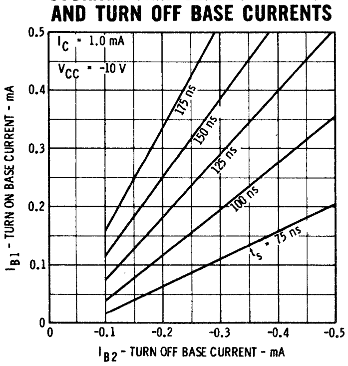
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



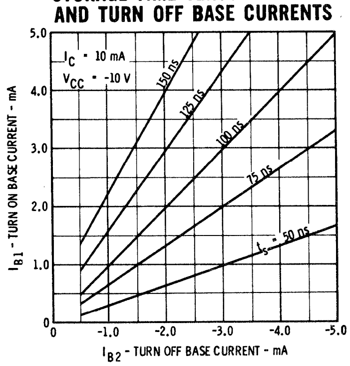
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



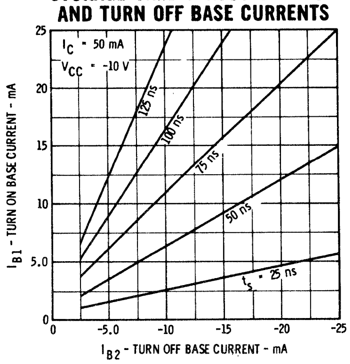
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



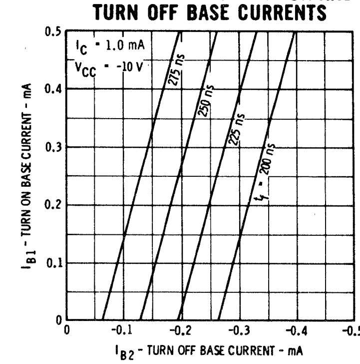
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



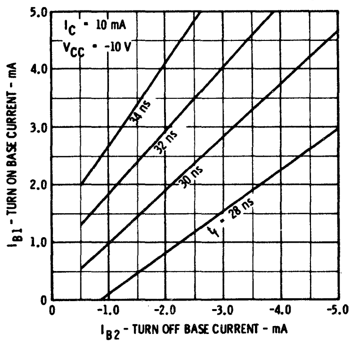
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



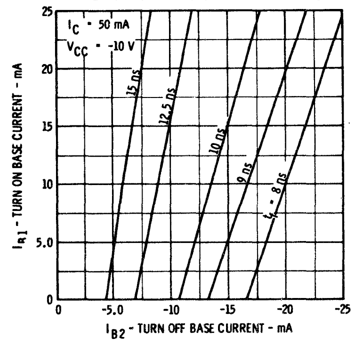
FAIRCHILD TRANSISTOR 2N5244

TYPICAL ELECTRICAL CHARACTERISTICS

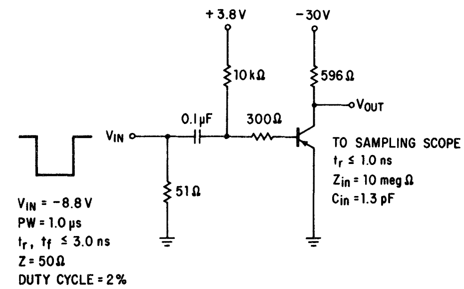
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



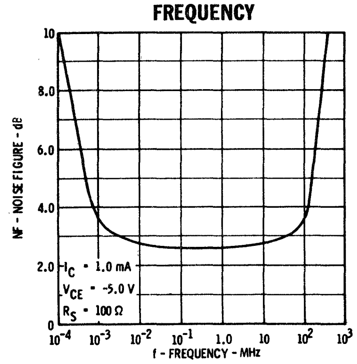
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



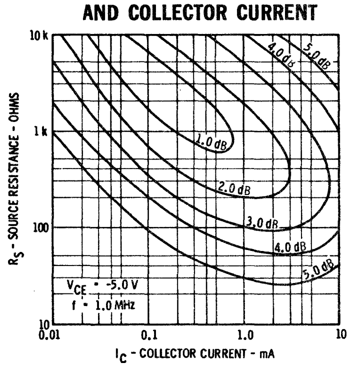
SWITCHING TIME TEST CIRCUIT



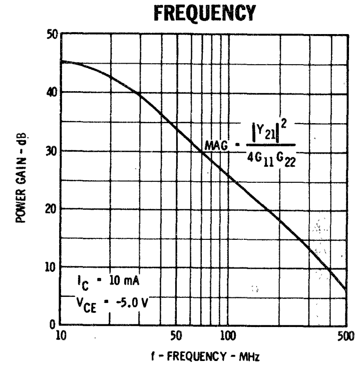
NOISE FIGURE VERSUS FREQUENCY



NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT

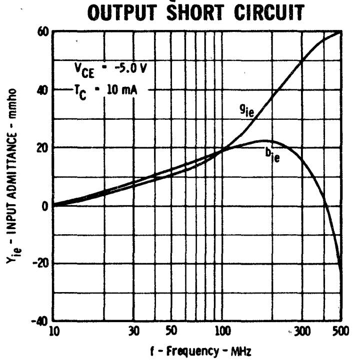


POWER GAIN VERSUS FREQUENCY

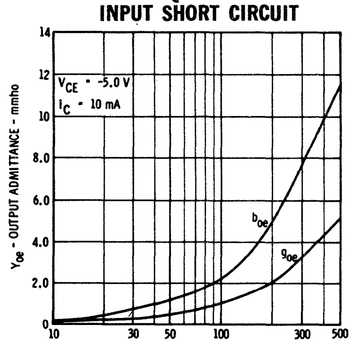


TYPICAL COMMON EMITTER "Y" PARAMETERS

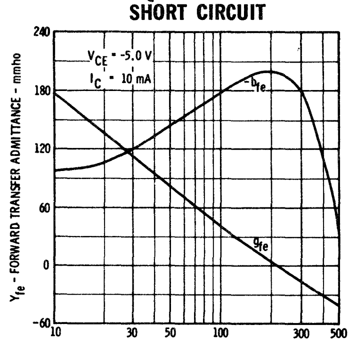
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



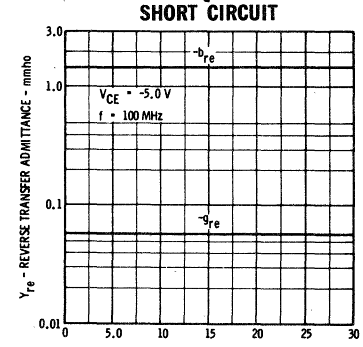
OUTPUT ADMITTANCE VERSUS FREQUENCY — INPUT SHORT CIRCUIT



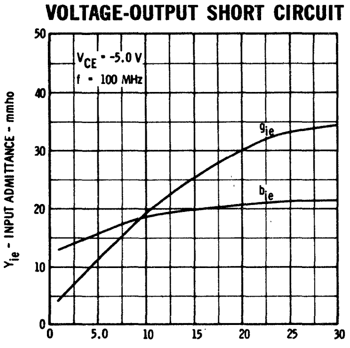
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY-OUTPUT SHORT CIRCUIT



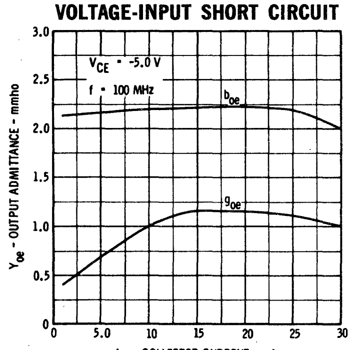
REVERSE TRANSFER ADMITTANCE VERSUS FREQUENCY-INPUT SHORT CIRCUIT



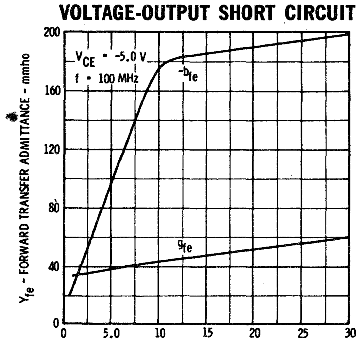
INPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



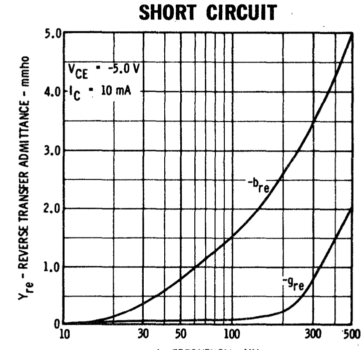
OUTPUT ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



FORWARD TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-OUTPUT SHORT CIRCUIT



REVERSE TRANSFER ADMITTANCE VERSUS COLLECTOR CURRENT AND VOLTAGE-INPUT SHORT CIRCUIT



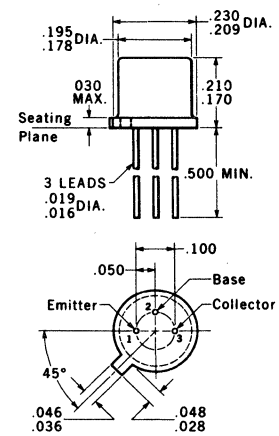
2N5292

RADIATION RESISTANT, PNP HIGH SPEED SATURATED SWITCH

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTOR

- **GUARANTEED PERFORMANCE AFTER NEUTRON IRRADIATION OF 3 x 10^{14} nvt > 10 keV**
- **FAST SWITCHING . . . . $t_{on} = 25$ ns (MAX) AFTER RADIATION**
  $t_{off} = 35$ ns (MAX) AFTER RADIATION
- **HIGH FREQUENCY . . . . $f_T = 600$ MHz (MIN) AFTER RADIATION**
- **LOW CAPACITANCE . . . . $C_{cb} = 4.5$ pF (MAX) AFTER RADIATION**
- **LOW SATURATION VOLTAGE . . . $V_{CE(sat)} = -0.65$ V (MAX) AT $I_C = 100$ mA 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 0.44 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		−65°C to +200°C
Operating Junction Temperature		200°C
Lead Temperature (Soldering, 60 second time limit)		300°C
Maximum Power Dissipation (Notes 2 and 3)		
Total Dissipation at 25°C Case Temperature		1.0 Watts
at 100°C Case Temperature		0.72 Watt
at 25°C Ambient Temperature		0.36 Watt
Maximum Voltages		
V_{CBO}	Collector to Base Voltage	−12 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	−12 Volts
V_{EBO}	Emitter to Base Voltage	−4.5 Volts

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

SYMBOL	CHARACTERISTICS	PRE-IRRADIATION			POST-IRRADIATION (3x10^{14} nvt > 10 keV)			UNITS	TEST CONDITIONS	
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.			
t_{on}	**Turn On Time** (Note 5, Figure 1)		6.0	15		**8.0**	**25**	ns	$I_C \approx 30$ mA	$I_{B1} \approx 6.0$ mA
t_{off}	**Turn Off Time** (Note 5, Figure 1)		18	35		**15**	**35**	ns	$I_C \approx 30$ mA	$I_{B1} \approx 6.0$ mA, $I_{B2} \approx -6.0$ mA
τ_s	Charge Storage Time Constant (Note 6, Figure 2)		15	20		5.0	20	ns	$I_C \approx 10$ mA	$I_{B1} \approx 10$ mA, $I_{B2} \approx -10$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 6)		−0.06	−0.12		−0.113	−0.24	Volts	$I_C = 10$ mA	$I_B = 2.0$ mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 6)		−0.12	−0.19		−0.212	−0.4	Volts	$I_C = 30$ mA	$I_B = 6.0$ mA
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)		−0.28	−0.44		**−0.367**	**−0.65**	**Volts**	$I_C = 100$ mA	$I_B = 20$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)	−0.78	−0.82	−0.92	−0.78	−0.83	−0.95	Volts	$I_C = 10$ mA	$I_B = 2.0$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)	−0.85	−0.93	−1.2	−0.85	−0.93	−1.2	Volts	$I_C = 30$ mA	$I_B = 6.0$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage	−1.0	−1.14	−1.6	−1.0	−1.14	−1.75	Volts	$I_C = 100$ mA	$I_B = 20$ mA
h_{fe}	**High Frequency Current Gain (f = 100 MHz)**	8.0	12		**6.0**	**10**			$I_C = 30$ mA	$V_{CE} = -10$ V
C_{cb}	**Collector to Base Capacitance (f = 1.0 MHz)**		2.2	4.5		**2.2**	**4.5**	**pF**	$I_E = 0$	$V_{CB} = -5.0$ V
C_{eb}	Emitter to Base Capacitance (f = 1.0 MHz)		4.0	6.0		4.0	6.0	pF	$I_C = 0$	$V_{EB} = -0.5$ V
h_{FE}	DC Pulse Current Gain (Note 6)	30	53		6.0	12.4			$I_C = 10$ mA	$V_{CE} = -0.3$ V
h_{FE}	DC Pulse Current Gain (Note 6)	40	63	100	10	15.2			$I_C = 30$ mA	$V_{CE} = -0.5$ V
h_{FE}	DC Pulse Current Gain (Note 6)	30	55		8.0	13.9			$I_C = 100$ mA	$V_{CE} = -1.0$ V
h_{FE}(−55°C)	DC Pulse Current Gain (Note 6)	20	38		5.0	8.6			$I_C = 30$ mA	$V_{CE} = -0.5$ V
I_{CES}	Collector Reverse Current		0.05	1.0		0.3	10	nA	$V_{BE} = 0$	$V_{CE} = -10$ V
I_{CES}(125°C)	Collector Reverse Current		0.01	10		0.5	20	μA	$V_{BE} = 0$	$V_{CE} = -10$ V
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	−12	−16		−12	−17.7		Volts	$I_C = 10$ mA	$I_B = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	−12	−24		−12	−24.3		Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−12	−23		−12	−23.3		Volts	$I_C = 10$ μA	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−4.5	−5.4		−4.5	−5.4		Volts	$I_C = 0$	$I_E = 100$ μA

Notes on Page 4

*Fairchild is a patented Fairchild process.

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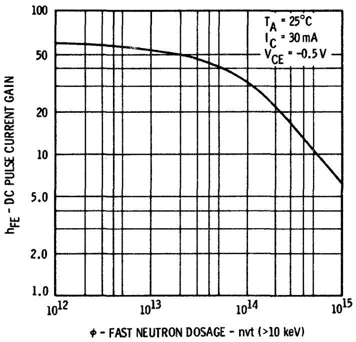
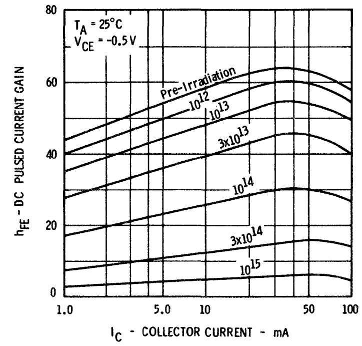
TYPICAL ELECTRICAL CHARACTERISTICS

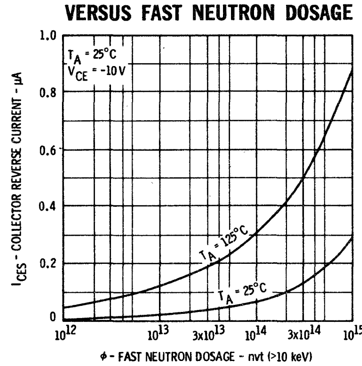
DC PULSE CURRENT GAIN VERSUS FAST NEUTRON DOSAGE



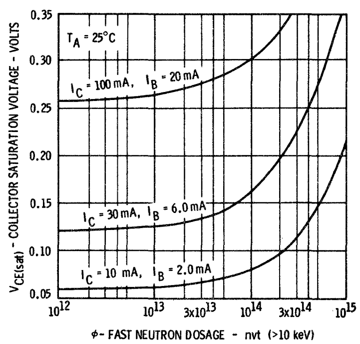
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT FAST NEUTRON DOSAGE



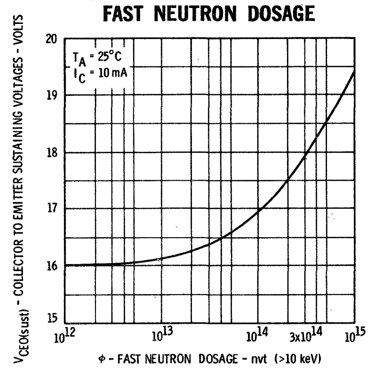
COLLECTOR TO EMITTER CURRENT VERSUS FAST NEUTRON DOSAGE



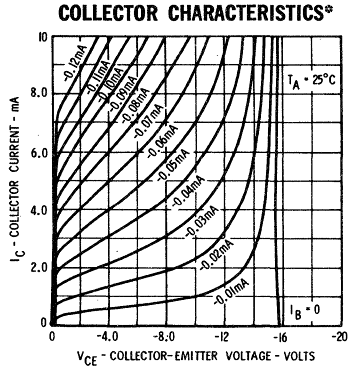
COLLECTOR SATURATION VOLTAGE VERSUS FAST NEUTRON DOSAGE



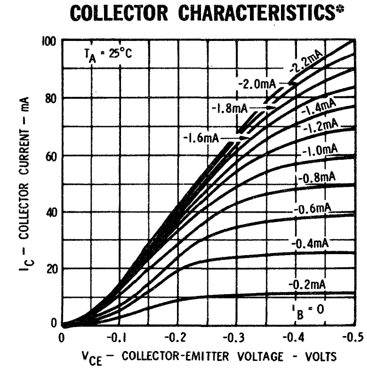
COLLECTOR TO EMITTER SUSTAINING VOLTAGE VERSUS FAST NEUTRON DOSAGE



COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*



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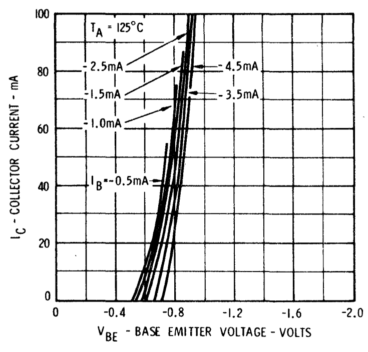
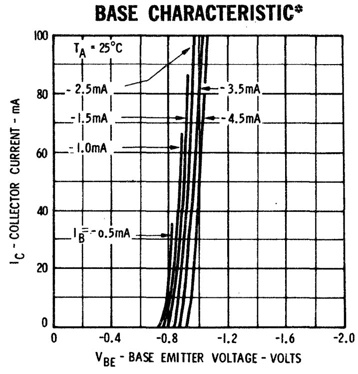
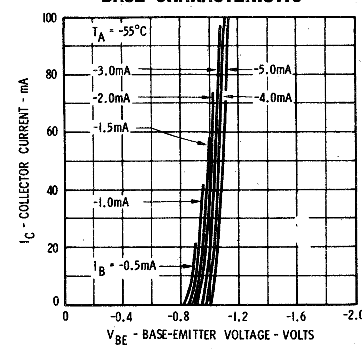


BASE CHARACTERISTIC*



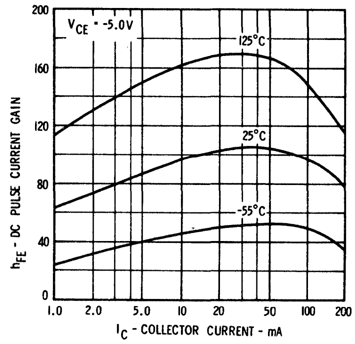
BASE CHARACTERISTIC*



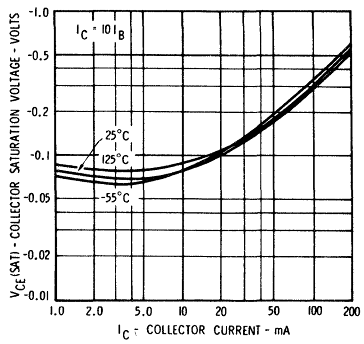
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

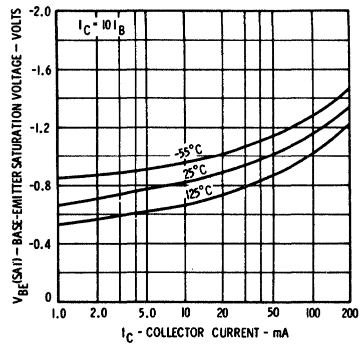
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



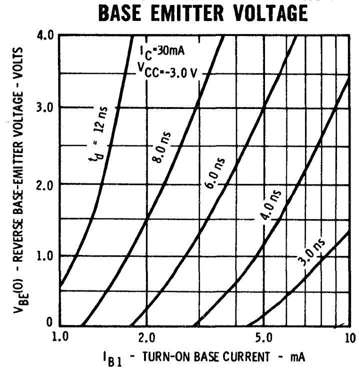
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



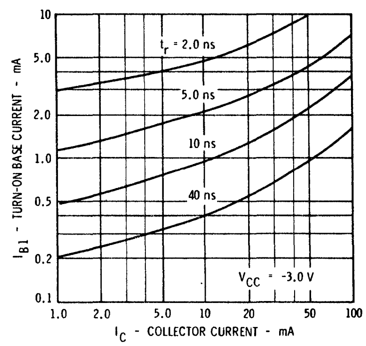
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



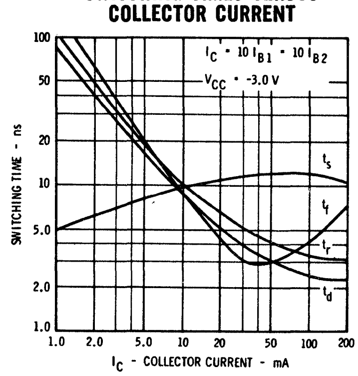
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



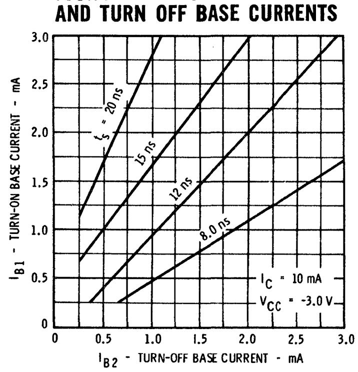
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



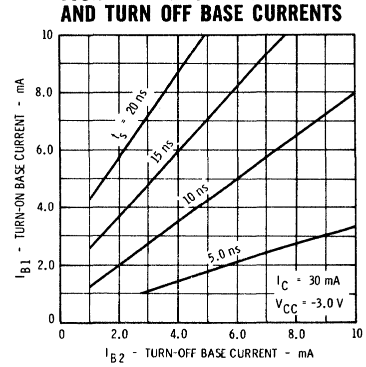
SWITCHING TIMES VERSUS COLLECTOR CURRENT



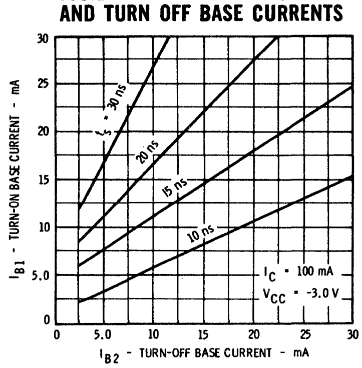
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



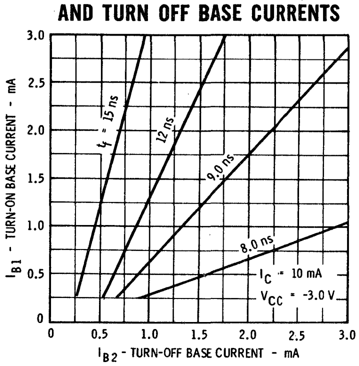
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



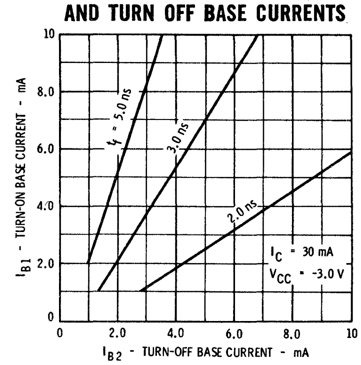
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



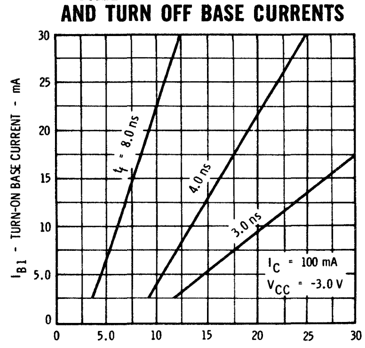
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

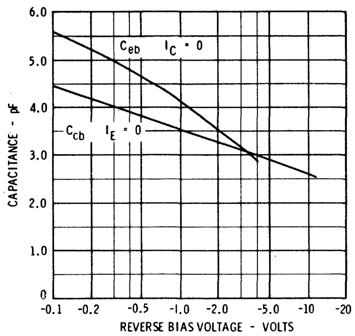


FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS

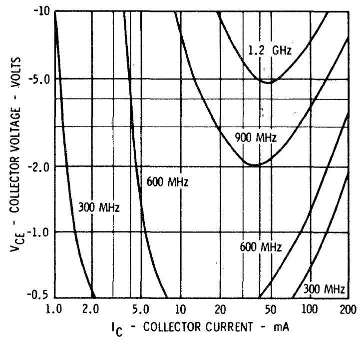


TYPICAL ELECTRICAL CHARACTERISTICS

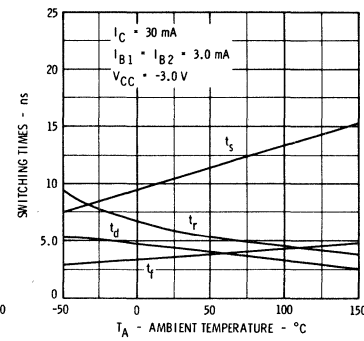
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



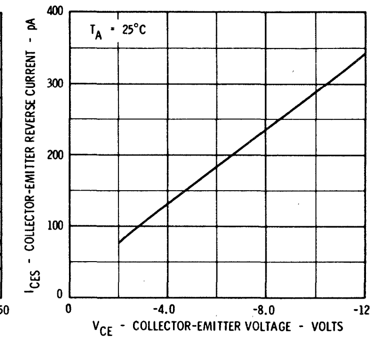
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



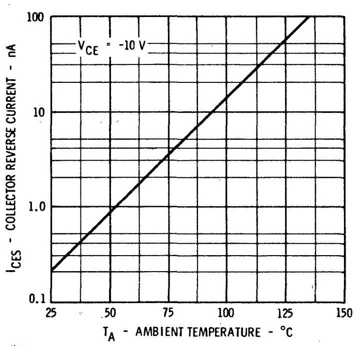
SWITCHING TIMES VERSUS TEMPERATURE



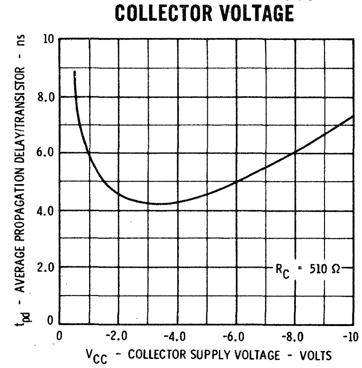
COLLECTOR-EMITTER REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



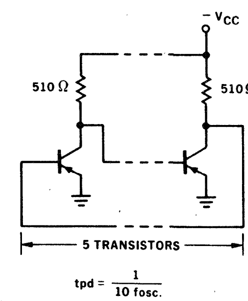
COLLECTOR REVERSE CURRENT VERSUS TEMPERATURE



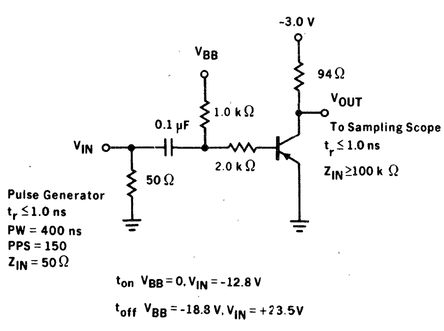
AVERAGE PROPAGATION DELAY PER TRANSISTOR VERSUS COLLECTOR VOLTAGE



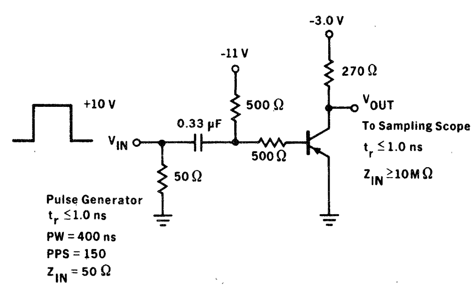
FIVE STAGE RING OSCILLATOR FOR MEASUREMENT OF PROPAGATION DELAY



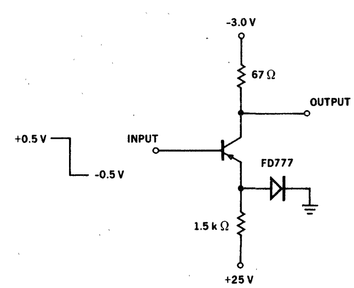
SWITCHING TIME TEST CIRCUIT FIGURE 1



STORAGE TIME TEST CIRCUIT FIGURE 2



NON SATURATED SWITCHING PERFORMANCE



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 175°C/Watt (derating factor of 5.71 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. For more information send for Fairchild Publication APP-4/2.
(5) See switching circuit for exact values of I_C, I_{B1}, and I_{B2}.
(6) Pulse Conditions: length = 300 µs; duty cycle = 1%.

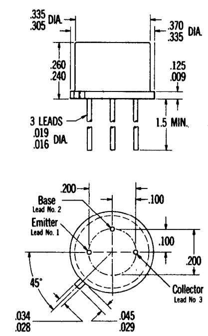
SE7001 • SE7002

NPN HIGH-VOLTAGE AUDIO / VIDEO AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

The SE7001 and SE7002 are NPN silicon PLANAR transistors designed for use in high-voltage video amplifier and line operated radio audio output applications. They feature low output capacitance and a five watt power rating. These devices are capable of producing up to one watt in high-voltage class "A" audio stages.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures		
Storage Temperature	−65°C to +200°C	
Operating Junction 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]	5.0 Watts	
at 25°C Free Air Temperature [Notes 2 and 3]	0.8 Watt	
Maximum Voltages	**SE7001**	**SE7002**
V_{CBO} Collector to Base Voltage	150 Volts	120 Volts
V_{CEO} Collector to Emitter Voltage [Note 4]	150 Volts	120 Volts
V_{EBO} Emitter to Base Voltage	5.0 Volts	5.0 Volts

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	SE7001 MIN.	SE7001 TYP.	SE7001 MAX.	SE7002 MIN.	SE7002 TYP.	SE7002 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	30	60		30	60			$I_C = 30$ mA	$V_{CE} = 10$ V
V_{BE} (sat)	Base Saturation Voltage		0.8	0.9		0.8	0.9	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.33	2.0		0.33	2.0	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	25	50		25	50			$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0	3.0		2.0	3.0			$I_C = 30$ mA	$V_{CE} = 10$ V
BV_{CBO}	Collector to Base Breakdown Voltage	150			120				$I_C = 0.1$ mA	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Note 4]	150			120				$I_C = 30$ mA (pulsed)	$I_B = 0$

Additional Electrical Characteristics on page 2.

* 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 35°C/watt (derating factor of 28.6 mW/°C); junction-to-ambient thermal resistance of 219°C/watt (derating factor of 4.56 mW/°C).
(4) This rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Pub. APP-4.
(5) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

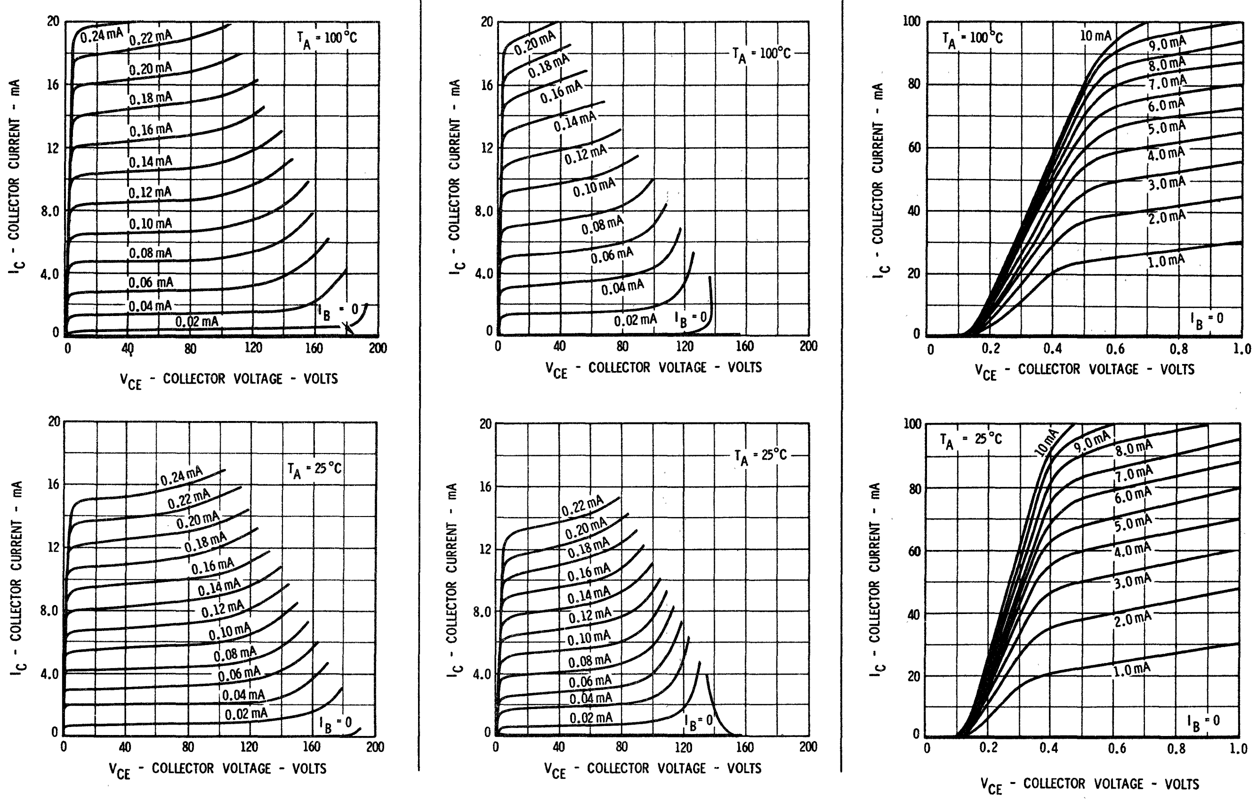
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

SYMBOL	CHARACTERISTIC	SE7001 MIN.	SE7001 TYP.	SE7001 MAX.	SE7002 MIN.	SE7002 TYP.	SE7002 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 5]	25	60		25	60			$I_C = 10$ mA	$V_{CE} = 10$ V
I_{CBO}	Collector Cutoff Current		0.3	100		0.3	100	nA	$I_E = 0$	$V_{CB} = 75$ V
I_{CBO} (150°C)	Collector Cutoff Current		2.0	50		2.0	50	μA	$I_E = 0$	$V_{CB} = 75$ V
I_{EBO}	Emitter Cutoff Current			100			100	nA	$I_C = 0$	$V_{EB} = 4.0$ V
C_{obo}	Output Capacitance		6.0	9.0		6.0	12	pF	$I_E = 0$	$V_{CB} = 20$ V
C_{TE}	Emitter Transition Capacitance		70	80		70	80	pF	$I_C = 0$	$V_{EB} = 0.5$ V
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			5.0			Volts	$I_C = 0$	$I_E = 0.1$ mA

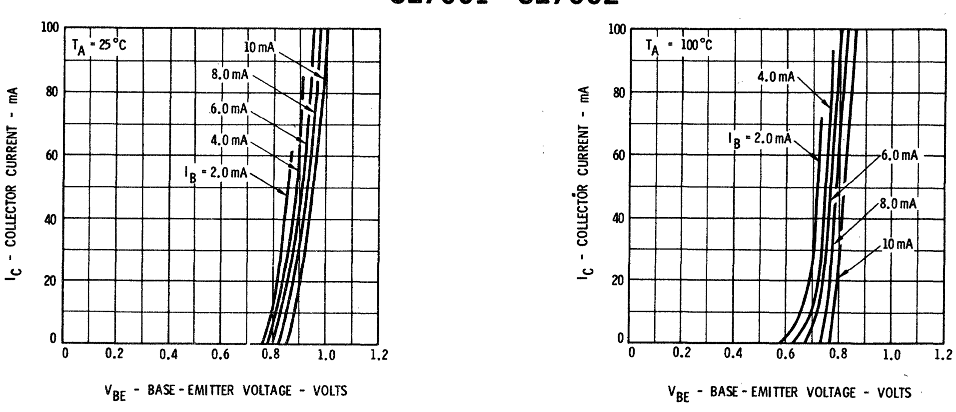
TYPICAL COLLECTOR CHARACTERISTICS *

SE7001 | SE7002 | SE7001 • SE7002



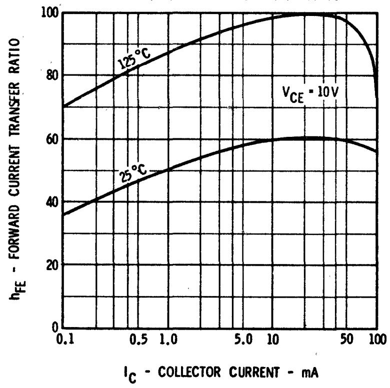
TYPICAL BASE CHARACTERISTICS *

SE7001 • SE7002

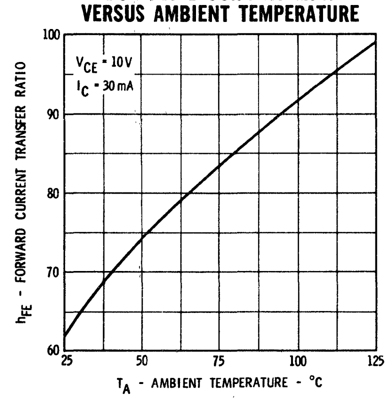


TYPICAL ELECTRICAL CHARACTERISTICS

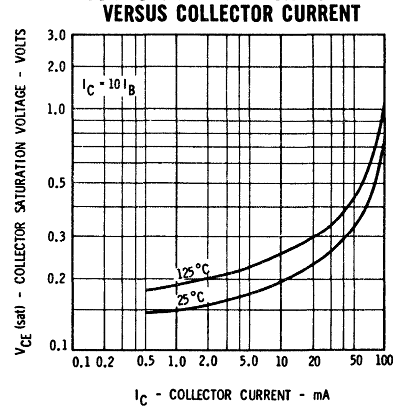
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



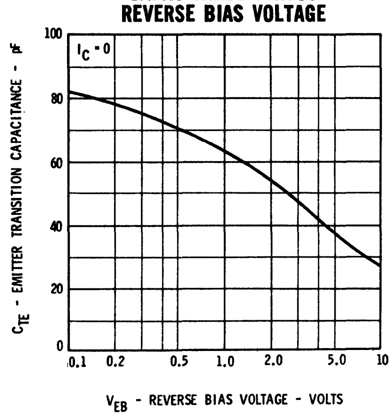
DC PULSED CURRENT GAIN VERSUS AMBIENT TEMPERATURE



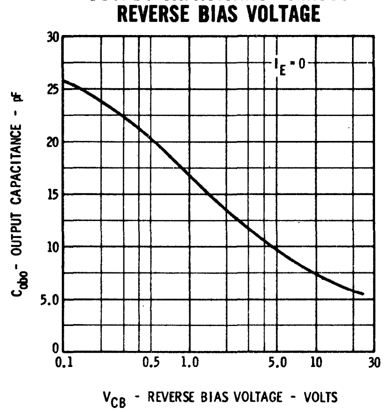
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



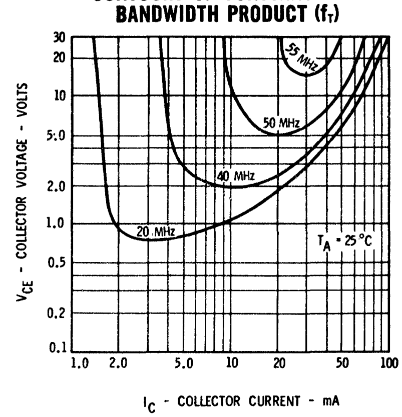
EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



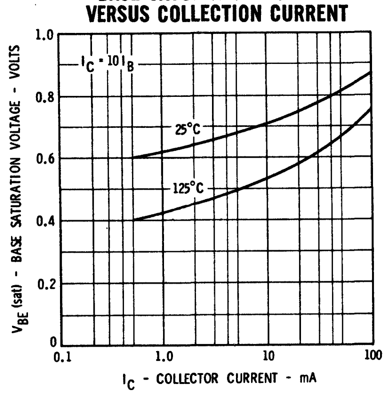
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



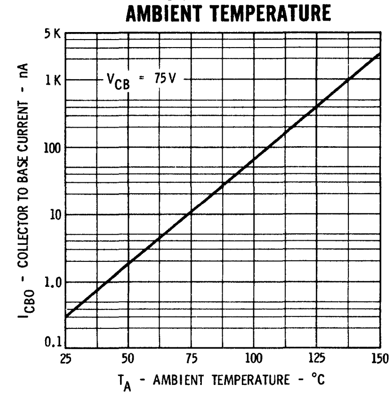
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



BASE SATURATION VOLTAGE VERSUS COLLECTION CURRENT



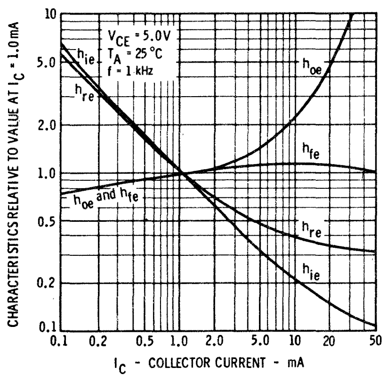
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS AMBIENT TEMPERATURE

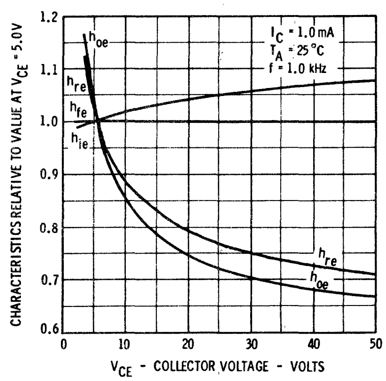


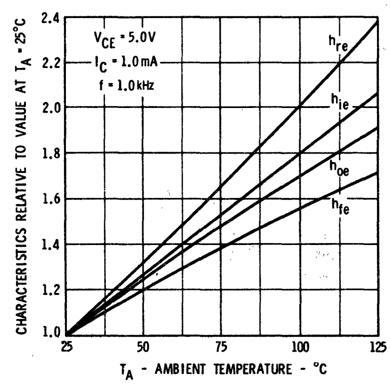
TYPICAL SMALL SIGNAL CHARACTERISTICS (f = 1.0 kHz)

SYMBOL	CHARACTERISTIC	TYPICAL	UNITS	TEST CONDITIONS	
h_{fe}	Small Signal Current Gain	50		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ie}	Input Resistance	1.5	k ohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance	5.3	μmhos	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio	1.5	$\times 10^{-4}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance	27	ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance	0.09	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{rb}	Voltage Feedback Ratio	0.25	$\times 10^{-4}$	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V

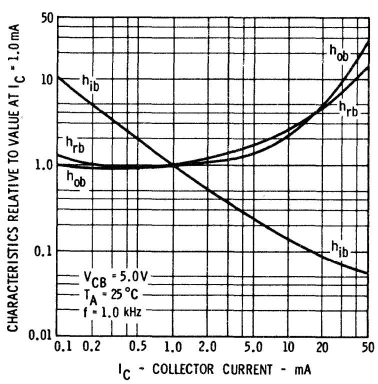
TYPICAL COMMON EMITTER CHARACTERISTICS

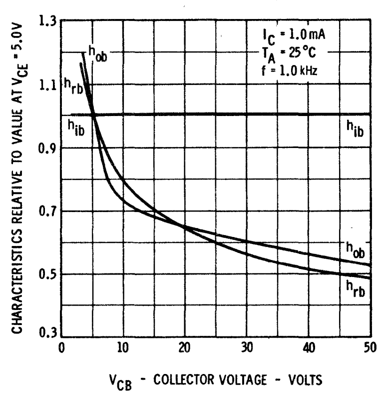


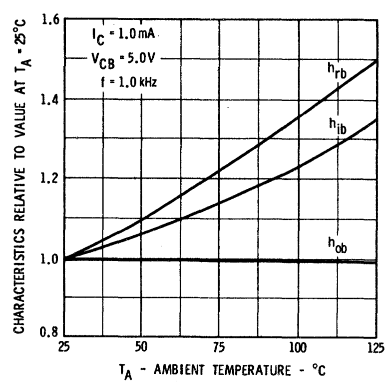




TYPICAL COMMON BASE CHARACTERISTICS







FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

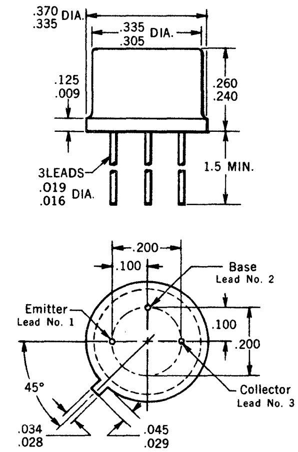
SE8001 • SE8002

NPN MEDIUM POWER

SILICON PLANAR* EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - The Fairchild SE8001 and SE8002 are NPN silicon PLANAR epitaxial transistors designed for general purpose use. They are suitable for one watt class "A" and up to ten watt class "B" audio output stages. These transistors also feature low saturation voltage at high current which makes them desirable for television applications such as vertical oscillator, horizontal driver, and audio output circuits.

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



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.1 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Operating Junction Temperature	200°C Maximum
Storage Temperature	-65°C to +200°C
Soldering Temperature (60 sec time limit)	300°C Maximum

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Note 2)	5.0 Watts
at 100°C Case Temperature (Note 2)	2.8 Watts
at 25°C Ambient Temperature (Note 2)	0.87 Watt

Maximum Voltages

		SE8001	SE8002
V_{CBO}	Collector to Base Voltage	60 Volts	80 Volts
V_{CEO}	Collector to Emitter Voltage (Note 3)	30 Volts	40 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts	5.0 Volts

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

Symbol	Characteristic		SE8001 Min.	SE8001 Max.	SE8002 Min.	SE8002 Max.		Test Conditions	
h_{FE}	DC Pulse Current Gain	(Note 4)	20		40	120		I_C = 150 mA	V_{CE} = 1.0 V
h_{FE}	DC Pulse Current Gain	(Note 4)			25			I_C = 500 mA	V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (f = 20 MHz)		2.0		2.0			I_C = 50 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector Saturation Voltage	(Note 5)		1.5		1.2	Volts	I_C = 1.0 A	I_B = 0.1 A
V_{BE}(sat)	Base Saturation Voltage	(Note 5)		2.0		2.0	Volts	I_C = 1.0 A	I_B = 0.1 A
I_{CBO}	Collector Cutoff Current			100			nA	I_E = 0	V_{CB} = 40 V
I_{CBO}	Collector Cutoff Current					10	nA	I_E = 0	V_{CB} = 60 V
I_{CBO}(150°C)	Collector Cutoff Current			50			μA	I_E = 0	V_{CB} = 40 V
I_{CBO}(150°C)	Collector Cutoff Current					10	μA	I_E = 0	V_{CB} = 60 V
I_{EBO}	Emitter Cutoff Current					100	nA	I_C = 0	V_{EB} = 4.0 V
C_{obo}	Output Capacitance			25		25	pF	I_E = 0	V_{CB} = 10 V
BV_{CBO}	Collector to Base Breakdown Voltage		60		80		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 3 and 4)		30		40		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage		5.0		5.0		Volts	I_E = 100 μA	I_C = 0

* 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 ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 35°C/watt (derating factor of 28.6 mW/°C. Junction-to-ambient thermal resistance of 200°C/watt (derating factor of 5.0 mW/°C).

(3) Rating refers to a high-current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

(4) Pulse Conditions: length = 300 μsec; duty cycle = 1.0%.

(5) Saturation voltages measured with 1/4" lead length.

FAIRCHILD SEMICONDUCTOR

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SE8010 • SE8012

NPN RF AMPLIFIER

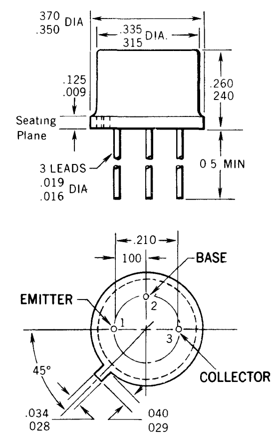
DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **HIGH POWER DISSIPATION . . . $P_D = 800$ mW AT $T_A = 25°C$**
  $P_D = 4.0$ W AT $T_C = 25°C$
- **HIGH POWER GAIN . . . . 600 mW P_O AT 27 MHz**
- **HIGH VOLTAGE . . . . $LV_{CEO} = 60$ V**

ABSOLUTE MAXIMUM RATINGS (Note 1)

	SE8010	SE8012
Maximum Temperatures	**SE8010**	**SE8012**
Storage Temperature	−65°C to +200°C	−65°C to +125°C
Operating Junction Temperature	200°C Maximum	125°C Maximum
Maximum Power Dissipation (Notes 2 and 3)	**SE8010**	**SE8012**
Total Dissipation at 25°C Case Temperature	**4.0 W**	**4.0 W**
at 25°C Free Air Temperature	**800 mW**	**500 mW**
Maximum Voltages and Current	**SE8010**	**SE8012**
V_{CBO} Collector to Base Voltage	100 Volts	100 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	**60 Volts**	**60 Volts**
V_{EBO} Emitter to Base Voltage	6.0 Volts	6.0 Volts
I_C Collector Current	500 mA	500 mA

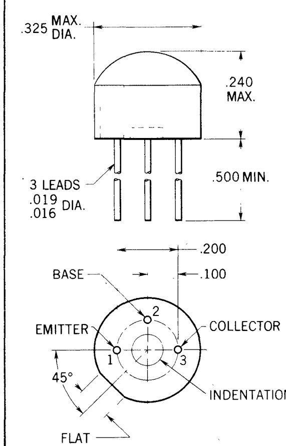
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Collector internally connected to case
Package weight is 1.23 gram

SE8010

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-105) outline



NOTES All dimensions in inches
Leads are gold-plated nickel
Package is electrically Non-conductive material
Package weight is 0.66 gram

SE8012

*Planar is a patented Fairchild process.

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

SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
G_{PE}	**Amplifier Power Gain (f = 27 MHz)** (Note 6)	**10.8**	**12**		**dB**	**$V_{CE} = 12$ V**	**$P_{in} = 50$ mW**
h_{FE}	DC Pulse Current Gain (Note 5)	40		150		$I_C = 100$ mA	$V_{CE} = 1.0$ V
h_{FE}	DC Pulse Current Gain (Note 5)	15				$I_C = 500$ mA	$V_{CE} = 3.0$ V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	3.0				$I_C = 50$ mA	$V_{CE} = 10$ V
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 5)			0.75	Volts	$I_C = 500$ mA	$I_B = 50$ mA
$V_{BE(sat)}$	Pulsed Emitter Saturation Voltage (Note 5)			1.20	Volts	$I_C = 500$ mA	$I_B = 50$ mA
I_{CES}	Collector Reverse Current			500	nA	$V_{CE} = 50$ V	$V_{EB} = 0$
C_{cb}	Collector-Base Capacitance			9.0	pF	$V_{CB} = 10$ V	$I_E = 0$
C_{eb}	Emitter-Base Capacitance			65	pF	$V_{EB} = 0.5$ V	$I_C = 0$
BV_{CBO}	Collector to Base Breakdown Voltage	100			Volts	$I_C = 100\ \mu A$	$I_E = 0$
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Note 5)	**60**			**Volts**	**$I_C = 10$ mA**	**$I_B = 0$**
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0			Volts	$I_E = 100\mu A$	$I_C = 0$

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, a junction to case thermal resistance of 43.8°C/Watt (derating factor of 22.8 mW/°C) and a junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the SE8010. These ratings give a maximum junction temperature of 125°C, a junction to case thermal resistance of 25°C/Watt (derating factor of 40 mW/°C) and a junction to ambient thermal resistance of 200°C/Watt (derating factor of 5.0 mW/°C) for the SE8012.
(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 Test Circuit.

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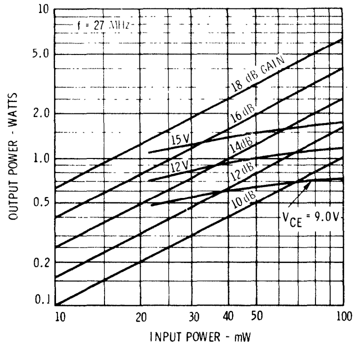
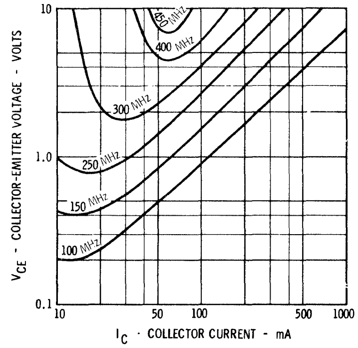
TYPICAL ELECTRICAL CHARACTERISTICS

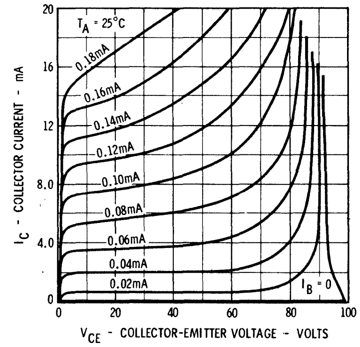
TYPICAL DRIVER AMPLIFIER PERFORMANCE



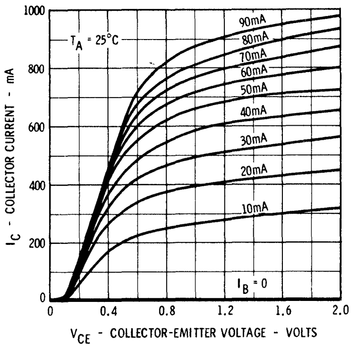
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



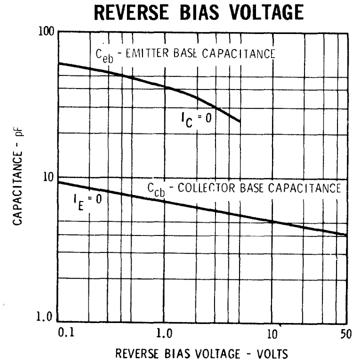
COLLECTOR CHARACTERISTICS*



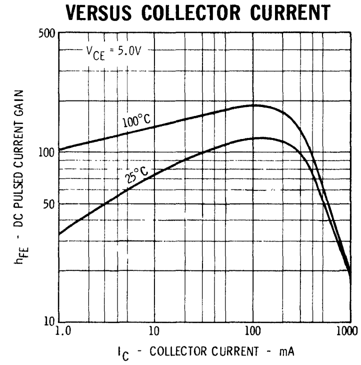
COLLECTOR CHARACTERISTICS*



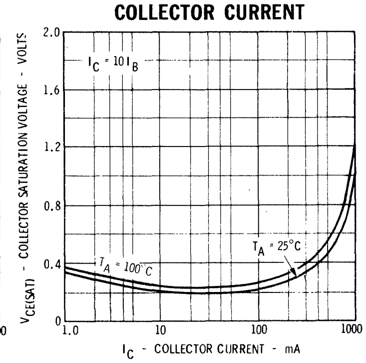
COLLECTOR AND EMITTER CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



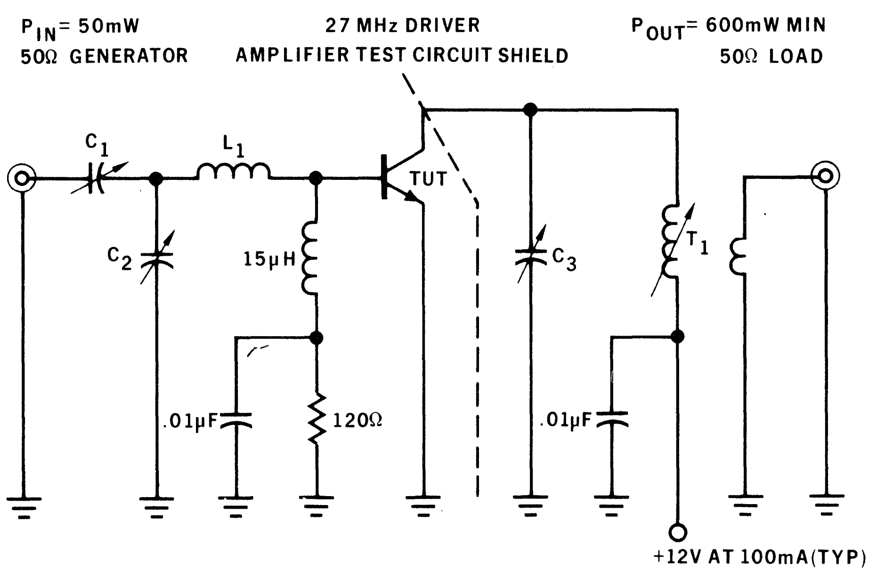
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



*Single family characteristic on Transistor Curve Tracer.



C_1, C_2 — 7 to 100pF, compression mica trimmer (Arco 423)
C_3 — 43 to 63pF, compression mica trimmer (Arco 402) in parallel with 43pF. Dipped mica.
L_1 — 0.35μH (7 T Air Dux 408)
T_1 — 9 turns primary, 5 turns secondary
No. 18 enamel close wound on 1/4 inch slug tuned form
(CTC 1535-2-2, red slug).

SE8040 • SE8041 • SE8042 • SE8540 • SE8541 • SE8542

NPN-PNP GENERAL PURPOSE COMPLEMENTARY AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

- **MATCHED h_{FE} GROUPINGS AVAILABLE (See Note 7)**
- **HIGH GAIN . . . . h_{FE} = 40-540 AT 150 mA, 1.0 V**
  h_{FE} = 30 (MIN) AT 500 mA, 1.0 V
- **NPN AND PNP COMPLEMENTS (Note 7) . . . SE8040, SE8041 AND SE8042 ARE NPN**
  SE8540, SE8541 AND SE8542 ARE PNP
- **LOW SATURATION VOLTAGE . . . . $V_{CE(sat)}$ = 0.12 V (MAX) AT 150 mA, 0.3 V (MAX) AT 500 mA FOR SE8040, SE8041 AND SE8042**
  $V_{CE(sat)}$ = —0.25 V (MAX) AT 150 mA, —0.7 V (MAX) AT 500 mA FOR SE8540, SE8541 AND SE8542

ABSOLUTE MAXIMUM RATINGS (Note 1)	**SE8040**	**SE8041**	**SE8042**
Maximum Temperatures	**SE8540**	**SE8541**	**SE8542**
Storage Temperature	−55°C to +125°C	−65°C to +200°C	−65°C to +200°C
Operating Junction Temperature	+125°C	+200°C	+200°C
Lead Temperature (Soldering, 10 second time limit)	+260°C	+300°C	+300°C
Maximum Power Dissipation (Notes 2, 3 and 4)			
Total Dissipation at or below 100°C Case Temperature			4.0 Watts
Total Dissipation at 25°C Case Temperature	4.0 Watts	4.0 Watts	
at 25°C Free Air Temperature	0.5 Watt	0.8 Watt	1.0 Watt

Maximum Voltages and Current		**SE8040 SE8041 SE8042**	**SE8540 SE8541 SE8542**
V_{CBO}	Collector to Base Voltage	30 Volts	−30 Volts
V_{CEO}	Collector to Emitter Voltage (Note 5)	30 Volts	−30 Volts
V_{EBO}	Emitter to Base Voltage	6.0 Volts	−5.0 Volts
I_C	Continuous Collector Current (T_C = +75°C)	1.0 Amp	1.0 Amp
I_C	Continuous Collector Current (T_C = +100°C)	0.75 Amp	0.75 Amp

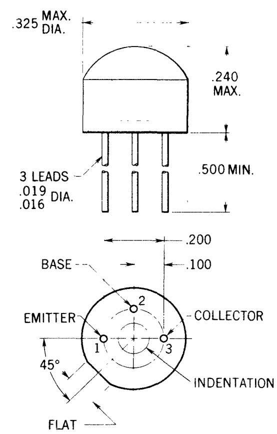
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS (Reverse Voltage Polarity For PNP)	
h_{FE}	**DC Pulse Current Gain** (Note 6)		**40**	**70**	**540**		**I_C = 150 mA**	**V_{CE} = 1.0 V**
h_{FE}	**DC Pulse Current Gain** (Note 6)		**30**	**65**			**I_C = 500 mA**	**V_{CE} = 1.0 V**
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 5 & 6)	SE8040 SE8041, SE8042	30			Volts	I_C = 30 mA	I_B = 0
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 5 & 6)	SE8540 SE8541, SE8542	−30			Volts	I_C = 30 mA	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	SE8040 SE8041, SE8042	30			Volts	I_C = 10 μA	I_E = 0
BV_{CBO}	Collector to Base Breakdown Voltage	SE8540 SE8541, SE8542	−30			Volts	I_C = 100 μA	I_E = 0
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 6)	SE8040 SE8041, SE8042		0.35	1.0	Volts	I_C = 1.0 A	I_B = 33 mA
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 6)	SE8540 SE8541, SE8542		−0.5	−1.3	Volts	I_C = 1.0 A	I_B = 33 mA
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)	**SE8040 SE8041, SE8042**		**0.2**	**0.3**	**Volts**	**I_C = 500 mA**	**I_B = 25 mA**
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)	**SE8540 SE8541, SE8542**		**−0.3**	**−0.7**	**Volts**	**I_C = 500 mA**	**I_B = 25 mA**
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)	**SE8040 SE8041, SE8042**		**0.08**	**0.12**	**Volts**	**I_C = 150 mA**	**I_B = 15 mA**
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)	**SE8540 SE8541, SE8542**		**−0.15**	**−0.25**	**Volts**	**I_C = 150 mA**	**I_B = 15 mA**

Additional Electrical Characteristics on Page 2

Notes on Page 6

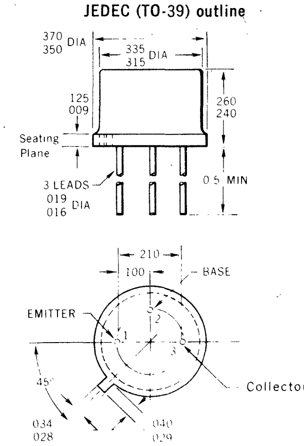
PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-105) outline



NOTES All dimensions in inches
Leads are gold plated nickel
Package is electrically Non-conductive material
Package weight is 0.66 gram

SE8040 • SE8540

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-39) outline



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.23 grams

SE8041 • SE8541
SE8042 • SE8542

*Planar is a patented Fairchild process.

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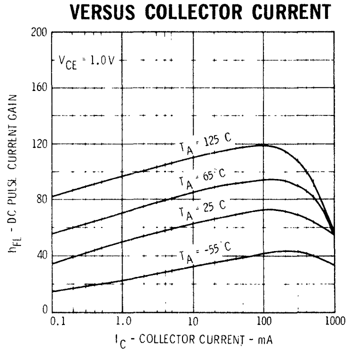
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	SE8040 • SE8041 • SE8042 MIN.	TYP.	MAX.	SE8540 • SE8541 • SE8542 MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS (Reverse Voltage Polarity For SE8540 • SE8541 • SE8542)	
h_{FE}	DC Pulse Current Gain (Note 6)	30	60		30	68			$I_C = 10$ mA	$V_{CE} = 1.0$ V
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)		0.95	1.2		−0.96	−1.2	Volts	$I_C = 1.0$ A	$I_B = 33$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)		0.93	1.0		−0.92	−1.15	Volts	$I_C = 500$ mA	$I_B = 25$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)		0.82	0.85		−0.79	−1.1	Volts	$I_C = 150$ mA	$I_B = 15$ mA
$V_{BE(on)}$	Pulsed Base Emitter (On) Voltage (Note 6)	0.63	0.68	0.73	−0.65	−0.68	−0.75	Volts	$I_C = 20$ mA	$V_{CE} = 5.0$ V
I_{CBO}	Collector Cutoff Current		0.9	50		0.1	50	nA	$I_E = 0$	$V_{CB} = 25$ V
I_{CBO}(65°C)	Collector Cutoff Current	(SE8040)	.008	5.0	(SE8540)	.002	1.0	μA	$I_E = 0$	$V_{CB} = 25$ V
I_{CBO}(125°C)	Collector Cutoff Current	(SE8041, SE8042)	0.1	20	(SE8541, SE8542)	0.1	20	μA	$I_E = 0$	$V_{CB} = 25$ V
BV_{EBO}	Base to Emitter Breakdown Voltage	6.0			−5.0			Volts	$I_E = 10$ μA	$I_C = 0$
I_{EBO}	Base to Emitter Cutoff Current		2.0	50		2.0	50	nA	$I_C = 0$	$V_{EB} = 4.0$ V
h_{fe}	High Frequency Current Gain (f = 100 MHz)	1.3	2.3	5.0	1.0	2.0	5.0		$I_C = 50$ mA	$V_{CE} = 10$ V
C_{cb}	Collector to Base Capacitance (f = 1.0 MHz)		9.0	12		20	35	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{eb}	Emitter to Base Capacitance (f = 1.0 MHz)		60	65		80	120	pF	$I_C = 0$	$V_{EB} = 0.5$ V

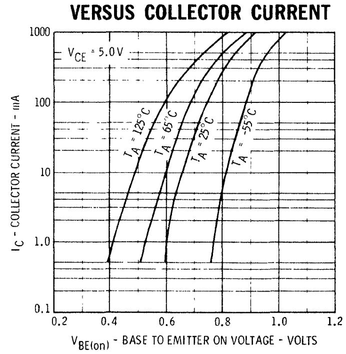
TYPICAL ELECTRICAL CHARACTERISTICS

SE8040 • SE8041 • SE8042

DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

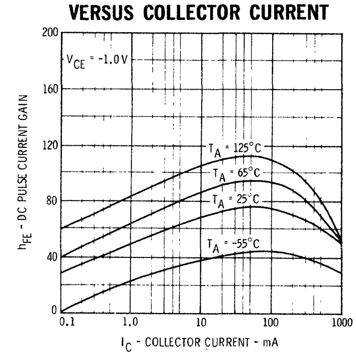


BASE TO EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT

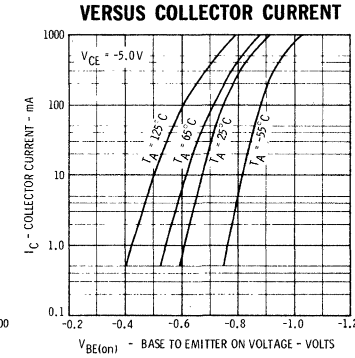


SE8540 • SE8541 • SE8542

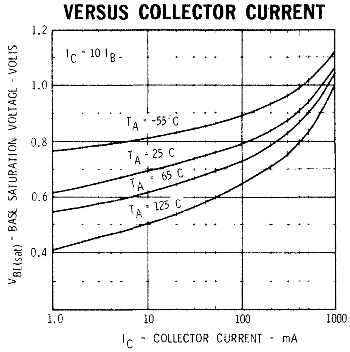
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



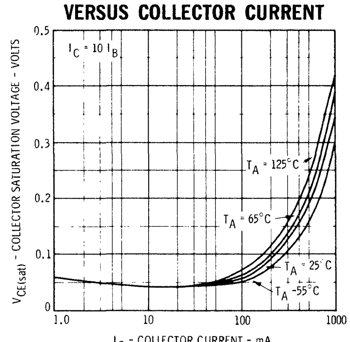
BASE TO EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



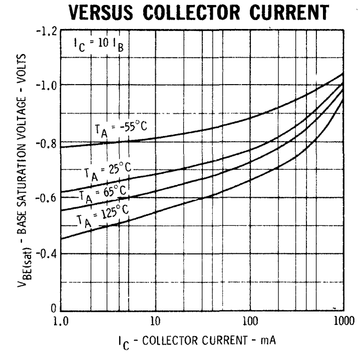
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



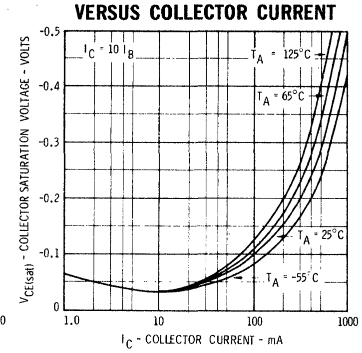
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



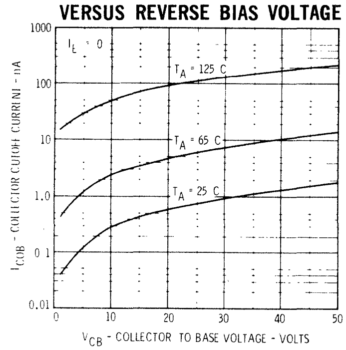
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



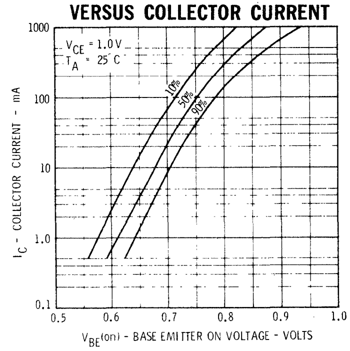
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



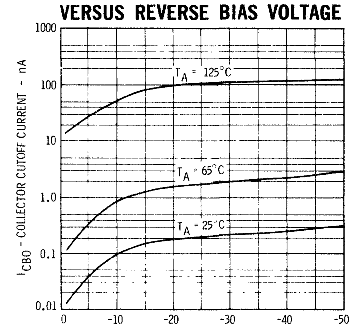
COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE



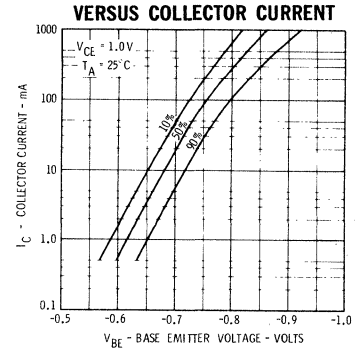
DISTRIBUTION OF BASE EMITTER VOLTAGE VERSUS COLLECTOR CURRENT



COLLECTOR CUTOFF CURRENT VERSUS REVERSE BIAS VOLTAGE

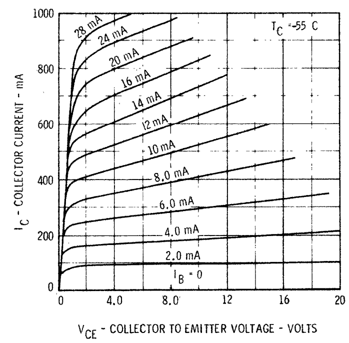


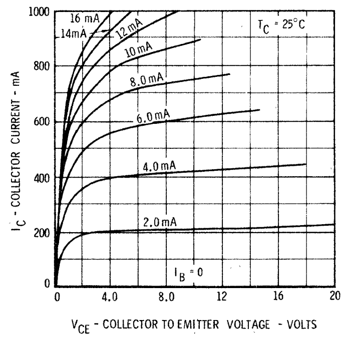
DISTRIBUTION OF BASE EMITTER VOLTAGE VERSUS COLLECTOR CURRENT

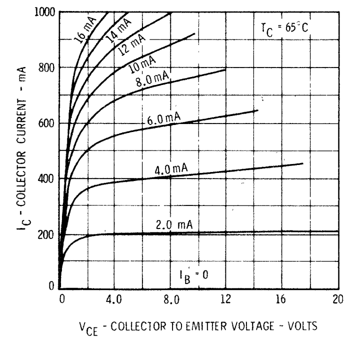


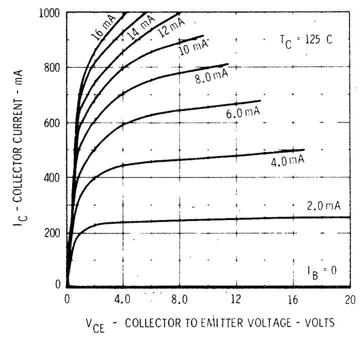
SE8040 • SE8041 • SE8042

TYPICAL LARGE SIGNAL COLLECTOR CHARACTERISTICS

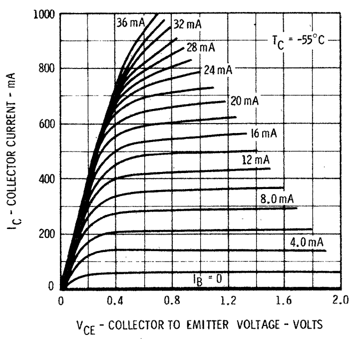


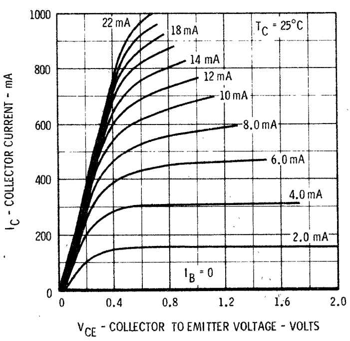


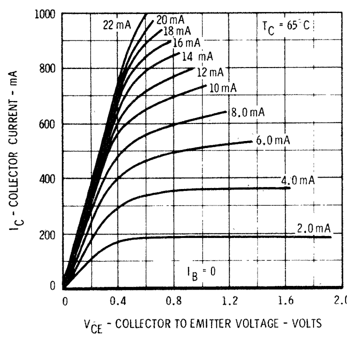


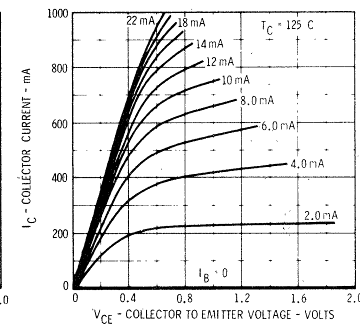


TYPICAL COLLECTOR SATURATION CHARACTERISTICS

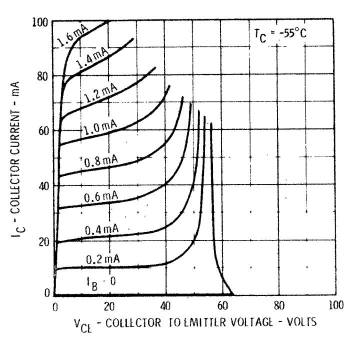


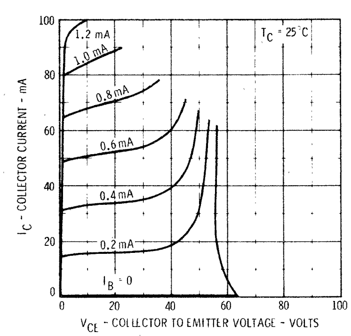


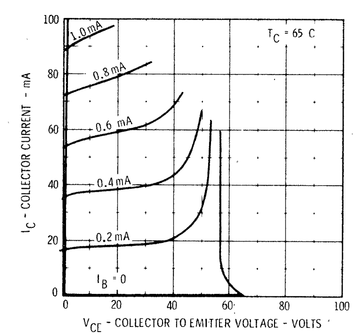


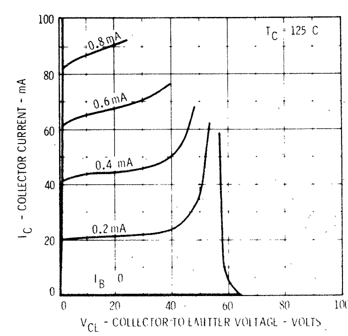


TYPICAL SMALL SIGNAL COLLECTOR CHARACTERISTICS

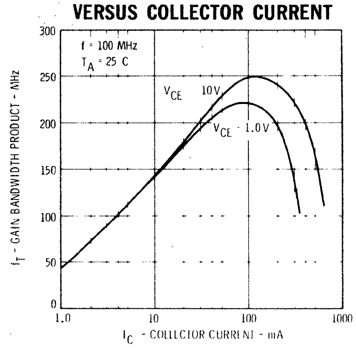




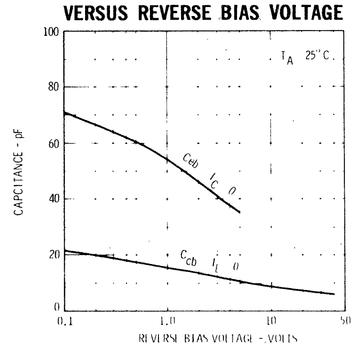




GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT

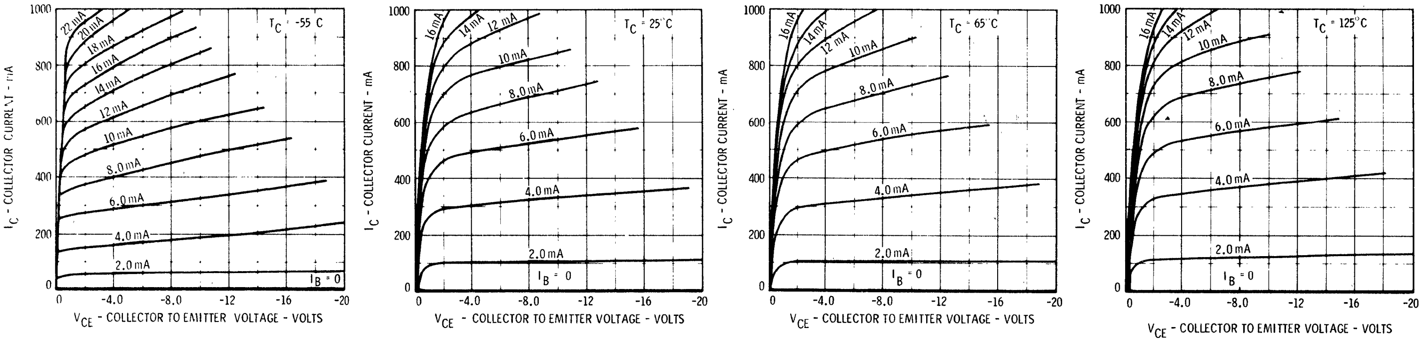


COLLECTOR TO BASE AND EMITTER TO BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

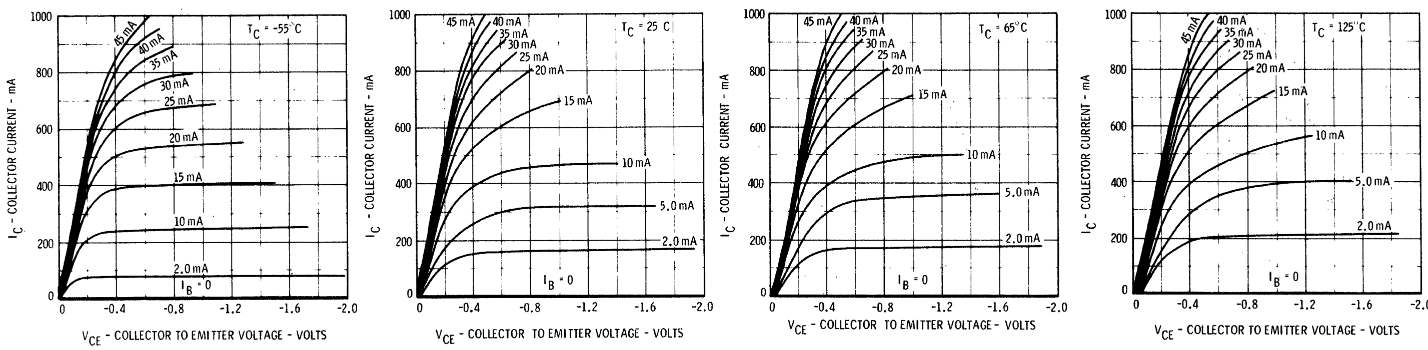


SE8540 • SE8541 • SE8542

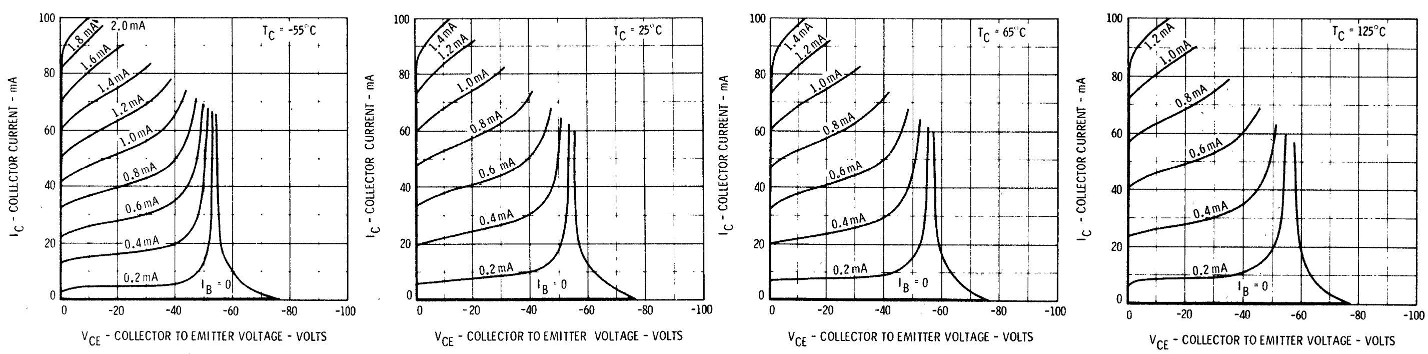
TYPICAL LARGE SIGNAL COLLECTOR CHARACTERISTICS



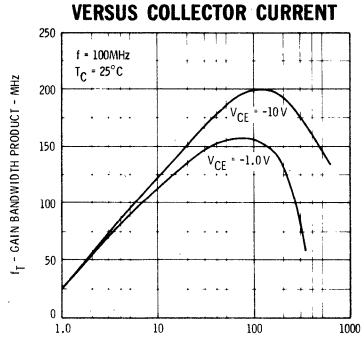
TYPICAL COLLECTOR SATURATION CHARACTERISTICS



TYPICAL SMALL SIGNAL COLLECTOR CHARACTERISTICS



GAIN BANDWIDTH PRODUCT VERSUS COLLECTOR CURRENT



COLLECTOR-BASE AND EMITTER BASE CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

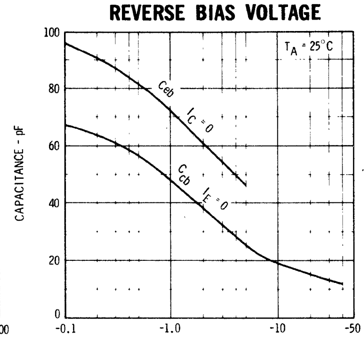


Figure 1—SCHEMATIC DIAGRAM

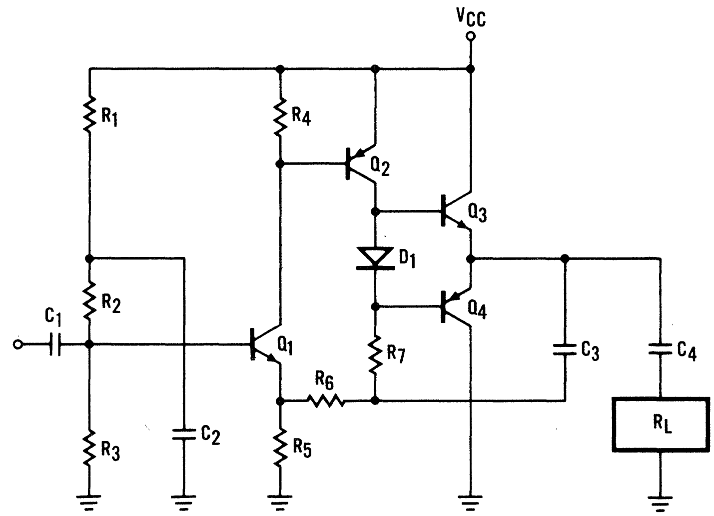


Table 1—SCHEMATIC VALUES

Circuit Voltage Load Resistance	12 V 4 ohm	18 V 8 ohm	28 V 16 ohm
Q_1	SE4021	SE4021	SE4021
Q_2	2N4249	2N3638	2N3638
Q_3	SE8040	SE8040	SE8042
Q_4	SE8540	SE8540	SE8542
D_1	FDH694	FDH694	FDH694
R_1	2.2 MΩ	4.7 MΩ	5.6 MΩ
R_2	2.7 MΩ	4.7 MΩ	10 MΩ
R_3	1.2 MΩ	1.2 MΩ	1 MΩ
R_4	22 kΩ	22 kΩ	22 kΩ
R_5	100 Ω	47 kΩ	56 Ω
R_6	180 Ω	180 Ω	470 Ω
R_7	120 Ω	120 Ω	150 Ω
C_1	0.01 μF	0.01 μF	0.01 μF
C_2	0.01 μF	0.01 μF	0.01 μF
C_3	50 μF, 6 V	25 μF, 6 V	25 μF, 6 V
C_4	500 μF, 10 V	500 μF, 15 V	250 μF, 20 V

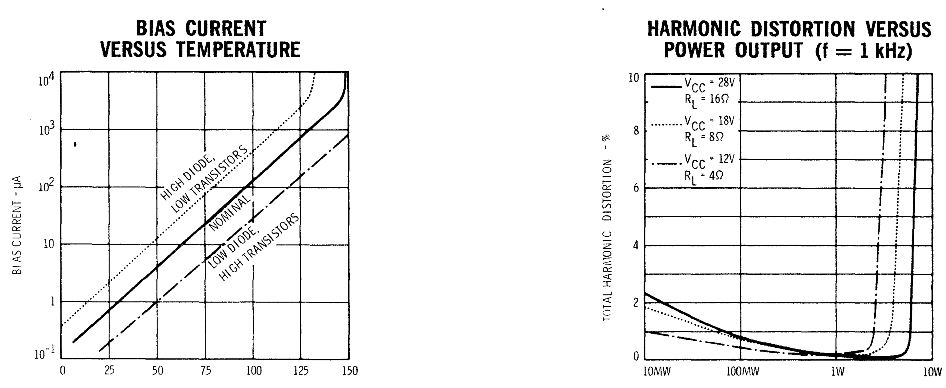
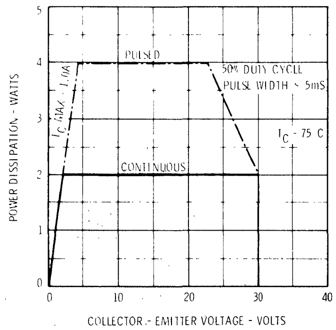


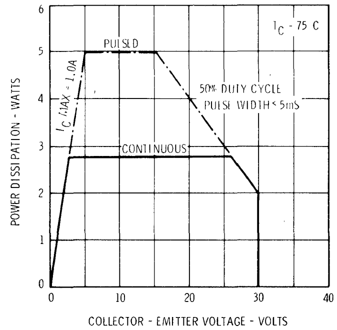
FIGURE 2

For additional information, send for Fairchild Application Brief 58

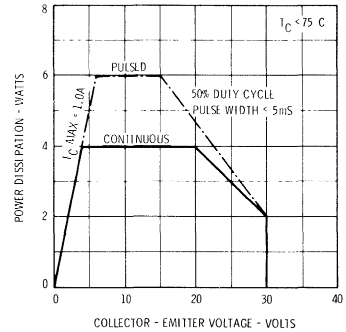
MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8040, SE8540 ONLY



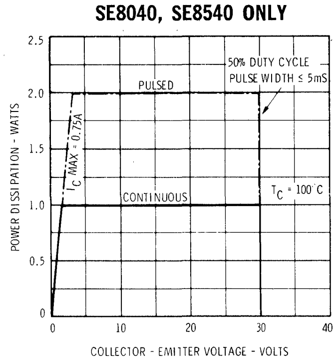
MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8041, SE8541 ONLY



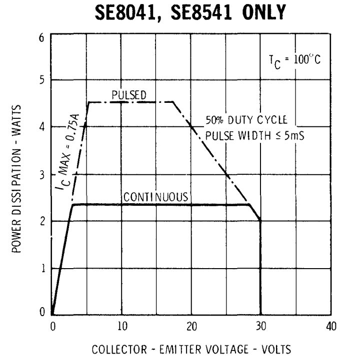
MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8042, SE8542 ONLY



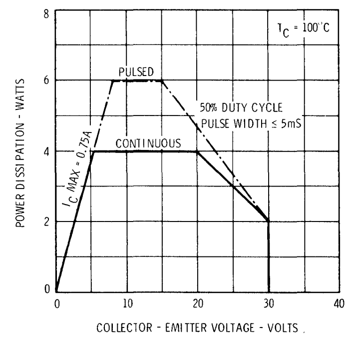
MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8040, SE8540 ONLY



MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8041, SE8541 ONLY



MAXIMUM FORWARD BIASED POWER DISSIPATION VERSUS COLLECTOR-EMITTER VOLTAGE SE8042, SE8542 ONLY



* Reverse Voltage Polarity for SE8540, SE8541 and SE8542

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 if curves shown above will be exceeded.
(3) These ratings give a maximum junction temperature of 125°C and junction to case thermal resistance of 25°C/Watt (derating factor of 40 mW/°C); junction to ambient thermal resistance of 200°C/Watt (derating factor of 5.0 mW/°C) for the SE8040 and SE8540.
(4) These ratings give a maximum junction temperature of 200°C and junction to case thermal resistance of 43.7°C/Watt (derating factor of 22.8 mW/°C); junction to ambient thermal resistance of 219°C/Watt (derating factor of 4.56 mW/°C) for the SE8041 and SE8541; junction to ambient thermal resistance of 175°C/Watt (derating factor of 5.71 mW/°C) for the SE8042 and SE8542.
(5) This rating refers to a high current point where collector to emitter voltage is lowest.
(6) Pulse Conditions: length = 300 μs; duty cycle = 1%.
(7) If h_{FE} matching is required, order SE804——M and SE854——M. Equal numbers of NPN's and PNP's from the following classifications will be shipped and will be marked to indicate matching group(s). There is no guarantee of the quantities of individual groupings. At the manufacturer's option, units marked with h_{FE} group suffixes (M1, etc.) may be shipped as SE8040 etc.

GROUP	M1	M2	M3	M4	M5	M6	M7
h_{FE} RANGE	40-52	48-64	58-77	70-93	83-110	100-130	118-150
I_C = 150 mA	M8	M9	M10	M11	M12	M13	M14
V_{CE} = 1.0 V	135-183	163-220	197-263	235-315	285-380	340-450	410-540

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

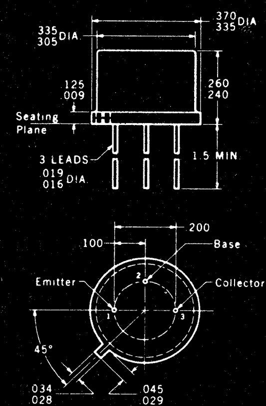
S18000

PNP HIGH - VOLTAGE, HIGH CURRENT SWITCH

SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The S 18000 is a PNP High-Voltage, High-Current Transistor designed for complementary use with the S 17900 NPN Transistor in memory applications requiring breakdown voltage up to 50 volts and operating current to 600 milliamperes.

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



NOTES: All dimensions in inches
Leads are gold plated kovar
Collector internally connected to case
Package weight is 1.11 grams

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature	-65°C to +200°C
Operating Junction 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)	3.0 Watts
at 25°C Free Air Temperature	(Notes 2 and 3)	0.7 Watt

Maximum Voltages

V_{CBO}	Collector to Base Voltage		-60 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-50 Volts
V_{EBO}	Emitter to Base Voltage		-5.0 Volts
I_C	Collector Current	(Note 2)	600 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	110	200		I_C = 100 mA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	15	30			I_C = 300 mA V_{CE} = -1.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	30	70			I_C = 500 mA V_{CE} = -10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	20	85			I_C = 100 mA V_{CE} = -1.0 V
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		-0.13	-0.3	Volts	I_C = 100 mA I_B = 10 mA
V_{CE}(sat)	Collector-Saturation Voltage (Note 5)		-0.5	-1.6	Volts	I_C = 500 mA I_B = 50 mA
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		-0.3	-0.8	Volts	I_C = 300 mA I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		-1.15	-2.0	Volts	I_C = 300 mA I_B = 30 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)		-0.95	-1.0	Volts	I_C = 100 mA I_B = 10 mA
V_{BE}(sat)	Base-Emitter Saturation Voltage (Note 5)		-1.25	-2.0	Volts	I_C = 500 mA I_B = 50 mA

Additional Electrical Characteristics on page 2

NOTES:

(1) These ratings are limiting values above which the serviceability of any individual semiconductor 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 58.3°C/Watt (derating factor of 17.2 mW/°C) junction-to-ambient 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. For more information send for Fairchild Publication APP-4/2.

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

(6) See switching circuit for exact values 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

FAIRCHILD TRANSISTOR S18000

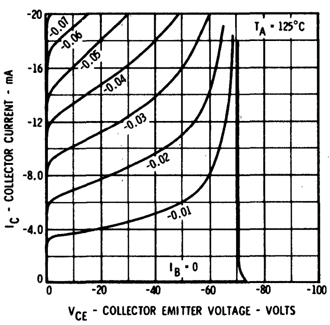
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

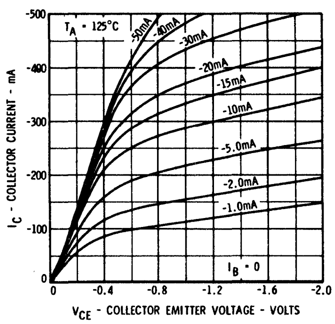
Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
h_{fe}	High Frequency Current Gain (f = 100 Mc)	2.0	2.50			I_C = 50 mA V_{CE} = -20 V
C_{obo}	Output Capacitance		4.5	8.0	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	Input Capacitance		15	25	pf	I_C = 0 V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		0.07	10	nA	V_{CB} = -40 V I_E = 0
I_{CBO}(100°C)	Collector Cutoff Current			10	µA	V_{CB} = -40 V I_E = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-60			Volts	I_C = 10 µA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-5.0			Volts	I_E = 10 µA I_C = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	-50			Volts	I_C = 10 mA (pulsed) I_B = 0
t_{on}	Turn On Time		40	70	nsec	I_C = 300 mA I_{B1} = 30 mA
t_{off}	Turn Off Time		120	150	nsec	I_C = 300 mA, I_{B1} = 30 mA, I_{B2} = -30 mA
t_{on}	Turn On Time (Note 6)		60	100	nsec	I_C ≈ 500 mA I_{B1} ≈ 50 mA
t_{off}	Turn Off Time (Note 6)		70	100	nsec	I_C ≈ 500 mA, I_{B1} ≈ 50 mA, I_{B2} ≈ -50 mA

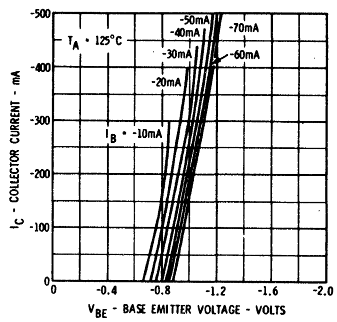
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*

ACTIVE REGION

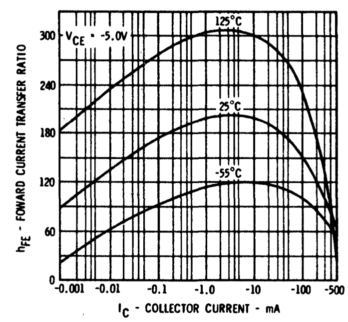
SATURATION REGION

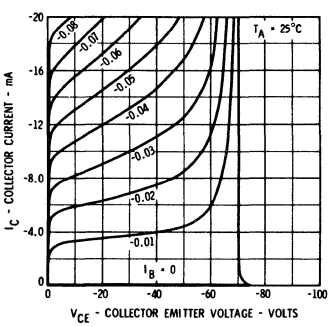


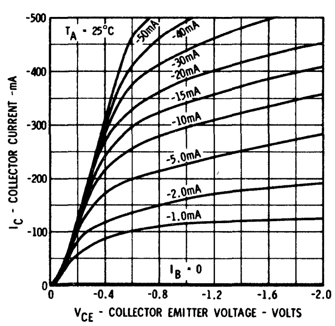


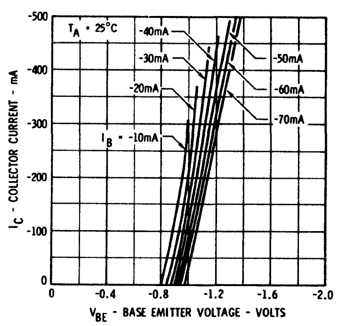


DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT

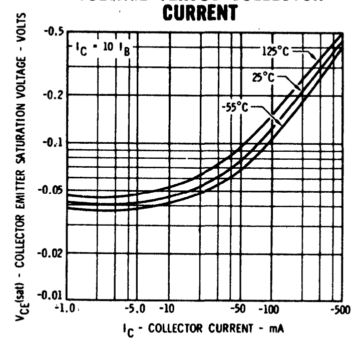


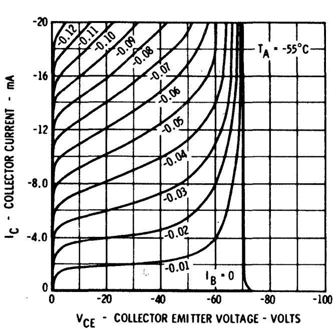


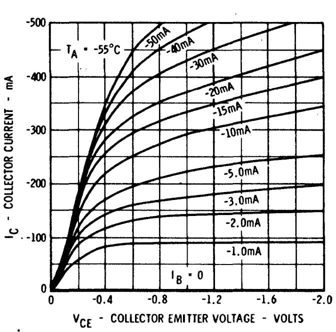


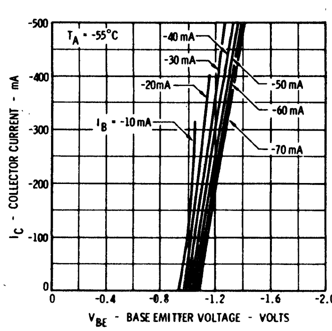


PULSED COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT

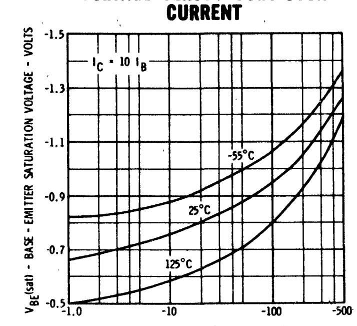








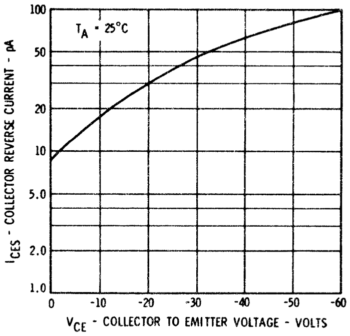
PULSED BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



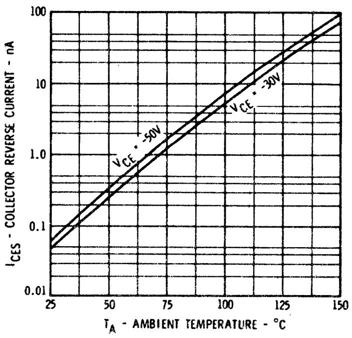
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

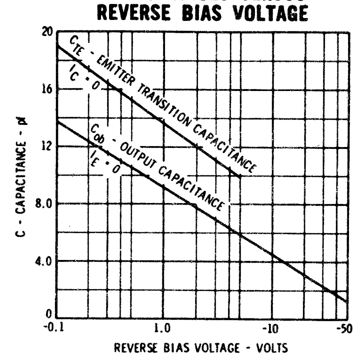
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



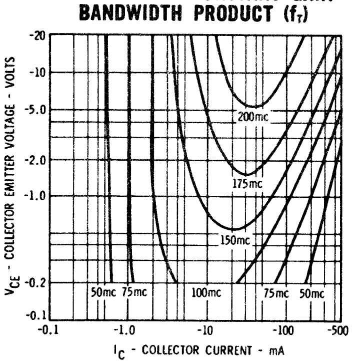
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



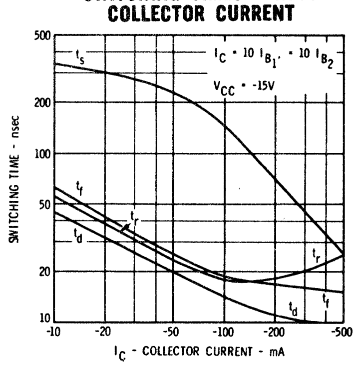
INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



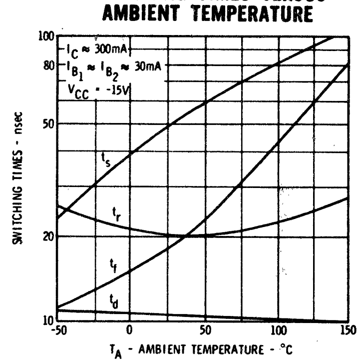
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



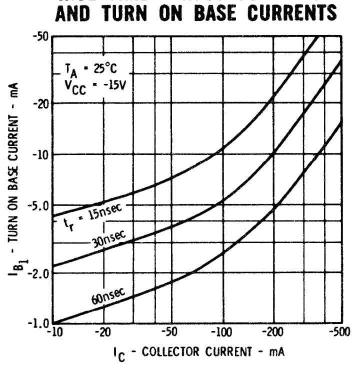
SWITCHING TIMES VERSUS COLLECTOR CURRENT



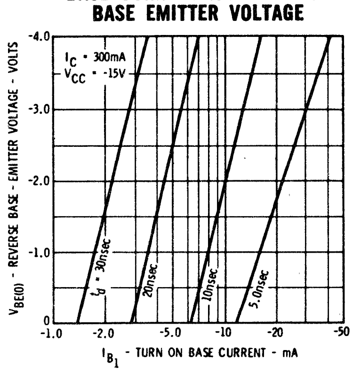
SWITCHING TIMES VERSUS AMBIENT TEMPERATURE



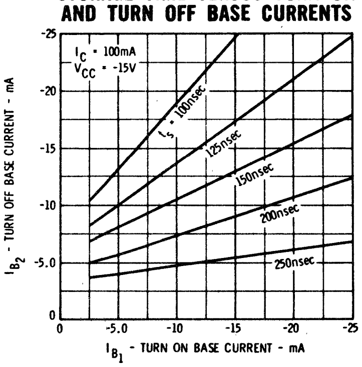
RISE TIME VERSUS COLLECTOR AND TURN ON BASE CURRENTS



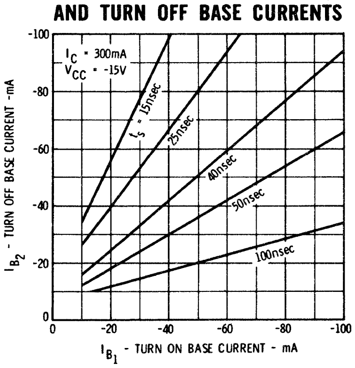
DELAY TIME VERSUS TURN ON BASE CURRENT AND REVERSE BASE EMITTER VOLTAGE



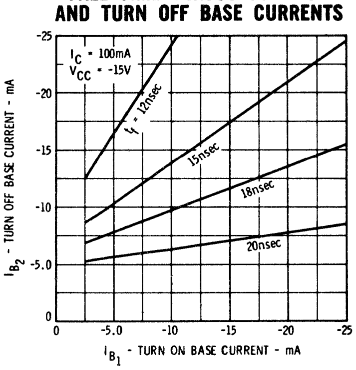
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



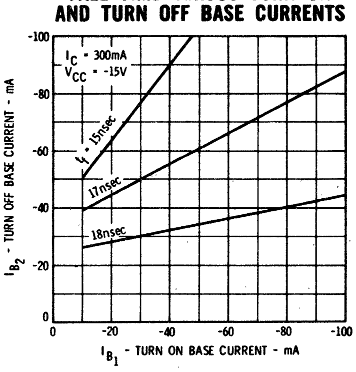
STORAGE TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



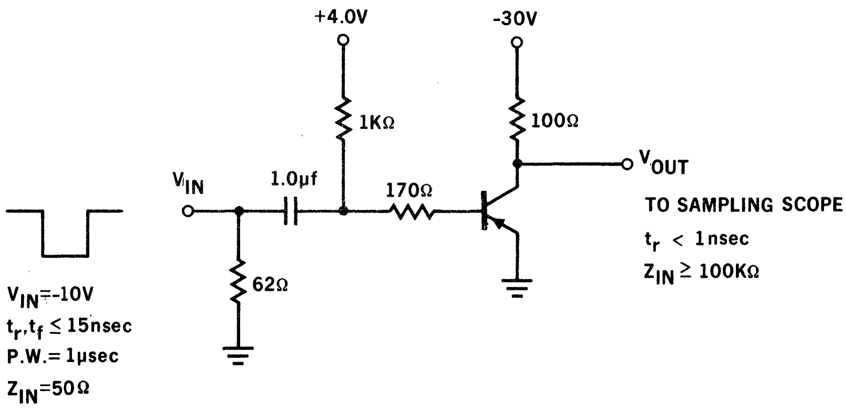
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



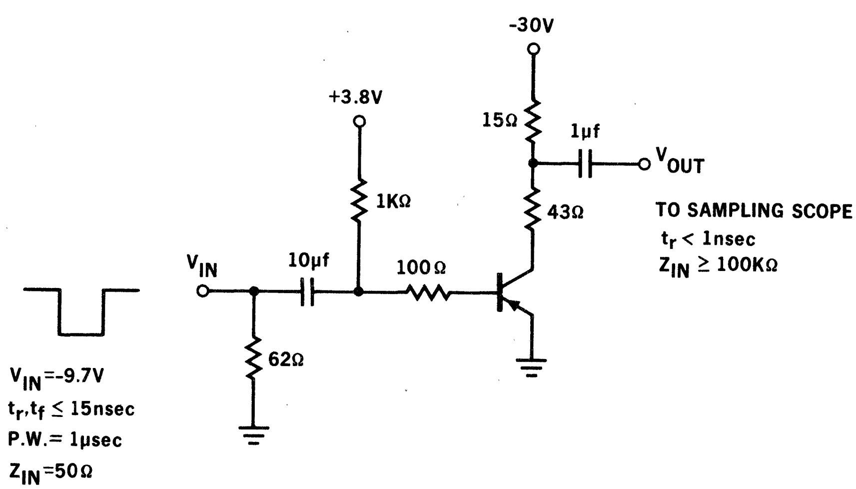
FALL TIME VERSUS TURN ON AND TURN OFF BASE CURRENTS



T_{ON} and T_{OFF} TEST CIRCUIT



$I_C = 300mA$, $I_{B1} = 30mA$, $I_{B2} = -30mA$



$I_C \approx 500mA$, $I_{B1} \approx 50mA$, $I_{B2} \approx -50mA$

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