Special Transistor Products

Differential Amplifiers
Darlington Amplifiers
Dual Transistors
Epoxy Dual Transistors
Photo Devices

SPECIAL PRODUCTS NUMERICAL INDEX

Additional Special Transistor Products

DIFFERENTIAL AMPLIFIERS SELECTION GUIDE

NPN Type	Case Type	Equivalent Triode	LV_{CEO} Volts min.	V_{BE} Match mV max.	H_{FE} Match Percent	H_{FE} @ Match min.	max.	$\Delta V_{BE1} - \Delta V_{BE2}$ ‡‡μV/°C max.	***Data Sheet Filed Under
2N2060	TO - 77*	2N1893	60	5.0	10	30	90	10	2N2060
FE2060	TO - 89	2N1893	60	5.0	10	30	90	10	2N2060
2N2060A	TO - 77*	2N1893	60	3.0	10	30	90	10	2N2060
FB2060A	TO - 71	2N1893	60	3.0	10	30	90	10	2N2060
FE2060A	TO - 89	2N1893	60	3.0	10	30	90	10	2N2060
2N2060B	TO - 77*	2N1893	60	1.5	10	30	90	5	2N2060
FB2060B	TO - 71	2N1893	60	1.5	10	30	90	5	2N2060
FE2060B	TO - 89	2N1893	60	1.5	10	30	90	5	2N2060
2N2223	TO - 77*	2N1711	60	15.0	—	25	150	25	—
FE2223	TO - 89	2N1711	60	15.0	—	25	150	25	—
2N2223A	TO - 77*	2N1711	60	5.0	—	25	150	25	—
FE2223A	TO - 89	2N1711	60	5.0	—	25	150	25	—
2N2915	TO - 77*	2N2484	45	3.0	10	100	—	10	2N2915
FE2915	TO - 89	2N2484	45	3.0	10	100	—	10	2N2915
2N2915A	TO - 77*	2N2484	45	1.5	10	100	—	5	2N2915
FE2915A	TO - 89	2N2484	45	1.5	10	100	—	5	2N2915
2N2916	TO - 77*	2N3117	45	3.0	10	225	—	10	2N2916
FE2916	TO - 89	2N3117	45	3.0	10	225	—	10	2N2916
2N2916A	TO - 77*	2N3117	45	1.5	10	225	—	5	2N2916
FE2916A	TO - 89	2N3117	45	1.5	10	225	—	5	2N2916
2N2917	TO - 77*	2N2484	45	5.0	20	100	—	20	2N2917
FE2917	TO - 89	2N2484	45	5.0	20	100	—	20	2N2917
2N2918	TO - 77*	2N3117	45	5.0	20	225	—	20	2N2917
FE2918	TO - 89	2N3117	45	5.0	20	225	—	20	2N2917
2N2919	TO - 77*	2N2484	60	3.0	10	100	—	10	2N2915
FE2919	TO - 89	2N2484	60	3.0	10	100	—	10	2N2915
2N2919A	TO - 77*	2N2484	60	1.5	10	100	—	5	2N2915
FE2919A	TO - 89	2N2484	60	1.5	10	100	—	5	2N2915
2N2920	TO - 77*	2N3117	60	3.0	10	225	—	10	2N2916
FE2920	TO - 89	2N3117	60	3.0	10	225	—	10	2N2916
2N2920A	TO - 77*	2N3117	60	1.5	10	225	—	5	2N2916
FE2920A	TO - 89	2N3117	60	1.5	10	225	—	5	2N2916
2N2974	TO - 71	2N2484	45	3.0	10	100	—	10	2N2915
FT2974	TO - 71	2N2484	45	1.5	10	100	—	5	2N2915
2N2975	TO - 71	2N3117	45	3.0	10	225	—	10	2N2916
FT2975	TO - 71	2N3117	45	1.5	10	225	—	5	2N2916
2N2976	TO - 71	2N2484	45	5.0	20	100	—	20	2N2917
2N2977	TO - 71	2N3117	45	5.0	20	225	—	20	2N2917
2N2978	TO - 71	2N2484	60	3.0	10	100	—	10	2N2915
FT2978	TO - 71	2N2484	60	1.5	10	100	—	5	2N2915
2N2479	TO - 71	2N3117	60	3.0	10	225	—	10	2N2916
FT2979	TO - 71	2N3117	60	1.5	10	225	—	5	2N2916
2N2980	TO - 71	2N1893	60	5.0	10	30	90	10	2N2980
2N2981	TO - 71	2N1893	60	15.0	20	25	150	25	2N2980
2N2982	TO - 71	2N1893	60	5.0	10	25	150	15	2N2980
2N3423	TO - 77*	2N918	15	10.0	20	20	—	40	2N3423
FB3423	TO - 71	2N918	15	10.0	20	20	—	40	2N3423
FE3423	TO - 89	2N918	15	10.0	20	20	—	40	2N3423
2N3424	TO - 77*	2N918	15	5.0	10	20	—	20	2N3423
FB3424	TO - 71	2N918	15	5.0	10	20	—	20	2N3423
FE3424	TO - 89	2N918	15	5.0	10	20	—	20	2N3423
2N3728	TO - 78	2N2222	30	5.0	20	45	180	20	2N3728
FB3728	TO - 71	2N2222	30	5.0	20	15	180	20	2N3728
FE3728	TO - 89	2N2222	30	5.0	20	45	180	20	2N3728
2N3729	TO - 78	2N2222	30	3.0	10	45	180	10	2N3728
FB3729	TO - 71	2N2222	30	3.0	10	45	180	10	2N3728
FE3729	TO - 89	2N2222	30	3.0	10	45	180	10	2N3728
2N4956	TO - 78**	2N2484	25	5.0	20	100	—	20	2N4955
SP10801	TO - 89		45	5.0	20	100	—	20	SP10801

*Devices have been re-registered to permit use of either full-height dual TO - 5 (TO - 77) or low profile dual TO - 5 (TO - 78).
**Epoxy dual TO - 5 (6 leaded TO - 105)
***Electrical specifications can be found on 2N data sheets. For power ratings of TO - 71 and TO - 89 package, see page
‡‡$T_A = -55°C$ to $+125°C$

DIFFERENTIAL AMPLIFIERS SELECTION GUIDE

PNP Type	Case Type	Equivalent Triode	LV_{CEO} Volts min.	V_{BE} Match mV max.	H_{FE} Match Percent	h_{FE} @ Match min.	max.	$\Delta V_{BE}/\Delta T$ ‡‡$\mu V/°C$ max.	*Data Sheet Filed Under
FT1718A	TO - 78	2N3251	40	1.5	10	160	350	10	FT1718A
FE1718A	TO - 89	2N3251	40	1.5	10	160	350	10	FT1718A
FT1718B	TO - 78	2N3250	40	1.5	10	70	250	10	FT1718A
FE1718B	TO - 89	2N3250	40	1.5	10	70	250	10	FT1718A
FT1718C	TO - 78	2N3251	40	3.0	10	160	350	20	FT1718A
FE1718C	TO - 89	2N3251	40	3.0	10	160	350	20	FT1718A
FT1718D	TO - 78	2N3250	40	3.0	10	70	250	20	FT1718A
FE1718D	TO - 89	2N3250	40	3.0	10	160	350	20	FT1718A
2N3726	TO - 78	2N2907	45	5.0	10	120	—	20	2N3426
FB3726	TO - 71	2N2907	45	5.0	10	120	—	20	2N3426
FE3726	TO - 89	2N2907	45	5.0	10	120	—	20	2N3426
2N3727	TO - 78	2N2907	45	2.5	10	120	—	10	2N3426
FB3727	TO - 71	2N2907	45	2.5	10	120	—	10	2N3426
FE3727	TO - 89	2N2907	45	2.5	10	120	—	10	2N3426
2N4015	TO - 78	2N2907A	60	5.0	10	120	—	20	2N3426
FB4015	TO - 71	2N2907A	60	5.0	10	120	—	20	2N3426
FE4015	TO - 89	2N2907A	60	5.0	10	120	—	20	2N3426
2N4016	TO - 78	2N2907A	60	2.5	10	120	—	10	2N3426
FB4016	TO - 71	2N2907A	60	2.5	10	120	—	10	2N3426
FE4016	TO - 89	2N2907A	60	2.5	10	120	—	10	2N3426
2N4020	TO - 78	2N3964	45	5.0	20	250	600	20	2N4020
FT4020	TO - 71	2N3964	45	5.0	20	250	600	20	2N4020
FE4020	TO - 89	2N3964	45	5.0	20	250	600	20	2N4020
2N4021	TO - 78	2N3962	60	5.0	20	100	500	20	2N4020
FT4021	TO - 71	2N3962	60	5.0	20	100	500	20	2N4020
FE4021	TO - 89	2N3962	60	5.0	20	100	500	20	2N4020
2N4022	TO - 78	2N3965	60	5.0	20	250	600	20	2N4020
FT4022	TO - 71	2N3965	60	5.0	20	250	600	20	2N4020
FE4022	TO - 89	2N3965	60	5.0	20	250	600	20	2N4020
2N4023	TO - 78	2N3964	45	3.0	10	250	600	10	2N4020
FT4023	TO - 71	2N3964	45	3.0	10	250	600	10	2N4020
FE4023	TO - 89	2N3964	45	3.0	10	250	600	10	2N4020
2N4024	TO - 78	2N3962	60	3.0	10	100	500	10	2N4020
FT4024	TO - 71	2N3962	60	3.0	10	100	500	10	2N4020
FE4024	TO - 89	2N3962	60	3.0	10	100	500	10	2N4020
2N4025	TO - 78	2N3965	60	3.0	10	250	600	10	2N4020
FT4025	TO - 71	2N3965	60	3.0	10	250	600	10	2N4020
FE4025	TO - 89	2N3965	60	3.0	10	250	600	10	2N4020
2N5255	TO - 78**	2N4250	40	5.0	20	150	750	20	2N5254
2N5256	TO - 78**	2N4250	40	3.0	10	150	750	10	2N5254
SP10810	TO - 89		15	5.0	20	35	—	50	SP10810

*Electrical specifications can be found on 2N data sheets. For power ratings of TO - 71 and TO - 89 packages, see page
**Epoxy package (6 leaded TO - 105)
‡‡$T_A = -55°C$ to $+125°C$

DIFFERENTIAL AMPLIFIERS NUMERICAL INDEX

DARLINGTON AMPLIFIER TRANSISTORS SELECTION GUIDE

Device Type	Polarity	Case Type	BV_{CE} Volts (min)	h_{FE} $I_C = 100\mu A$ (min)	(max)	h_{FE} $I_C = 1.0mA$ (min)	(max)	h_{FE} $I_C = 10nA$ (min)	(max)	h_{FE} $I_C = 100mA$ (min)	(max)
2N997	NPN	TO - 72	40	1,000	—	—	—	4,000	—	7,000	70,000
2N998	NPN	TO - 72	60	—	—	800	—	1,600	8,000	2,000	—
2N999	NPN	TO - 72	60	1,000	—	—	—	4,000	—	7,000	70,000
2N2723	NPN	TO - 72	60	—	—	—	—	2,000	10,000	—	—
2N2724	NPN	TO - 72	60	—	—	—	—	7,000	50,000	—	—
2N2725	NPN	TO - 72	45	2,000	10,000	—	—	2,000	10,000	—	—
2N2785	NPN	TO - 72	40	—	—	600	—	1,200	—	2,000	20,000
2N4974	PNP	TO - 12*	30	20,000	—	25,000	50,000	30,000	60,000	25,000	50,000
2N4975	PNP	TO - 12*	30	10,000	—	15,000	30,000	15,000	30,000	15,000	30,000

DARLINGTON AMPLIFIER TRANSISTORS NUMERICAL INDEX

DUAL TRANSISTORS SELECTION GUIDE — AMPLIFIER APPLICATIONS

Device Type	Polarity	Case Type	Equivalent Triode	LV_{CEO} Volts (min)	h_{FE} @ I_C (min)	(max)	mA	f_t MHz (min)	N.F. f = 1kHz db (max)	*Data Sheet Filed Under
FT1718E	PNP	TO - 78	2N3250	20	70	350	0.1	400	6	FT1718A
FE1718E	PNP	TO - 89	2N3250	20	70	350	0.1	400	6	FT1718A
2N2913	NPN	TO - 78	2N2483	45	60	240	0.01	60	4	2N2913
FE2913	NPN	TO - 89	2N2483	45	60	240	0.01	60	4	2N2913
2N2914	NPN	TO - 78	2N2484	45	150	600	0.01	60	3	2N2913
FE2914	NPN	TO - 89	2N2484	45	150	600	0.01	60	3	2N2913
2N2972	NPN	TO - 71	2N2483	45	60	240	0.01	60	4	2N2913
2N2973	NPN	TO - 71	2N2484	45	150	600	0.01	60	3	2N2913
2N4017	PNP	TO - 78	2N3963	80	100	350	0.01	40	3	2N4017
FT4017	PNP	TO - 71	2N3963	80	100	350	0.01	40	3	2N4017
FE4017	PNP	TO - 89	2N3963	80	100	350	0.01	40	3	2N4017
2N4018	PNP	TO - 78	2N3962	60	100	500	0.01	40	3	2N4017
FT4018	PNP	TO - 71	2N3962	60	100	500	0.01	40	3	2N4017
FE4018	PNP	TO - 89	2N3962	60	100	500	0.01	40	3	2N4017
2N4019	PNP	TO - 78	2N3964	45	250	500	0.01	50	2	2N4017
FT4019	PNP	TO - 71	2N3964	45	250	500	0.01	50	2	2N4017
FE4019	PNP	TO - 89	2N3964	45	250	500	0.01	50	2	2N4017
SP10800	NPN	TO - 89	2N2484	45	60	600	0.01	65	4	SP10800
SP10811	PNP	TO - 89	—	15	35	—	10.0	100	—	SP10811

*Electrical specifications can be found on 2N data sheets for power ratings of TO-71 and TO-89 packages

DUAL TRANSISTORS SELECTION GUIDE — SWITCHING APPLICATIONS

Device Type	Polarity	*Case Type	Single Device 2N No.	LV_{CEO} Volts (min)	Current Range mA (min)	(max)	f_t MHz (min)	t_{on} nsec (max)	t_{off} nsec (max)
2N3425	NPN	TO - 77	2N914	15	0.1	500	300	40	40
SP8300	NPN	TO - 77*	2N708	15	0.1	200	300	10	40
SP8301	NPN	TO - 77*	2N709	6	.01	100	500	15	15
SP8307	PNP	TO - 77*	2N995	15	0.1	200	100	65*	125*
SP8314	NPN	TO - 77*	2N2369	10	0.1	300	400	12	18
SP8701	NPN	TO - 71	2N709	6	.01	100	500	15	15
SP8318	NPN	TO - 71	2N2369	10	0.1	300	400	12	18
SP8868	PNP	TO - 77*	2N2894	12	0.1	300	400	60	90
SP8869	PNP	TO - 71	2N2894	12	0.1	300	400	60	90
SP12350	NPN	TO - 78	2N3724	30	10.0	1000	300	35	60
SP12351	NPN	TO - 89	2N3724	30	10.0	1000	300	35	60
SP12352	NPN	TO - 78	2N3725	50	10.0	1000	300	35	60
SP12353	NPN	TO - 89	2N3725	50	10.0	1000	300	35	60
SP12360	PNP	TO - 78	2N5023	30	10.0	1000	170	40	90
SP12361	PNP	TO - 89	2N5023	30	10.0	1000	170	40	90
SP12362	PNP	TO - 78	2N5022	50	10.0	1000	170	40	90
SP12363	PNP	TO - 89	2N5022	50	10.0	1000	170	40	90

*Electrical specifications can be found on 2N data sheets for power ratings of TO-71, TO-79, TO-78, and TO-89

DUAL TRANSISTORS NUMERICAL INDEX

EPOXY DUAL TRANSISTORS (6 lead TO - 105) SELECTION GUIDE

Device Type	Polarity	Equivalent Triode	LV_{CEO} Volts (min)	V_{BE} Match mV (max)	H_{FE} Match Percent	H_{FE} @ Match (min)	(max)	$\Delta V_{BE1} - \Delta V_{BE2}$ $T_A = -40°C$ to $+85°C$ $\mu V/°C$ max
2N4955	NPN	2N3565	25	—	—	100	—	—
2N4956	NPN	2N3565	25	5	20	100	—	20
2N5254	PNP	2N4249	60	—	—	50	750	—
2N5255	PNP	2N4250	40	5	20	150	750	20
2N5256	PNP	2N4250	40	3	10	150	750	10

EPOXY DUAL TRANSISTORS NUMERICAL INDEX

PHOTO DEVICES SELECTION GUIDE

Family	Description	Device Type	Family	Description	Device Type
Discrete Sensors	Phototransistor	2N986/2N2452	Complex Optical Arrays	Integrated Sensors	FPA507
Discrete Sensors	Phototransistor	FPM100	Complex Optical Arrays	Integrated Sensors	FPA509
Discrete Sensors	Phototransistor	FPT100	Complex Optical Arrays	Integrated Sensors	FPA210
Discrete Sensors	Diode	FPM200	Complex Optical Arrays	Integrated Sensors	FPA201-4
Discrete Sensors	Tape Reader Array	FPM7011/FPM7012	Complex Optical Arrays	Integrated Emitters	FLA610
Discrete Emitters	Tape Reader Array	FLB100/FLC100	Complex Optical Arrays	Integrated Emitters	FLA611
Complex Optical Arrays	Integrated Sensors	FPA500	Complex Optical Arrays	Integrated Emitters	FLA630
Complex Optical Arrays	Integrated Sensors	FPA505			

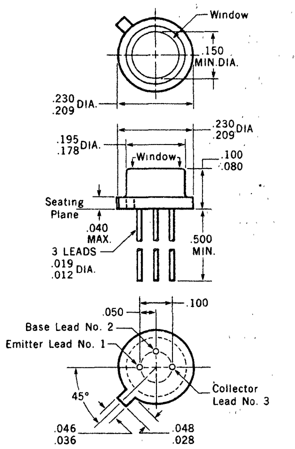
PHOTO DEVICES NUMERICAL INDEX

FLB-100 • FLC-100
AVALANCHE LUMINESCENT DIODES
DIFFUSED SILICON PLANAR* DEVICES

GENERAL DESCRIPTION - The Fairchild Avalanche Luminescent Diode emits visible light from a large geometry diffused silicon P-N junction when operated under continuous or pulsed conditions. Extremely short rise time light pulses can be obtained by driving the diode into avalanche. They provide a simple method of generating light pulses less than 3 nanoseconds turn-on time and turn-off time desirable for calibrating scintillator-photomultiplier assemblies and other photosensitive equipment.

These avalanche luminescent diodes are of great usefulness for the simulation of nuclear event scintillation pulses and other applications where a very fast turn-on/turn-off characteristic is desirable. The nanosecond light pulser together with its linear current efficiency adds ease and accuracy in aligning photomultiplier tubes with respect to signal propagation delay and pulse height calibration as required for scintillation crystal particle detectors used in coincidence circuitry.

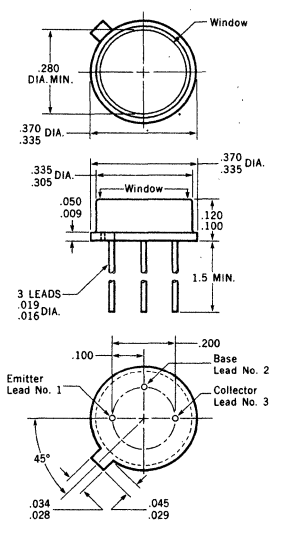
PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Dimensions similar to JEDEC TO-46 except for overall height and semi-rigid silicon resin window
Lead No. 3 internally connected to case
Leads are gold-plated kovar
See note 6
Package weight is 0.317 gram

FLB-100

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Dimensions similar to JEDEC TO-5 except for overall height and semi-rigid silicon resin window
Lead No. 3 internally connected to case
Leads are gold-plated kovar
See note 6
Package weight is 1.0 gram

FLC-100

ABSOLUTE MAXIMUM RATINGS (Note 3)

Maximum Temperatures

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

Maximum Power Dissipation

		FLB-100	FLC-100
Total Dissipation at 25°C Case Temperature	(Notes 4 and 5)	5.0 Watts	6.0 Watts
at 100°C Case Temperature	(Notes 4 and 5)	2.86 Watts	3.4 Watts
at 25°C Ambient Temperature	(Notes 4 and 5)	0.44 Watt	0.9 Watt

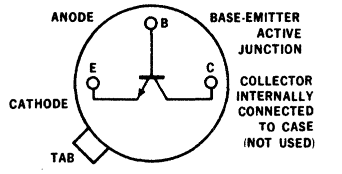
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Conditions
I_R	Reverse Leakage Current			10	mA	V_{EB} = 5.0 V
BV	Avalanche Voltage			7.0	Volts	I_E = 10 mA
Z_z	Incremental Slope of V-I Characteristic in Avalanche Region		2.0	5.0	Ohms	(see Note 1)
	Current Efficiency of Visible Light Output		10×10^{-8}		Watt/Amp	(see Note 2)

NOTES:

(1) 1.0 mA rms, f = 1.0 kHz, superimposed on 50 mA DC.

(2) Color Temperature = 2500°K, $\lambda < 0.65\ \mu$.
The light emitting area of the diode measures approximately 0.030" x 0.040".



BOTTOM VIEW OF DEVICE

* Planar is a patented Fairchild process.

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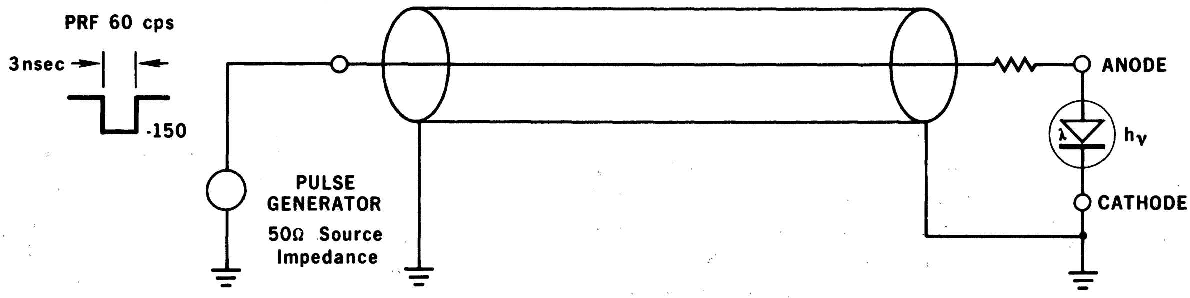
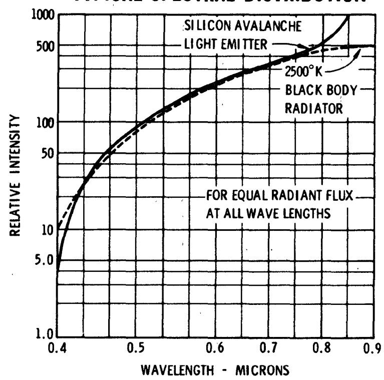
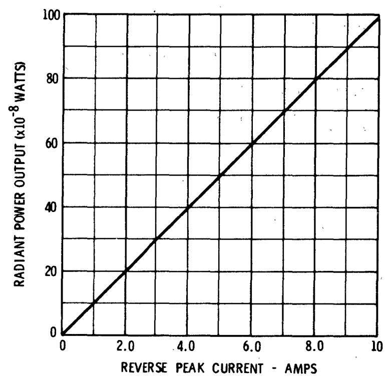
TYPICAL CIRCUIT



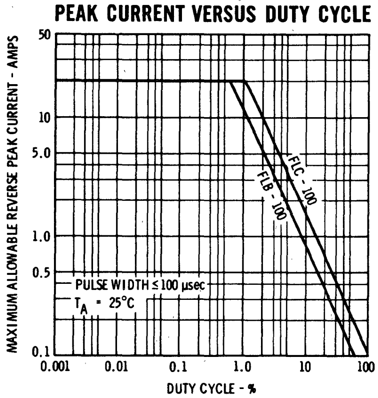
TYPICAL SPECTRAL DISTRIBUTION



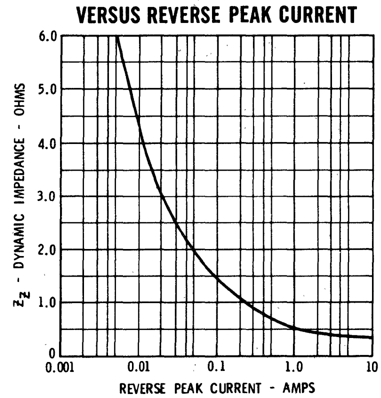
TYPICAL CURRENT EFFICIENCY OF VISIBLE LIGHT OUTPUT



MAXIMUM ALLOWABLE REVERSE PEAK CURRENT VERSUS DUTY CYCLE



TYPICAL DYNAMIC IMPEDANCE VERSUS REVERSE PEAK CURRENT



NOTES:

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

(4) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations. See maximum allowable reverse peak current versus duty cycle graph.

(5) These ratings give a maximum junction temperature of 200°C and thermal resistance (junction-to-case) for the FLB-100 of 35 °C/Watt (derating factor of 28.6 mW/°C); for the FLC-100 29.2°C/Watt (derating factor of 34.3 mW/°C). Junction-to-ambient thermal resistance of 395°C/Watt (derating factor of 2.5 mW/°C) for the FLB-100 and 194°C/Watt (derating factor of 5.15 mW/°C for the FLC-100.

(6) Handle window surface with extreme care to prevent scratching or puncturing semi-rigid silicone resin.

FPM100 • FPO100

SILICON NPN PLANAR* PASSIVATED PHOTOTRANSISTOR

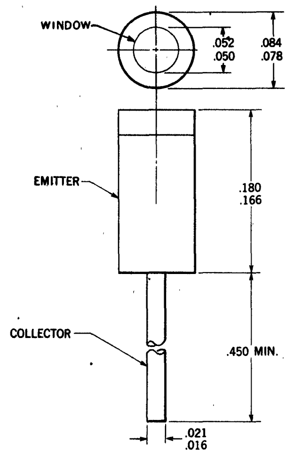
TWO TERMINAL COAXIAL PACKAGE

GENERAL DESCRIPTION — The FPM100 and FPO100 are Miniature Photosensors in a hermetic, welded case. A large photosensitive base combined with an optically flat window afford exceptional sensitivity without the need for critical alignment. In tape and card reader applications the flat window permits flush mounting in the wear-plate thereby minimizing cross-talk. The spectral response, extending from 0.4 to 1.1 microns, is compatible with daylight, tungsten, and gallium arsenide sources.

ABSOLUTE MAXIMUM RATINGS

V_{CE}	Collector-Emitter Voltage	40 V
V_{EC}	Emitter-Collector Voltage	5 V
P	Power Dissipation (25°C Ambient) (See Note 1)	75 mW
T_A	Operating Temperature, Ambient	−65°C to +150°C
T_{stg}	Storage Temperature, Ambient	−65°C to +200°C

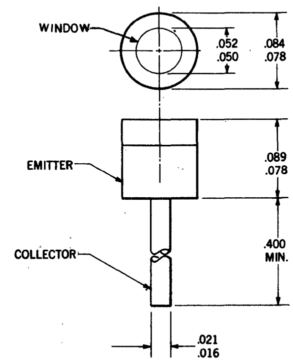
PHYSICAL DIMENSIONS



NOTES: All dimensions in inches

FPM 100

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches

FPO 100

ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS		
$V_{CEO}(sus)$	Collector-Emitter Sustaining Voltage	40		Volts	$I_C = 0.1$ mA	$H \leqq 0.1$	µW/cm²
$V_{CE}(sat)$	Collector Saturation Voltage (See Note 2)		0.3	Volts	$I_C = 0.4$ mA	$H = 20$	mW/cm²
$I_{CE}(L)$	Collector Light Current (See Note 2)	0.8		mA	$V_{CE} = 5.0$ V	$H = 20$	mW/cm²
$I_{CE}(L)$	Collector Light Current (See Note 3)	1.0		mA	$V_{CE} = 5.0$ V	$H = 9.0$	mW/cm²
$I_{CE}(D)$	Collector Dark Current		0.1	µA	$V_{CE} = 15$ V	$H \leqq 0.1$	µW/cm²
BV_{ECO}	Emitter-Collector Breakdown Voltage	5		Volts	$I_C = 0.1$ mA	$H \leqq 0.1$	µW/cm²

*Planar is a patented Fairchild process.

NOTES:

(1) Derating factor is 0.6 mW/°C above 25°C. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(2) Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature. Unless otherwise stated, all H values refer to this color temperature.
(3) Irradiation source is a filtered tungsten lamp with Corning CS7-69 filter, plus a 2 cm H_2O filter cell. This rejects wavelengths outside the 0.7 to 1.0 micron range of maximum response. This test method is included only for reference because of common usage. The unfiltered source is more typical of actual applications.
(4) Switching time is defined here as the 10% to 90% rise time of $I_{CE(L)}$ for an irradiance step input. The rise and fall times are essentially equal. See page 4 for the test circuit used for switching time measurements.
(5) Silicon radiometric photocurrent efficiency with typical GaAs irradiance is approximately three times greater than with tungsten at 2870°K color temperature. Therefore, all graphs with H as a parameter or variable will apply for GaAs irradiation if the H values are divided by three.

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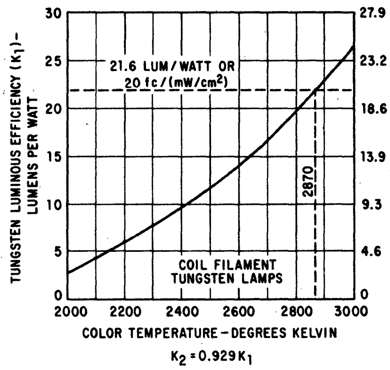
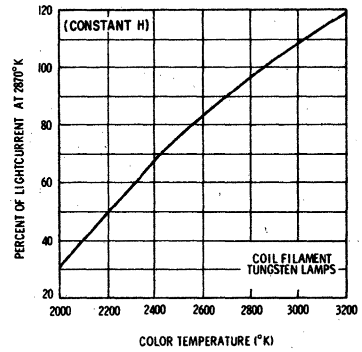
IRRADIATION AND ILLUMINATION

All irradiation levels are given in radiometric units (mW/cm²). Conversion to illumination units requires knowledge of luminous efficiency the of the source in lumens per watt of radiated power. For tungsten incandescent sources graph A may be used. Graph B shows the effect of tungsten color temperature upon light current for silicon sensors.

(GRAPH A)



(GRAPH B)



Ft. candles = candle power/distance in ft² = lumens/ft² = (mW/cm²) x 0.929 x lumens per watt.

DEFINITIONS

IRRADIANCE — Total incident radiant power. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

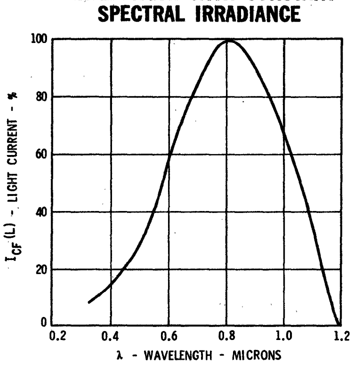
LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

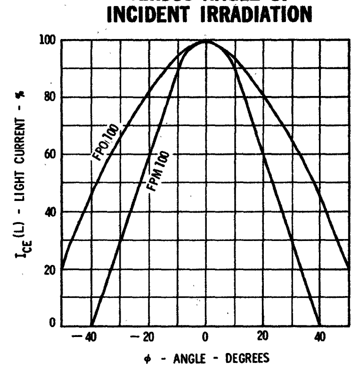
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

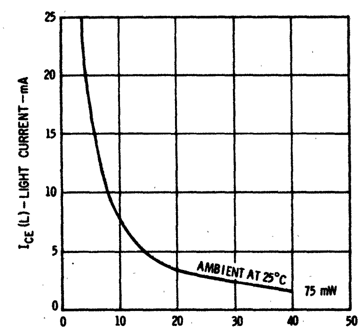
TYPICAL LIGHT CURRENT VERSUS WAVELENGTH WITH CONSTANT SPECTRAL IRRADIANCE



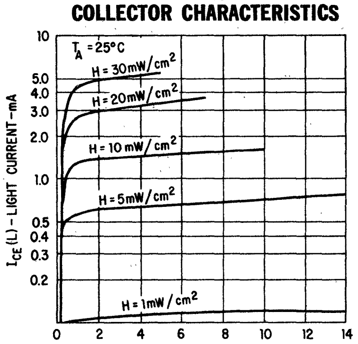
TYPICAL LIGHT CURRENT VERSUS ANGLE OF INCIDENT IRRADIATION



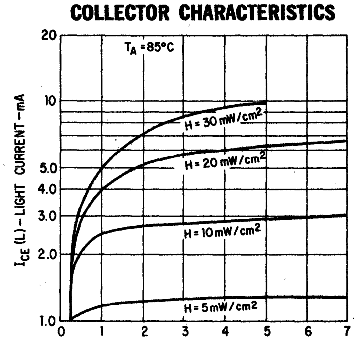
MAXIMUM POWER LIMITS



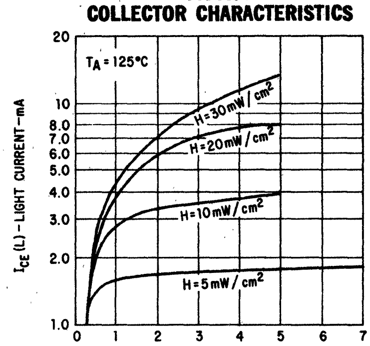
TYPICAL COLLECTOR CHARACTERISTICS



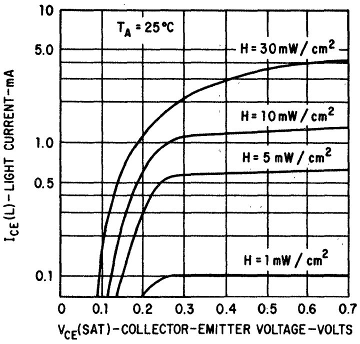
TYPICAL COLLECTOR CHARACTERISTICS



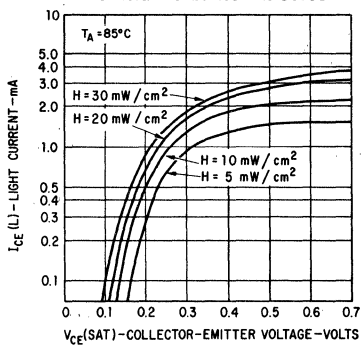
TYPICAL COLLECTOR CHARACTERISTICS



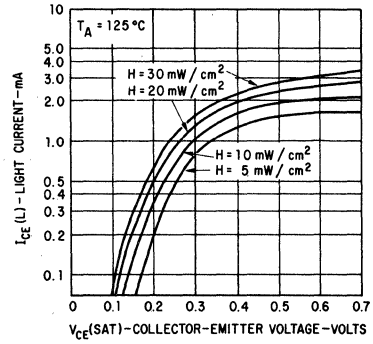
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



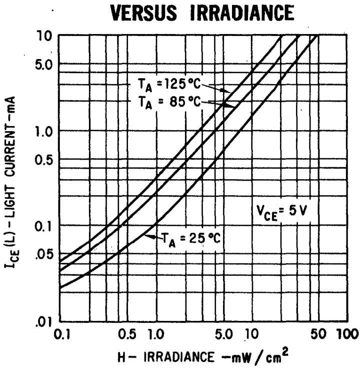
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



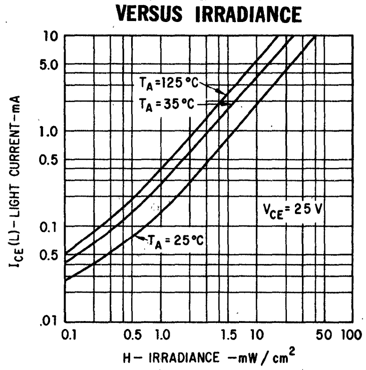
TYPICAL SATURATION VOLTAGE CHARACTERISTICS



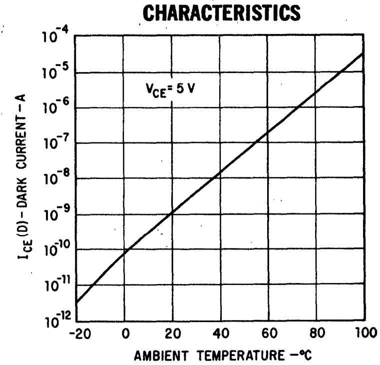
TYPICAL LIGHT CURRENT VERSUS IRRADIANCE



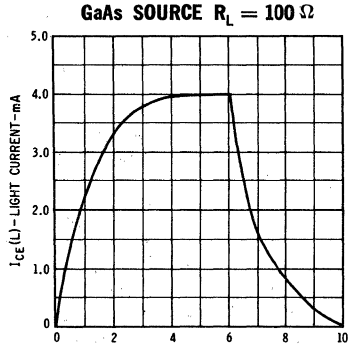
TYPICAL LIGHT CURRENT VERSUS IRRADIANCE



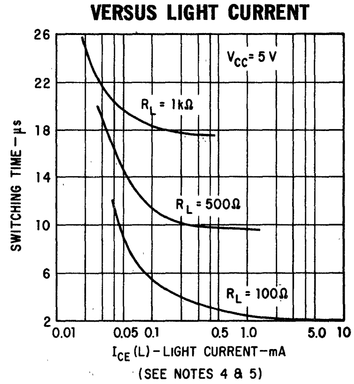
TYPICAL DARK CURRENT CHARACTERISTICS



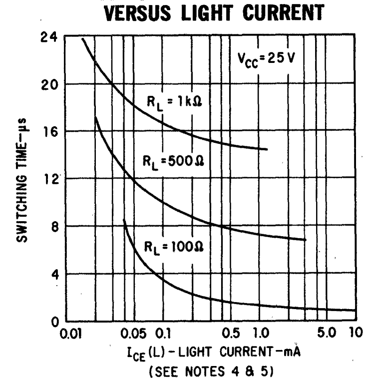
TYPICAL LIGHT CURRENT VERSUS TIME GaAs SOURCE $R_L = 100\,\Omega$



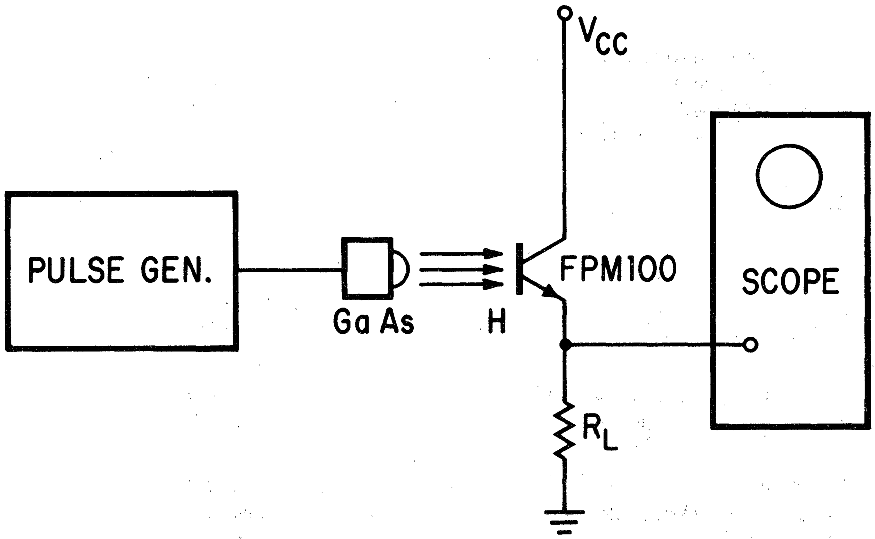
TYPICAL SWITCHING TIME VERSUS LIGHT CURRENT



TYPICAL SWITCHING TIME VERSUS LIGHT CURRENT



SWITCHING TIME MEASUREMENT SETUP

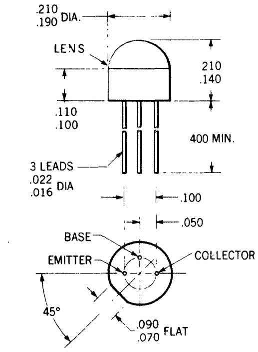


FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

FPT100
NPN PLANAR* PHOTOTRANSISTOR

GENERAL DESCRIPTION — The FPT 100 is a three-terminal NPN Planar phototransistor having exceptionally stable characteristics and high illumination sensitivity. The availability of the base lead gives wide latitude for flexible circuit design. The case is a special plastic compound with transparent resin encapsulation capable of exhibiting stable characteristics under high humidity conditions.

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
All leads electrically isolated from case

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures/Humidity

Storage Temperature	−40°C to 100°C
Operating Junction Temperature	−40°C to 85°C
Relative Humidity @ Temperature	95% at 65°C

Maximum Power Dissipation

Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	200 mW
at 25°C Ambient Temperature (Notes 2 and 3)	100 mW

Maximum Voltages (Note 7)

V_{CBO}	Collector to Base Voltage	80 Volts
V_{CEO}	Collector to Emitter Sustaining Voltage (Note 4)	30 Volts
V_{EBO}	Emitter to Collector Voltage	5.0 Volts

Maximum Current

I_C	Collector Current	25 mA

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

SYMBOL	CHARACTERISTICS		MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
I_{CBO}	Collector Dark Current	(Note 7)		0.25	25	nA	$V_{CB} = 10$ V
I_{CBO}(65°C)	Collector Dark Current	(Note 7)		0.025	0.5	μA	$V_{CB} = 10$ V
I_{CEO}	Collector Dark Current	(Note 7)		2.0	100	nA	$V_{CE} = 5.0$ V
RS_{CE}	Radiometric Sensitivity	(Notes 5 & 9)	40	280		μA/mW/cm²	$V_{CE} = 5.0$ V
LS_{CE}	Luminous Sensitivity	(Notes 6 & 9)	2.0	14		μA/fc	$V_{CE} = 5.0$ V
RS_{CB}	Radiometric Sensitivity	(Notes 5 & 10)	0.6	1.6		μA/mW/cm²	$V_{CB} = 10$ V
LS_{CB}	Luminous Sensitivity	(Notes 6 & 10)	.03	.08		μA/fc	$V_{CB} = 10$ V
t_r	Light Current Rise Time	(Note 8)		3.0		μs	GaAs, $I_C = 4.0$ mA
t_f	Light Current Fall Time	(Note 8)		3.0		μs	$R_L = 100\ \Omega$, $V_{CC} = 5.0$ V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage			0.16	0.3	Volts	$I_C = 500\ \mu A$ $H = 20$ mW/cm²
BV_{CBO}	Collector to Base Breakdown Voltage	(Note 7)	80	150		Volts	$I_C = 100\ \mu A$
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage	(Note 7)	30	50		Volts	$I_C = 1.0$ mA (Pulsed)
BV_{ECO}	Emitter to Collector Breakdown Voltage	(Note 7)	5.0	10		Volts	$I_{EC} = 100\ \mu A$

*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 85°C and junction to case thermal resistance of 300°C/Watt (derating factor of 3.33 mW/°C), and a junction to ambient thermal resistance of 600°C/Watt (derating factor of 1.67 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.

Notes continued on page 2

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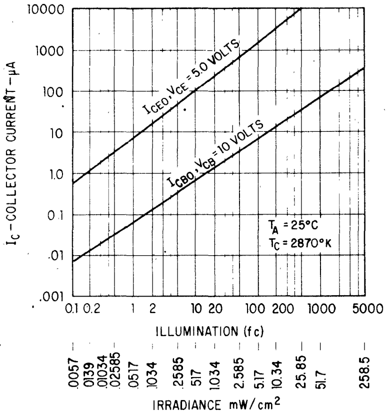
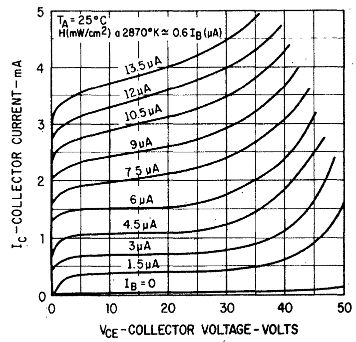
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL ELECTRICAL CHARACTERISTICS

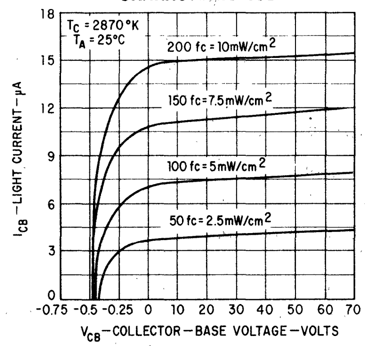
LIGHT CURRENT CHARACTERISTICS



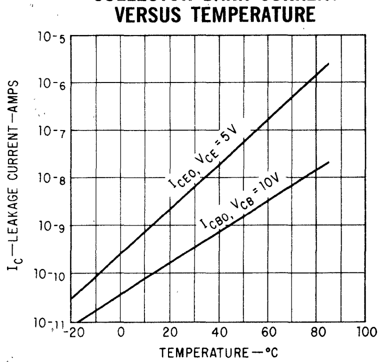
LIGHT CURRENT VERSUS COLLECTOR VOLTAGE*



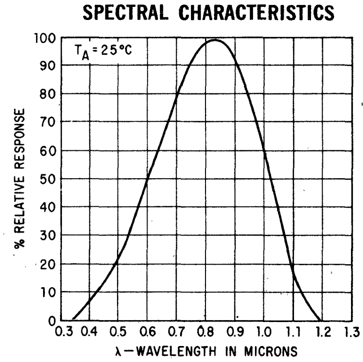
COLLECTOR BASE CHARACTERISTICS



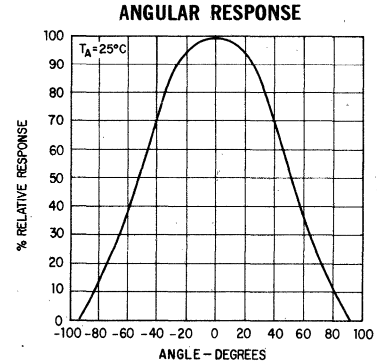
COLLECTOR DARK CURRENT VERSUS TEMPERATURE



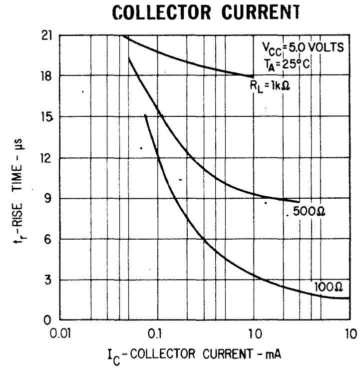
SPECTRAL CHARACTERISTICS



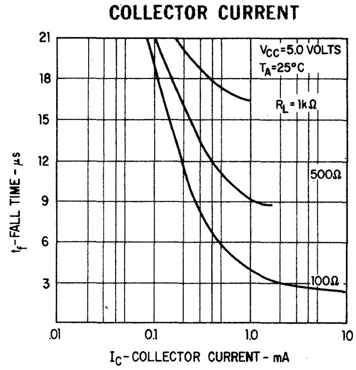
ANGULAR RESPONSE



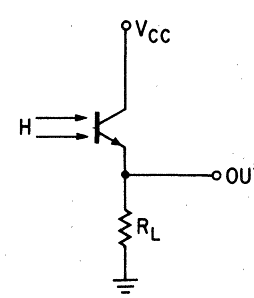
RISE TIME VERSUS COLLECTOR CURRENT



FALL TIME VERSUS COLLECTOR CURRENT



SWITCHING CIRCUIT



SOURCE — Ga As

* Single family characteristic on Transistor Curve Tracer.

NOTES (continued):

(5) Measured at radiation flux intensity of 5.0 mW/cm² as emitted from a tungsten filament lamp at a color temperature of 2870°K. The effective photosensitive area is typically 1.8 mm².

(6) These are values obtained at an illumination level of 100 foot-candles from a tungsten filament lamp operated at a color temperature of 2870°K. All production tests are performed as stated in Note 5. For more information send for Fairchild Publication APP-47.

(7) Measured with radiation flux intensity of less than .1 μW/cm² over the spectrum from 0.1 micron to 1.5 microns.

(8) Rise time is defined as the time required for I_{CE} to rise from 10% to 90% of a peak value of 1.0 milliampere. Fall time is defined as the time required for I_{CE} to decrease from 90% to 10% of a peak value of 1.0 milliampere. For more information send for Fairchild Publication APP-93.

(9) No electrical connection to base lead.

(10) No electrical connection to emitter lead.

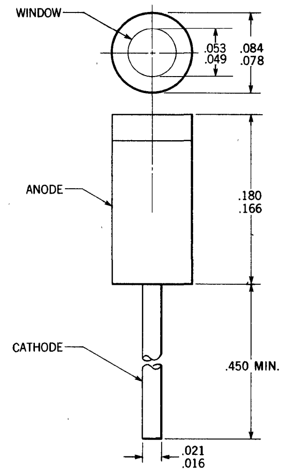
FPM200 • FPO200

SILICON PLANAR* PASSIVATED PHOTODIODE

TWO TERMINAL COAXIAL PACKAGE

GENERAL DESCRIPTION — The FPM200 and FPO200 are Miniature Light-sensing Diodes in a hermetic, welded case. In the reverse-bias mode of operation excellent photocurrent linearity is obtained. In the photovoltaic mode the open-circuit voltage varies in a logarithmic manner, being most sensitive to low-level light variations. This type of response is often desirable in light detectors, curve followers, and other servo-type applications.

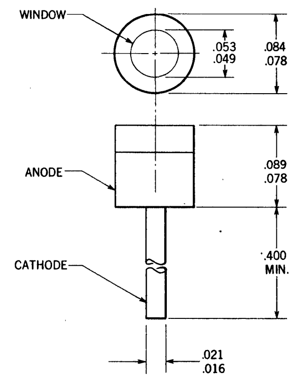
PHYSICAL DIMENSIONS



All dimensions in inches

FPM200

PHYSICAL DIMENSIONS



All dimensions in inches

FPO200

ABSOLUTE MAXIMUM RATINGS

V_R	Reverse Voltage	−100 V
T_A	Operating Temperature, Ambient	−65°C to +150°C
T_{stg}	Storage Temperature, Ambient	−65°C to +200°C
P	Power Dissipation 25°C Ambient (Note 1)	75 mW

ELECTRICAL CHARACTERISTICS (25°C) (Note 2)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS		
BV	Breakdown Voltage	−100		Volts	$I_R = 5\ \mu A$	$H \leq 0.1$	$\mu W/cm^2$
I_D	Dark Current		25	nA	$V_R = -10\ V$	$H \leq 0.1$	$\mu W/cm^2$
V_{OC}	Open Circuit Voltage	380		mV	No bias	H = 20	mW/cm^2
I_L	Light Current	13		μA	$V_R = -10\ V$	H = 20	mW/cm^2
I_{SC}	Short Circuit Current	13		μA	No bias	H = 20	mW/cm^2
S	Sensitivity	0.65		$\mu A/mW/cm^2$	No bias		

*Planar is a patented Fairchild process.

NOTES:

(1) Derating factor is 0.6 mW/°C above 25°C.
(2) Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature.

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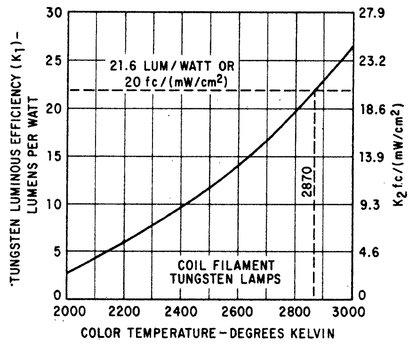
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

IRRADIATION AND ILLUMINATION

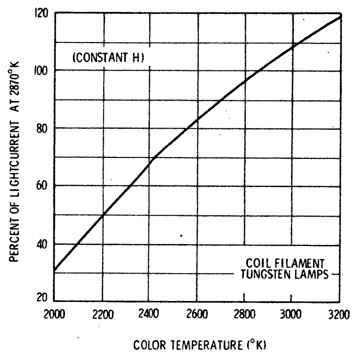
All light current ratings are given in radiometric dimensions (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For Tungsten incandescent sources graph A may be used. Graph B shows the effect of Tungsten color temperature upon light current for silicon sensors.

(GRAPH A)



$K_2 = 0.929 K_1$

(GRAPH B)



DEFINITIONS

IRRADIANCE — Total incident radiant power. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

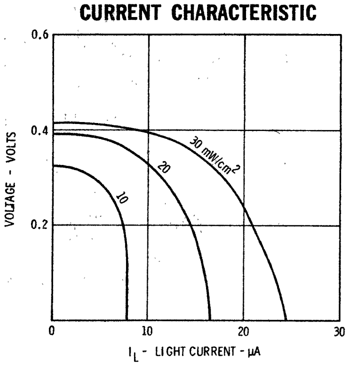
LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

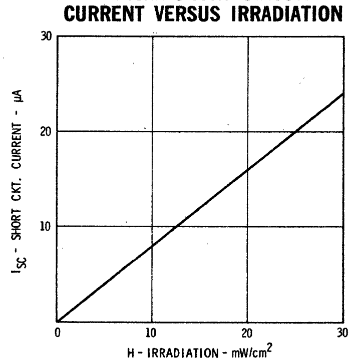
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

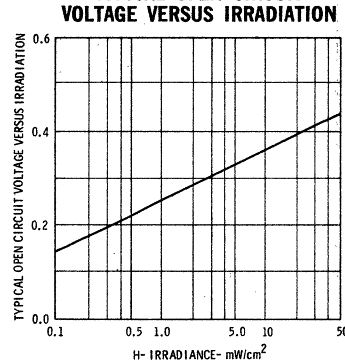
TYPICAL VOLTAGE VERSUS CURRENT CHARACTERISTIC



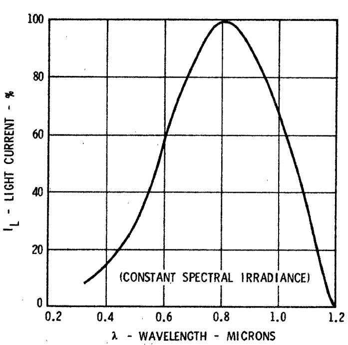
TYPICAL SHORT CIRCUIT CURRENT VERSUS IRRADIATION



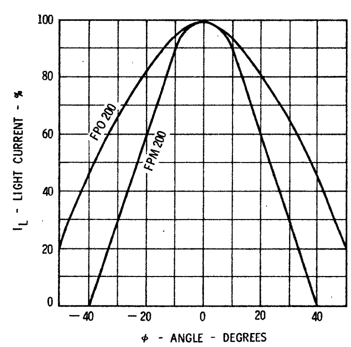
TYPICAL OPEN CIRCUIT VOLTAGE VERSUS IRRADIATION



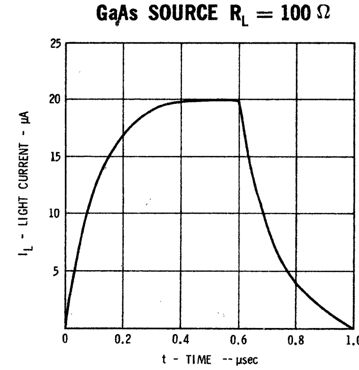
TYPICAL LIGHT CURRENT VERSUS WAVELENGTH



TYPICAL LIGHT CURRENT VERSUS ANGLE OF INCIDENT IRRADIATION



TYPICAL LIGHT CURRENT VERSUS TIME GaAs SOURCE $R_L = 100\ \Omega$



FPA201 • 202 • 203 • 204

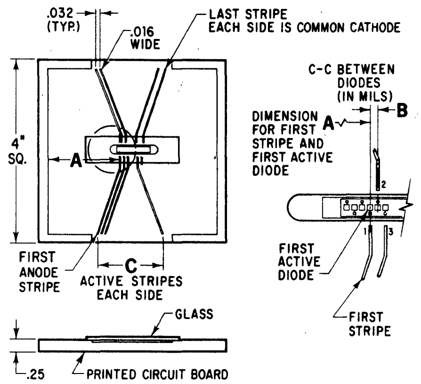
LINEAR INTEGRATED PHOTODIODE ARRAY

SILICON PLANAR* PASSIVATED

PRINTED CIRCUIT BOARD PACKAGE

GENERAL DESCRIPTION—The FPA 200 series linear photodiode arrays are monolithic chips of silicon mounted on a 4"x4"x¼" printed circuit board. The substrate is a common cathode of the array. Individual anode leads are brought out for each photodiode, and the array is protected by a glass plate. The typical array shown is an FPA-204. The purpose of this type of package is to allow "breadboard evaluation" prior to utilizing complete complex optical array. Typical applications include character recognition, star tracking, modulation transfer function analysis, and industrial process control.

PHYSICAL DIMENSIONS



TYPE	A ±.030	B (MILS)	C	NO. OF ACTIVE DIODES	AREA OF UNIFORM LIGHT SENSITIVITY
FPA 201	1.950	2.0	50	100	2.0 mil²
FPA 202	1.937	2.5	50	100	3.7 mil²
FPA 203	1.900	4.0	32/31	63	8.5 mil²
FPA 204	1.850	6.0	21	42	25 mil²

ABSOLUTE MAXIMUM RATINGS

V_F	Forward Voltage	0.4 Volt
V_R	Reverse Voltage	8 Volts
P	Total Array Power Dissipation at 25°C Ambient (derating factor is 20 μW/°C above 25°C)	1.0 mW
T_A	Operating Temperature, Ambient	−30°C to 75°C
T_{stg}	Storage Temperature, Ambient	−30°C to 100°C

CHARACTERISTICS OF THE ELEMENTAL PHOTODIODE

PARAMETER / DEVICE	CENTER TO CENTER SPACING	# DIODES	I_D@ V_R =7V 25°C	I_D@ V_R =7V 75°C	I_L @V_R =7V 25°C** MIN.	I_L @V_R =7V 25°C** MAX.	I_L @V_R =7V 75°C** MIN.	I_L @V_R =7V 75°C** MAX.	T_r,T_f @V_R =7V R_L < 50 kΩ	BV I_D = 1 μA	TYPICAL DIODE EFFECTIVE AREA (EACH)
FPA 201	.002"	100	60 pA Max.	3 nA Max.	52 nA	80 nA	52 nA	90 nA	2 μs Max.	8 V Min.	4 Mil²
FPA 202	.0025"	100	80 pA Max.	4 nA Max.	80 nA	120 nA	80 nA	145 nA	2 μs Max.	8 V Min.	6.25 Mil²
FPA 203	.004	62	120 pA Max.	6 nA Max.	200 nA	320 nA	200 nA	370 nA	2 μs Max.	8 V Min.	14 Mil²
FPA 204	.006	42	200 pA Max.	10 nA Max.	340 nA	700 nA	340 nA	770 nA	2 μs Max.	8 V Min.	35 Mil²

**Photocurrent at 20 mW/cm² irradiance (See Note 1)

*Planar is a patented Fairchild process.

NOTES:

(1) Irradiation source is an unfiltered tungsten lamp operated at 2870° K color temperature.
(2) Effective area is defined as the area outside of which the photo-response is less than 50% of peak photo-response.

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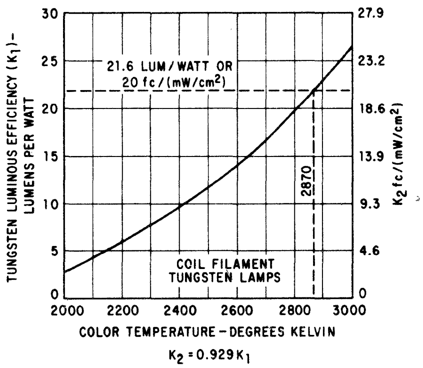
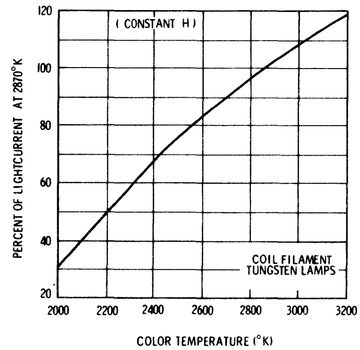
IRRADIATION AND ILLUMINATION

All light current ratings are given in radiometric dimensions (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For tungsten incandescent sources graph A may be used. Graph B shows the effect of tungsten color temperature upon light current for silicon sensors.

(GRAPH A)



(GRAPH B)



Ft. candles = candle power/distance in ft² = lumens/ft² = (mW/cm²) x 0.929 x lumens per watt.

DEFINITIONS:

IRRADIANCE — Total incident radiant power. Measured in power per unit área. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

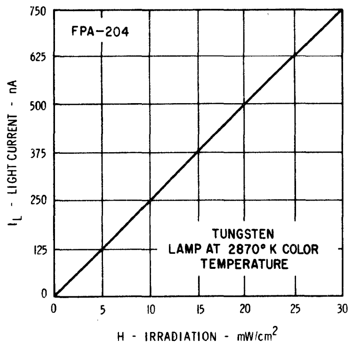
LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

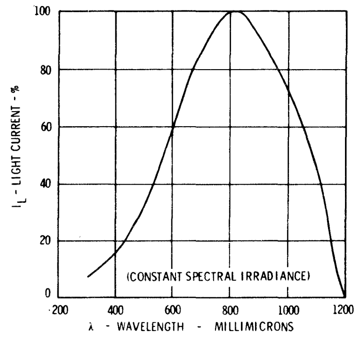
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

TYPICAL LIGHT CURRENT VERSUS IRRADIATION



TYPICAL LIGHT CURRENT VERSUS WAVE LENGTH



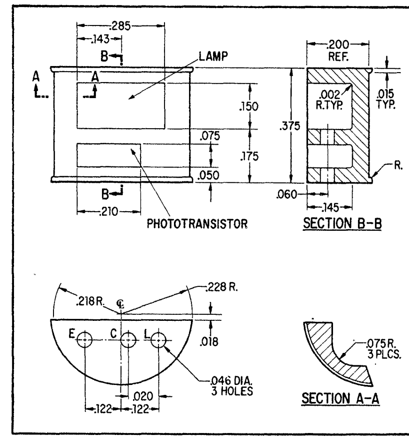
FPA210

LIGHT REFLECTION TRANSDUCER

PHOTOTRANSISTOR/ENCAPSULATED LAMP

GENERAL DESCRIPTION: The FPA 210 is a plastic package containing a miniature incandescent light bulb and a FPM 100 Phototransistor die. Possible applications include process control, medical technology (heartbeat monitor), and character recognition.

DIE DESCRIPTION: The FPM 100 Phototransistor die has a large photosensitive base, affording exceptional sensitivity. The spectral response extending from .4 to 1.1 microns is compatible with the tungsten light source.



DIE ELECTRICAL CHARACTERISTICS (25°C)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
$V_{CEO(sus)}$	Collector-Emitter Sustaining Voltage	40		Volts	$I_C = 0.1$ mA	$H \leqq 0.1\ \mu W/cm^2$
$V_{CE(sat)}$	Collector Saturation Voltage (Note 1)		0.3	Volts	$I_C = 0.4$ mA	$H = 20\ mW/cm^2$
I_{L-I}	Light Current (Note 1)	0.8		mA	$V_{CE} = 5.0$ V	$H = 20\ mW/cm^2$
I_D	Dark Current		0.1	μA	$V_{CE} = 15$ V	$H \leqq 0.1\ \mu W/cm^2$
BV_{ECO}	Emitter-Collector Breakdown Voltage	5		Volts	$I_C = 0.1$ mA	$H \leqq 0.1\ \mu W/cm^2$

FPA-210 LIGHT REFLECTION TRANSDUCER CHARACTERISTICS
Operating Temperature Range −10°C to 80°C

	TYPICAL (see note 2)	TEST CONDITIONS (see note 3)
I_{CE} (see note 4)	35 μAmp	2 steradians of 90% white at 2 cm distance
I_{CE} (see note 4)	50 μAmp	2 π steradians of 90% white at 2 cm distance
I_{CE} (see note 5)	70 μAmp	2 steradians of 90% white at 2 cm distance
I_{CE} (see note 5)	100 μAmp	2 π steradians of 90% white at 2 cm distance
I_{CE} (dark) (see note 4)	250 pAmp	irradiance $< 0.1\ \mu$watt cm^{-2} lamp OFF, $V_{CE} = 5$ volts
I_{CE} (black) (see note 5)	500 pAmp	reflectance $< 1\%$ over 2 π sr., lamp ON
I_{CE} (ambient light) (see note 4)	0.9 μAmp	20 ft. cd. parallel to face, lamp OFF

DEFINITIONS

IRRADIATION — Total incident radiant energy. Measured in power per unit area. Symbol: H
ILLUMINATION — Incident irradiation of wavelengths which are visible to the human eye. Measured in ft. candles.
LUMINOUS EFFICIENCY — Ratio of illumination to irradiation.
LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.
DARK CURRENT — Current in a photosensitive device which is effectively shielded from wavelengths to which it responds.
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

NOTES:
(1) Irradiation source is an unfiltered tungsten lamp at 2870°K color temperature.
(2) Lamp current 50 mA (5 volts), $V_{CE} = 5$ volts.
(3) Eastman Kodak neutral white test card with 90% diffuse reflectance.
(4) Case temp. 25°C, lamp operated ON 5% duty cycle.
(5) Case temp. 40°C, lamp operated ON continuously at 25°C ambient.

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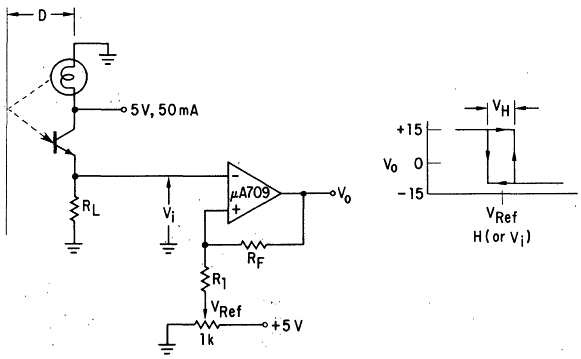
The following circuits are examples of amplifying systems that have been used in conjunction with the FPA 210.

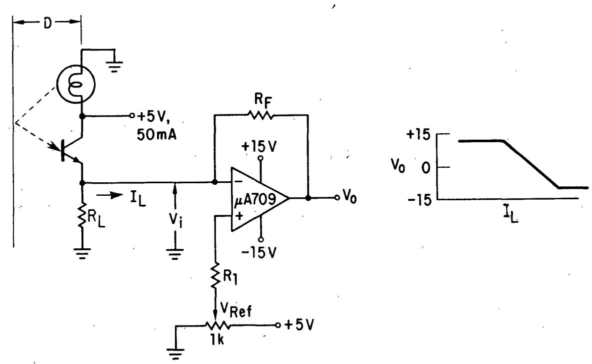
ON/OFF DETECTOR



$R_I = R_L$

V_H (hysteresis) $\approx \frac{30 R_I}{R_I + R_F}$

LINEAR AMPLIFIER CIRCUIT



$R_L \leq 100$ k

$I_L \propto \frac{B R}{D^4}$

B = Brightness
R = Reflectance of subject
D = Distance to subject

$V_i \approx R_L I_L$

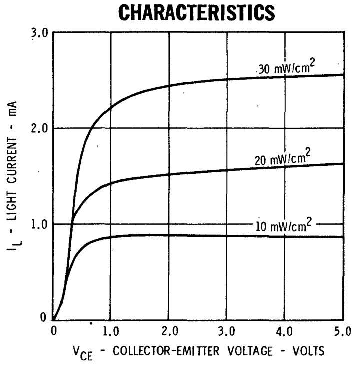
$A_V \approx \frac{R_F}{R_L}$

$R_I = R_L$ for best stability

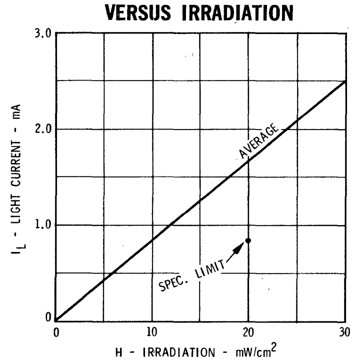
$V_O \propto A_V \frac{R}{D^4}$

V_{Ref} = offset adjustment to compensate for contact reflected illumination or ambient light.

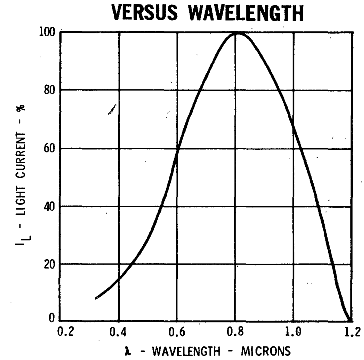
TYPICAL COLLECTOR CHARACTERISTICS



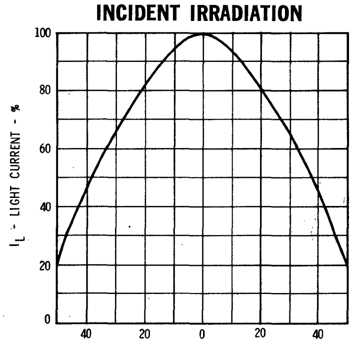
TYPICAL LIGHT CURRENT VERSUS IRRADIATION



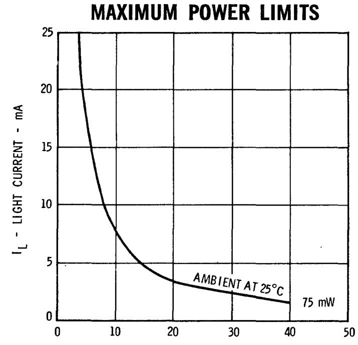
TYPICAL LIGHT CURRENT VERSUS WAVELENGTH



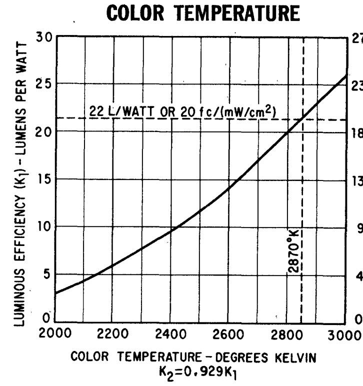
TYPICAL LIGHT CURRENT VERSUS ANGLE OF INCIDENT IRRADIATION



MAXIMUM POWER LIMITS



TUNGSTEN LUMINOUS EFFICIENCY (K) VERSUS COLOR TEMPERATURE



FPA301

8 X 8 INTEGRATED PHOTOTRANSISTOR ARRAY

SILICON PLANAR* PASSIVATED

GENERAL DESCRIPTION — The FPA301 is an 8 by 8 array of dual emitter phototransistors of monolithic construction. The silicon substrate serves as the common collector. Row emitters and column emitters are connected by metalization strips to form a matrix of word rows and bit columns. Word rows are interrogated one at a time by switching them from STANDBY to the READ state. Amplified photo currents then appear simultaneously at the bit column terminals from each illuminated photosensitive element in the row. Word rows may be interrogated at random or sequentially. The array is designed to be operated as a read only optical memory (ROOM). It may also be used for low resolution image scanning applications.

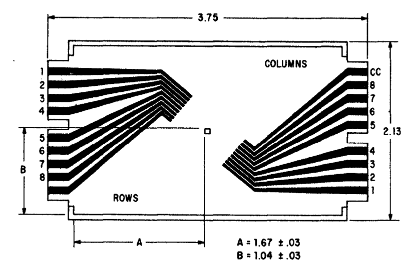
OPERATING PARAMETERS — The array has 5 mil center to center spacing along row and column axes. Each photo sensitive element has a nominal effective area of 15 square mils or 0.01 square mm. The relative spectral response is shown in Fig. 1. The monolithic array is mounted on a printed circuit board with 17 fanned-out terminals. Emitter follower operation is illustrated by the equivalent circuit of Fig. 2. The following three equations are a useful guide for establishing the standby voltage, V_{STBY}, and the read voltage, V_{READ}. The substrate voltage, V_{SUB}, is the voltage at the common collector (substrate) terminal, S, for all elements. The voltage V_{SIG} is defined as the maximum possible signal in the bit column sequence, $e_{r1}, e_{r2}, \ldots e_{r8}$ for a particular application.

$$-7.0 \text{ VOLTS} \leq V_{STBY} \leq -1.0 \text{ VOLT}$$

$$V_{SIG} + 1.0 \text{ VOLT} \leq V_{READ} \leq +7.0 \text{ VOLTS}$$

$$V_{SIG} + 2.0 \text{ VOLTS} \leq V_{SUB} \leq 13.0 \text{ VOLTS}$$

PHYSICAL DIMENSIONS OF PRINTED CIRCUIT BOARD



DIMENSIONS A & B LOCATE THE ROW 1 COLUMN 1 ELEMENT

ABSOLUTE MAXIMUM RATINGS

Operating temperature, ambient	−30°C to 75°C
Total array electrical power dissipation† (derating factor is 2 mW per °C above 25°C)	100 mW
Irradiation level, all wavelengths	1.0 W/cm^2
Photocurrent per column†	150 µA

ELECTRICAL CHARACTERISTICS

SYMBOL	CHARACTERISTICS	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
A_e	Photosensitive Area of Each Element		15		mil^2	
$BV_{SR\text{-}C}$	Substrate to Row or Column Breakdown Voltage	20			Volts	$I_{substrate} = 10\mu A$
BV_{RS}	Row to Substrate Breakdown Voltage	7			Volts	$I_{substrate} = 10\mu A$
BV_{CS}	Column to Substrate Breakdown Voltage	7			Volts	$I_{substrate} = 10\mu A$
$1 + h_{FE}$	Photocurrent Gain	10	15	30		
I_{STBY}	Leakage Current Per Column, All Rows in STBY		−10	−50	pA	See Note 1
I_D	Dark Current Per Column†		50	500	pA	$H < 0.1\ \mu W/cm^2$ See Note 1
I_E	Photocurrent Per Column†	0.1		1.0	µA	$H = 5 mW/cm^2$ See Note 2
t_{sw}	Word Row Switching Time, 10% to 90%		50	100	ns	$H = 5 mW/cm^2$ $R_L = 1\ k\Omega$ See Notes 2 and 3
$\frac{I_{Emax} - I_{Emin}}{I_{Emean}}$	Uniformity of Column Photocurrent Within Each Array†		0.4			$H = 5 mW/cm^2$ See Note 2

†Any single word row in the READ state. Rows in STBY contribute to total power.

*Planar is a patented Fairchild process.

NOTES:

(1) $V_{STBY} = -2$ volts, $V_{READ} = 2$ volts, $V_{SUB} = 5$ volts.
(2) Tungsten source at 2870°K color temperature, same voltages as Note 1.
(3) Word row switching time is proportional to R_L when $R_L > 1\ k\Omega$. See Figure 2.

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IRRADIATION AND ILLUMINATION

All irradiation levels are given in radiometric units (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For tungsten incandescent sources, Figure 4 may be used. Figure 5 shows the effect of tungsten color temperature upon light current for silicon sensors at constant H.

TYPICAL SPECTRAL RESPONSE
(Not Showing Oxide ± 5% Interference Structure)

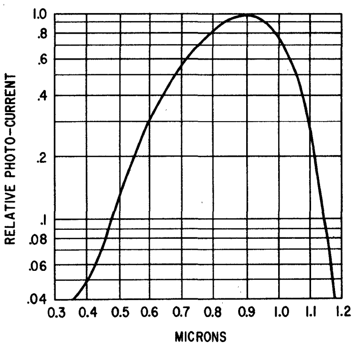
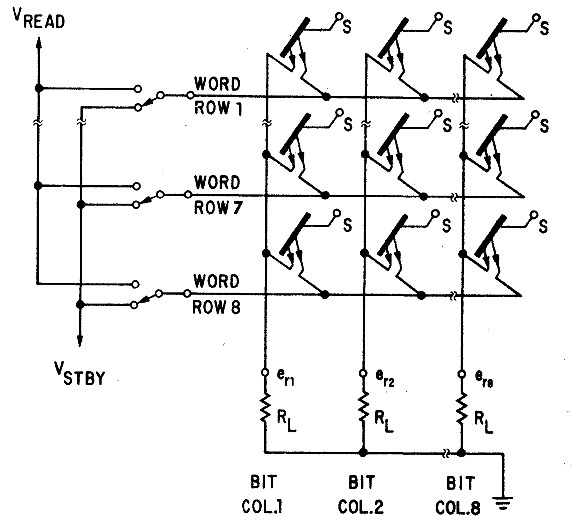


Fig. 1

EQUIVALENT CIRCUIT MATRIX SHOWING TYPICAL OPERATION



The Substrate Terminal, S, is a common collector for all elements.

r = Row Designation

Fig. 2

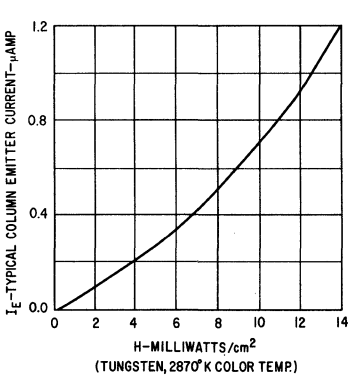


Fig. 3

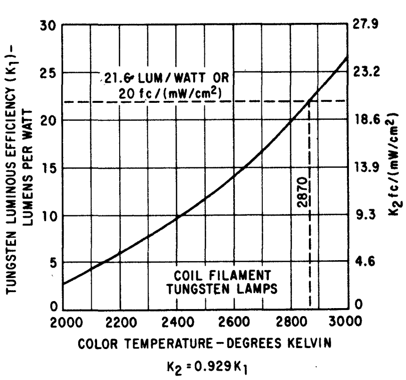


Fig. 4

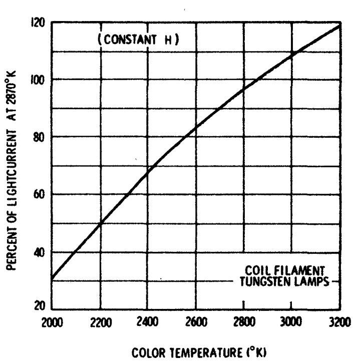


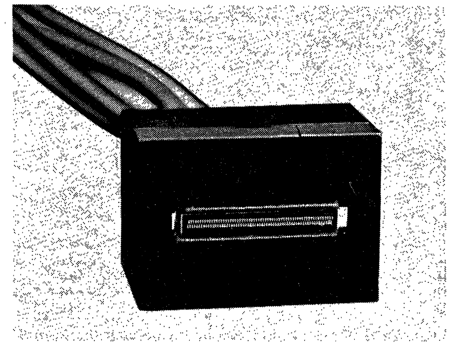
Fig. 5

FPA 500

LINEAR INTEGRATED PHOTODIODE ARRAY

SILICON PLANAR* PASSIVATED

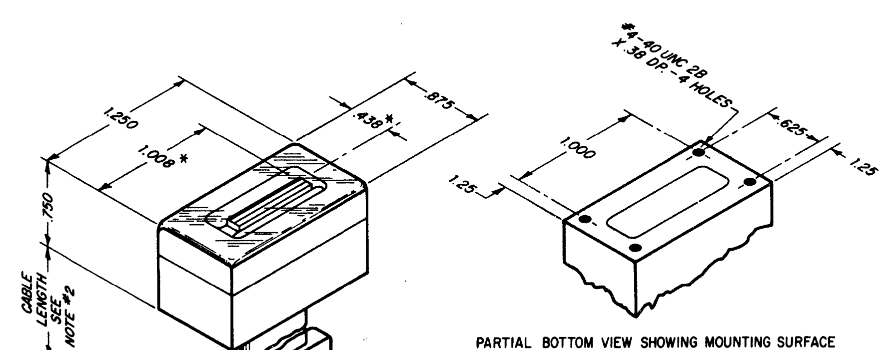
GENERAL DESCRIPTION — The FPA 500 photodiode array consists of 126 photodiodes on 6 mil centers forming a linear array 0.756 inch in length as measured between centers of the end photodiodes. The array is fabricated as a monolithic silicon structure. Each photodiode has a 4 x 6 mil area of uniform light sensitivity and a total effective sensitive area of approximately 35 mil². The package includes a thin glass window positioned close to the array face; it is not hermetically sealed.



CHARACTERISTICS OF THE ELEMENTAL PHOTODIODES

SYMBOL	CHARACTERISTIC	MIN.	NOM.	MAX.	CONDITIONS
I_D	Dark Current		20 pA	200 pA	7 V 25°C
				30 nA	7 V 100°C
I_L	Light current at20mW/cm²	340 nA	480 nA	700 nA	7 V 25°C
		70 nA		200 nA	7 V 100°C
t_r, t_f	Risetime, Falltime			2 μs	7 V R_L <50 kΩ
BV	Breakdown Voltage	8 V			$I_D = 1\ \mu A$

* Planar is a Patented Fairchild Process



PARTIAL BOTTOM VIEW SHOWING MOUNTING SURFACE

NOTES:
1. CABLE TERMINATES IN CONNECTOR WINCHESTER MRE-75SJTC6H MATES WITH MRE-75PJ6 MAY BE CHANGED TO SATISFY CUSTOMER REQUIREMENTS BY TERMS OF P.O.
2. CABLE LENGTH TO BE SPECIFIED IN P.O.
3. STARRED DIMENSIONS INDICATE CENTER OF LIGHT SOURCE NO. 1 IN THE MATRIX ARRAY

NOTE:
Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature.

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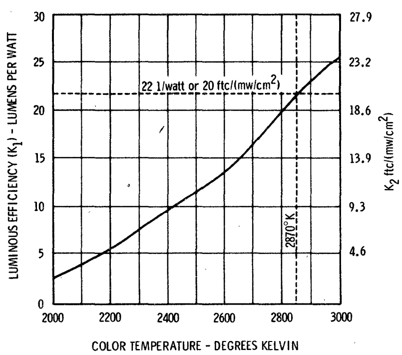
IRRADIANCE AND ILLUMINANCE

All light current ratings are given in radiometric dimensions (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For incandescent sources graph A may be used. Graph B shows the effect of color temperature upon light current for silicon sensors.

(GRAPH A)

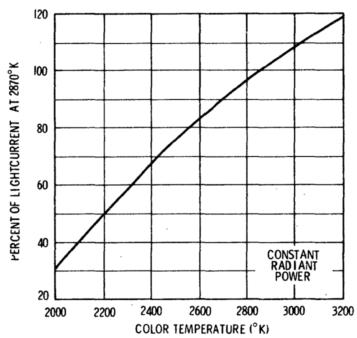
INCANDESCENT SOURCES



$K_2 = 0.929K_1$

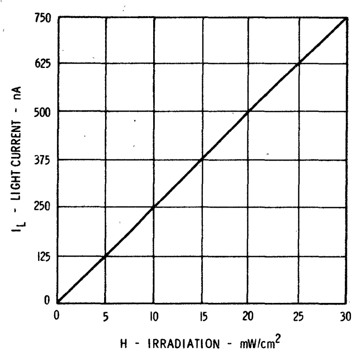
(GRAPH B)

COLOR TEMPERATURE VERSUS LIGHT CURRENT

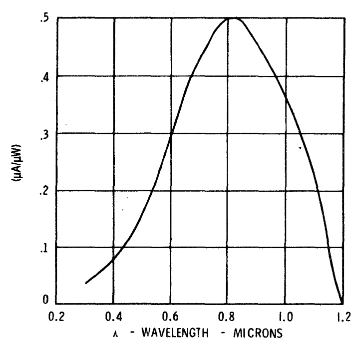


Ft. candles = candle power/distance in ft² = lumens/ft² = mW/cm² × 0.929 × lumens per watt.

TYPICAL LIGHT CURRENT VERSUS IRRADIATION



TYPICAL LIGHT CURRENT VERSUS WAVE LENGTH



DEFINITIONS

IRRADIANCE — Total incident radiant energy. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths which are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device which is effectively shielded from wavelengths to which it responds.

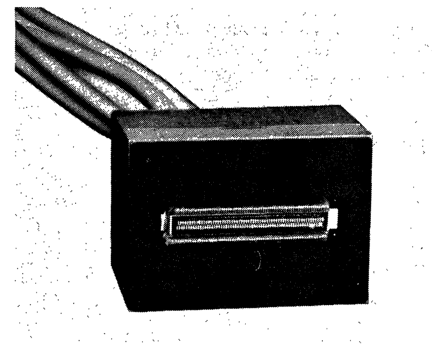
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

FPA505

LINEAR INTEGRATED PHOTODIODE ARRAY

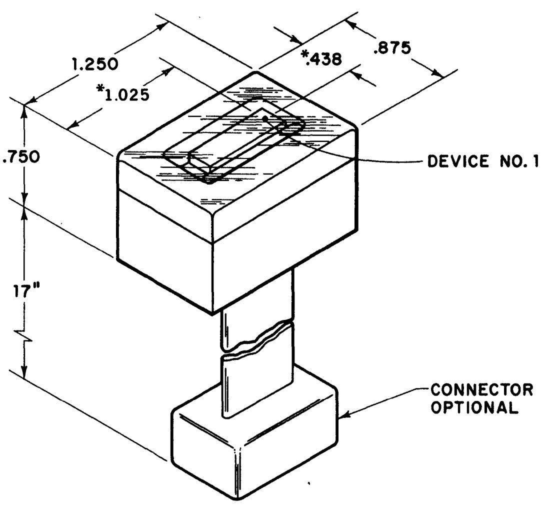
SILICON PLANAR* PASSIVATED

GENERAL DESCRIPTION—The FPA 505 photodiode array consists of 320 photodiodes on 2.5 mil centers forming a linear array .800 inch in length as measured between centers of the end photodiodes. The array is fabricated as a monolithic silicon structure. Each photodiode has a 2.0x2.0 mil area of uniform light sensitivity and a total effective sensitive area of approximately 5.6 mil². The package includes a thin glass window positioned close to the array face; it is not hermetically sealed.

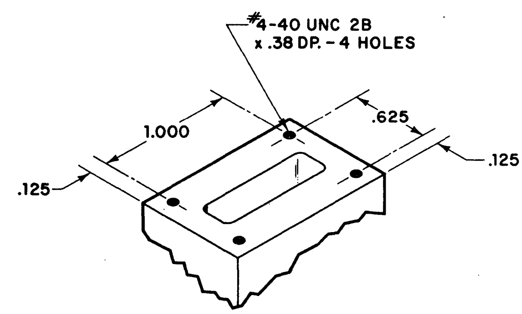


CHARACTERISTICS OF THE ELEMENTAL PHOTODIODES

SYMBOL	CHARACTERISTICS	MIN.	MAX.	CONDITIONS
I_D	Dark Current		80 pA	7 V 25°C
			12 nA	7 V 100°C
I_L	Photocurrent at 20 mW/cm²	80 nA	120 nA	7 V 25°C (see Note)
		60 nA	160 nA	7 V 100°C (see Note)
t_r, t_f	Risetime, Falltime		2 μs	7 V $R_L < 50$ kΩ
BV	Breakdown Voltage	8 V		$I_R = 1$ μA



NOTE:
* STARRED DIMENSIONS INDICATE CENTER OF LIGHT SENSOR NO. 1 IN MATRIX ARRAY



PARTIAL BOTTOM VIEW SHOWING MOUNTING HOLES

*Planar is a patented Fairchild process.

NOTE:
Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature.

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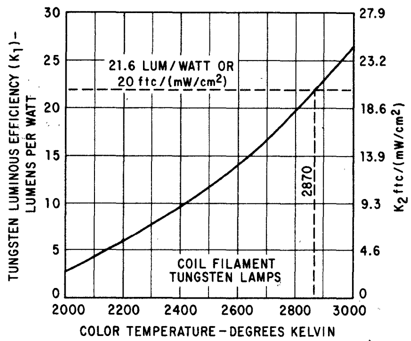
IRRADIATION AND ILLUMINATION

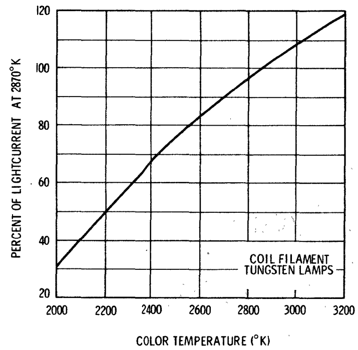
All light current ratings are given in radiometric dimensions (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For Tungsten incandescent sources graph A may be used. Graph B shows the effect of Tungsten color temperature upon light current for silicon sensors.

(GRAPH A)

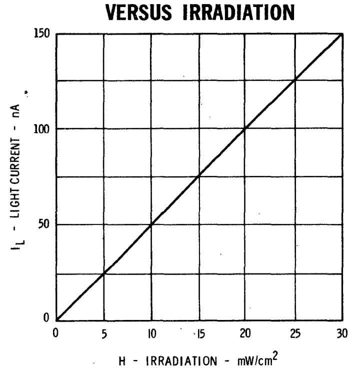


$K_2 = 0.929 K_1$

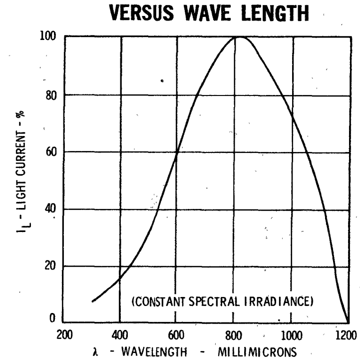
(GRAPH B)



TYPICAL LIGHT CURRENT VERSUS IRRADIATION



TYPICAL LIGHT CURRENT VERSUS WAVE LENGTH



Ft. cd. = Lumens/ft² = K_2 x mW/cm²

DEFINITIONS:

IRRADIANCE — Total incident radiant power. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

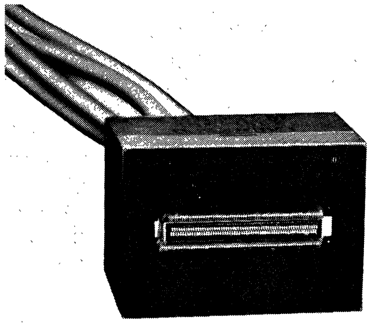
SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

FPA507

LINEAR INTEGRATED PHOTODIODE ARRAY

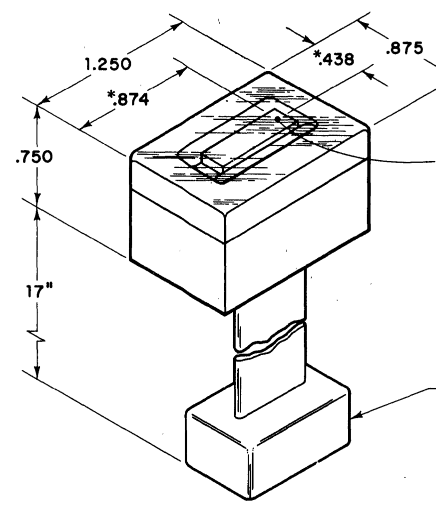
SILICON PLANAR* PASSIVATED

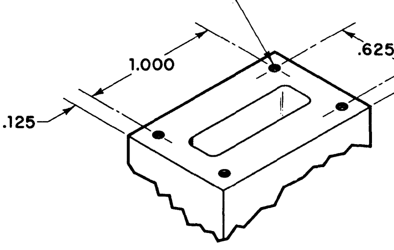
GENERAL DESCRIPTION—The FPA 507 photodiode array consists of 250 photodiodes on 2 mil centers forming a linear array .500 inch in length as measured between centers of the end photodiodes. The array is fabricated as a monolithic silicon structure. Each photodiode has a 1.5x1.5 mil area of uniform light sensitivity and a total effective sensitive area of approximately 3.5 mil². The package includes a thin glass window positioned close to the array face; it is not hermetically sealed.



CHARACTERISTICS OF THE ELEMENTAL PHOTODIODES

SYMBOL	CHARACTERISTICS	VALUE MIN.	NOM.	MAX.	CONDITIONS
I_D	Dark Current			60 nA	7 V 25°C
				10 nA	7 V 100°C
I_L	Photocurrent at 20 mW/cm²	52 nA		80 nA	7 V 25°C (see Note)
		40 nA		100 nA	7 V 100°C (see Note)
t_r, t_f	Risetime, Falltime			2 μs	7 V $R_L < 50$ kΩ
BV	Breakdown Voltage	8 V			$I_R = 1$ μA





PARTIAL BOTTOM VIEW SHOWING MOUNTING HOLES

NOTE:
* STARRED DIMENSIONS INDICATE CENTER OF LIGHT SENSOR NO. 1 IN MATRIX ARRAY

NOTE:
Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature.

*Planar is a patented Fairchild process.

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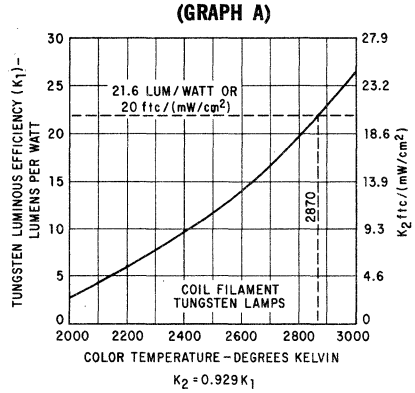
IRRADIATION AND ILLUMINATION

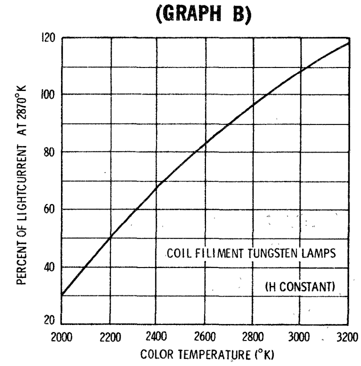
All light current ratings are given in radiometric dimensions (mW/cm^2). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For Tungsten incandescent sources graph A may be used. Graph B shows the effect of Tungsten color temperature upon light current for silicon photosensors.

(GRAPH A)

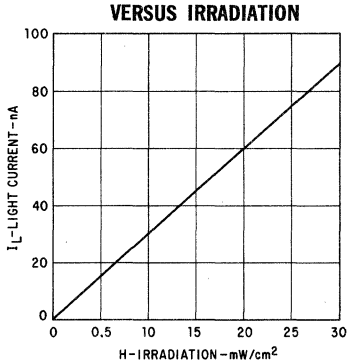


$K_2 = 0.929 K_1$

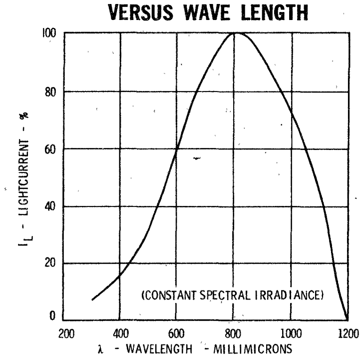
(GRAPH B)



TYPICAL LIGHT CURRENT VERSUS IRRADIATION



TYPICAL LIGHT CURRENT VERSUS WAVE LENGTH



Ft.-cd. = Lumens/ft^2 = K_2 x mW/cm^2

DEFINITIONS:

IRRADIANCE — Total incident radiant power. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

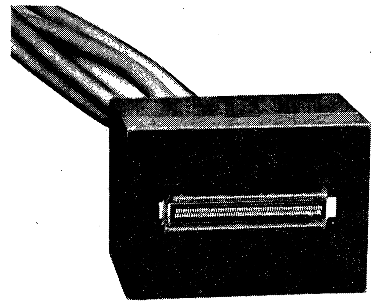
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

FPA509

LINEAR INTEGRATED PHOTODIODE ARRAY

SILICON PLANAR* PASSIVATED



GENERAL DESCRIPTION—The FPA509 photodiode array consists of 125 photodiodes on 4 mil centers forming a linear array 0.496 inch in length as measured between centers of the end photodiodes. The array is fabricated as a monolithic silicon structure. The substrate is a common cathode of the array. Each photodiode has a 2.5 x 3.5 mil area of uniform light sensitivity and a total effective sensitive area of approximately 14 mil^2. The package includes a thin glass window positioned close to the array face; typical applications include optical character recognition, star tracking, modulation transfer function analysis, and industrial process control.

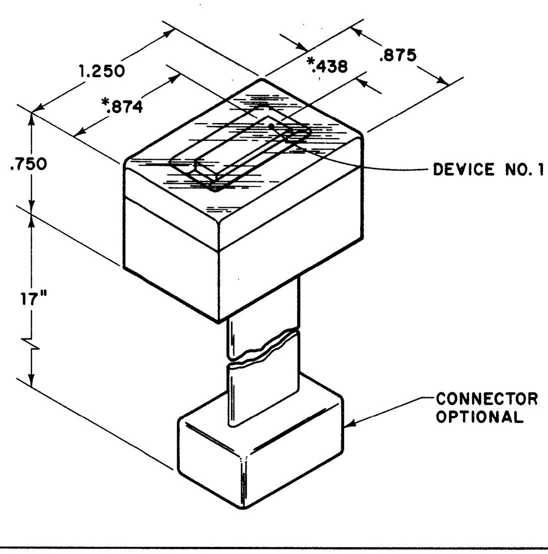
ABSOLUTE MAXIMUM RATINGS

V_R	Reverse voltage	8 Volts
V_F	Forward voltage	0.4 Volt
T_A	Operating temperature, ambient	−30°C to +100°C
T_{stg}	Storage temperature, ambient	−30°C to 100°C

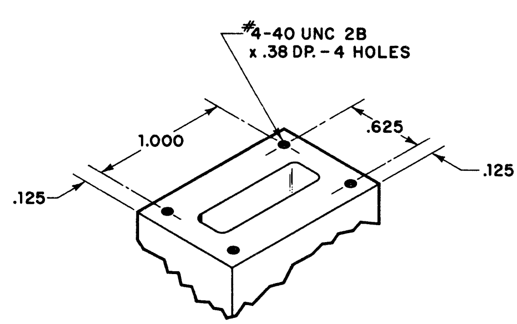
CHARACTERISTICS OF THE ELEMENTAL PHOTODIODES (25°C Case Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	CONDITIONS
I_D	Dark Current		120 pA	$V_R = 7$ V
			20 nA	$V_R = 7$ V $T_A = 100$°C
I_L	Photocurrent at 20 mW/cm^2 (See Note)	200 nA	320 nA	$V_R = 7$ V
		160 nA	400 nA	$V_R = 7$ V $T_A = 100$°C
t_r, t_f	Risetime, Falltime		2 μs	$V_R = 7$ V, $R_L < 50$ kΩ
BV	Breakdown Voltage	8 V		$I_D = 1$ μA

NOTE:
Irradiation source is an unfiltered tungsten lamp operated at 2870°K color temperature.



NOTE:
* STARRED DIMENSIONS INDICATE CENTER OF LIGHT SENSOR NO. 1 IN MATRIX ARRAY



PARTIAL BOTTOM VIEW SHOWING MOUNTING HOLES

*Planar is a patented Fairchild process

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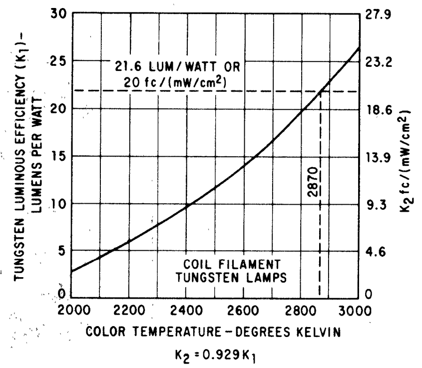
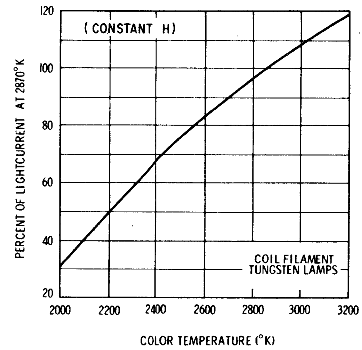
IRRADIATION AND ILLUMINATION

All light current ratings are given in radiometric dimensions (mW/cm²). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For Tungsten incandescent sources graph A may be used. Graph B shows the effect of Tungsten color temperature upon light current for silicon sensors.

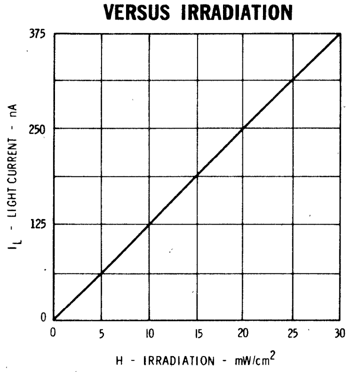
(GRAPH A)



(GRAPH B)

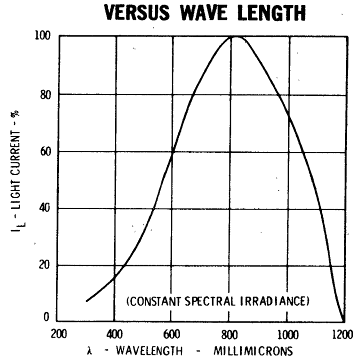


TYPICAL LIGHT CURRENT VERSUS IRRADIATION



(TUNGSTEN LAMP AT 2870°K COLOR TEMPERATURE)

TYPICAL LIGHT CURRENT VERSUS WAVE LENGTH



DEFINITIONS:

IRRADIANCE — Total incident radiant power. Measured in power per unit area. Symbol: H.

ILLUMINANCE — Incident irradiation of wavelengths that are visible to the human eye. Measured in ft. candles.

LUMINOUS EFFICIENCY — Ratio of illuminance to irradiance.

LIGHT CURRENT — The current resulting from the action of light upon a light sensitive device.

DARK CURRENT — Current in a photosensitive device that is effectively shielded from wavelengths to which it responds.

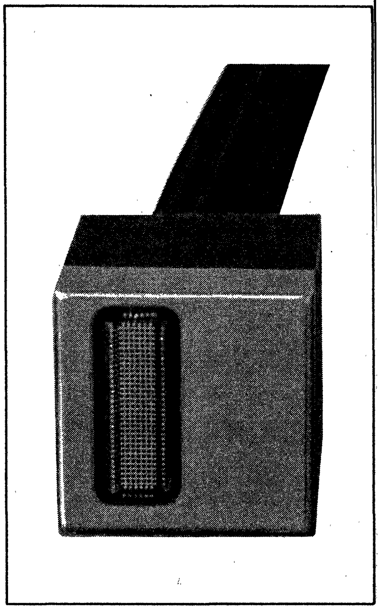
COLOR TEMPERATURE — The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

SPECTRAL IRRADIANCE — The radiant power within a specified wavelength interval that is incident on a surface. Measured in power per unit surface per unit wavelength.

FLA-610

AVALANCHE LUMINESCENT DIODE ARRAY

DIFFUSED SILICON PLANAR* DEVICE



GENERAL DESCRIPTION

The Fairchild Avalanche Luminescent Diode Array, FLA-610, is a data recording device containing 192 light emitting diffused silicon-planar diodes (arranged in a 6-column, 32-row diode matrix). These diodes emit light to produce "dot" patterns on photographic emulsions by "contact printing." Monolithic construction on large area silicon substrates provides precise positioning of the individual diodes which results in efficiently arranged, easily read photographic data block recordings.

GENERAL

Typical current efficiency of visible light output of:	$\lambda < 0.65\ \mu$, approximate 2×10^{11} photons/amp. second 2×10^{-5} lumen/amp. 7×10^{-8} watt/amp.
Uniformity of current efficiency:	±15%
Approximate color temperature:	2500°K

INDIVIDUAL DIODE LIGHT SOURCE CONFIGURATION

Light is emitted from the perimeter of a 0.002" square. The light-emitting line width is approximately 20 microinches. The metalization pattern masks 0.001" of the center of two opposite sides of the diode to leave 0.006" of light-emitting line.

INDIVIDUAL LIGHT-EMITTING ELEMENT

Light emission is obtained by operating the diode in the reverse bias mode. Typical diode operating parameters are:

$5.8 \leq V_R \leq 12.5$ volts (13.5 V for 611)

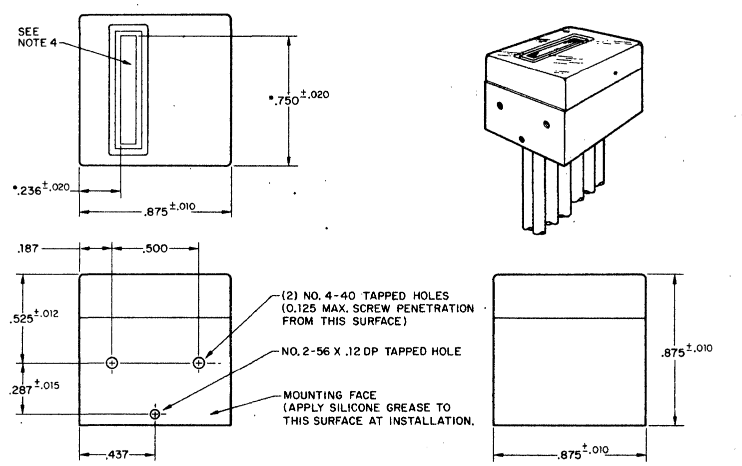
$0 \leq I_R \leq 100$ mA

where

V_R = voltage between any pair of, each, row and column pins at the connector

I_R = current at any row pin of the connector

PACKAGE OUTLINE



NOTES:

(1) Cable Terminates in Connector: U.S. Components, Inc. #SMI-42 F1-HRSL-DM40 (Mates with #SMI-42 M1-SL-DM40)

(2) Cable length 17" standard length.

(3) Starred dimensions indicate center lines of 1st row and 1st column of the light sources in the matrix array.

(4) Handle film plane surface with **EXTREME CARE** to prevent scratching or puncturing thin mylar film.

*Planar is a patented Fairchild process.

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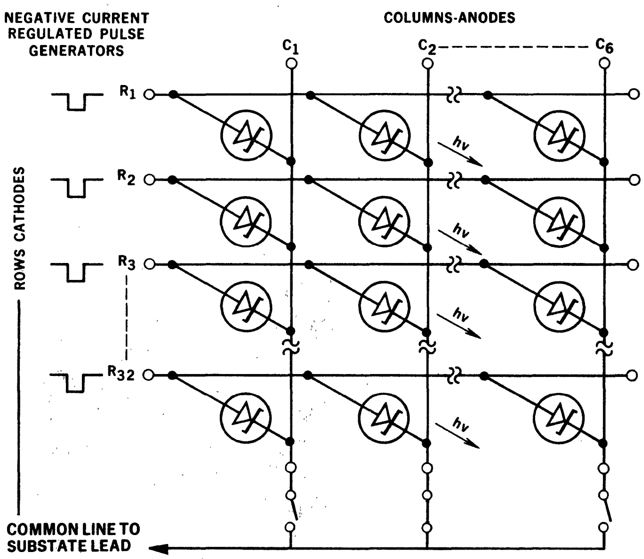
FAIRCHILD DIODE ARRAY FLA-610

TYPICAL COLUMN SEQUENTIAL CIRCUIT



MAXIMUM PULSE LENGTH:	160 ms at 25 mA 40 ms at 50 mA 10 ms at 100 mA
MAXIMUM DUTY CYCLE PER DIODE:	50%

DIODE ARRAY

Peak power dissipation:	40 watts
Average power dissipation, maximum:	5.5 watts
Maximum duty cycle per column: @ 100 mA per Diode:	50%
Effective thermal time constant of package:	~ 10 seconds

NORMAL OPERATIONAL MODE

The normal mode of operation of the FLA-610 is column sequential; one column, or 32 anode set, at a time is activated; any combination of the 32-row, or cathodes is driven simultaneously by negative independent current-regulated pulses. A separate substrate lead is supplied which can be connected to the common column lead. (This is recommended for use with current levels $>$ 70mA/diode.)

SPECIAL OPERATIONAL MODES

A large number of operating arrangements may be used. For special applications information should be obtained from Fairchild Semiconductor before installation.

PHYSICAL DESCRIPTION

The array is 6 elements wide by 32 elements long. Electrical connection is made via 6 anode leads and 32 cathode leads. Connections to the silicon chip are arranged to minimize current densities in the device metalization. The package body is electrically isolated ($>$1.0 megohm at 50 volts) from the array and its connections.

ARRAY

Light emitting diode size:	0.002″ x 0.0002″
Center-to-center spacings:	0.018″ each way, (6 x 32)
Array size (to corner-device centers):	0.090″ x 0.558″

PACKAGE

Dimensions, external:	(See physical dimensions drawing)
Distance of silicon surface below package face, equivalent optical path in air:	0.004″ maximum

MOUNTING

The package is designed for minimum thermal resistance from the array to the side mounting surface. When operating near maximum power rating, mounting support should be kept below 55°C.

For film located within 0.001″ of face of FLA-610 and with emulsion facing same:

Dot shape:	Circular
Dot diameter, nominal:	0.008″
Peak optical density of dot for prescribed conditions:	$>$ 1.3

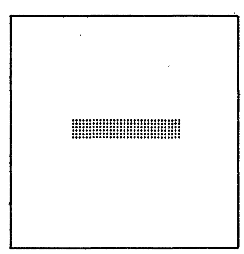
Exposure Index: Daylight-20 (Kodak Panatomic - X, Type 4400)

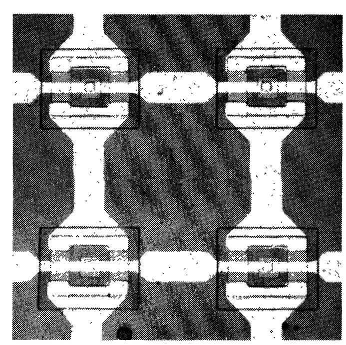
3 ms pulse at 50 mA

Developed in D 19 at 68°F, for 5 minutes

LUMINESCENT DIODE ARRAY CHIP

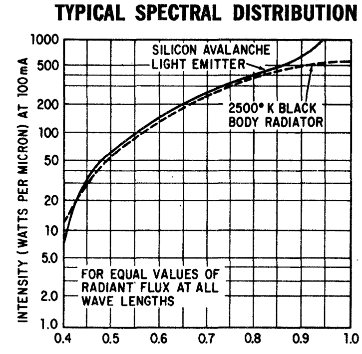
TYPICAL TEST EXPOSURE





(ENLARGED 50X)

TYPICAL SPECTRAL DISTRIBUTION

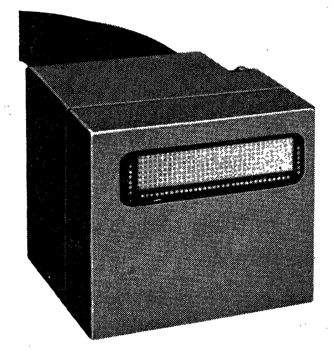


FLA611

AVALANCHE LUMINESCENT DIODE ARRAY

DIFFUSED SILICON PLANAR* DEVICE

GENERAL DESCRIPTION — The Fairchild Avalanche Luminescent Diode Array, FLA-611, is a data recording device containing 192 light emitting diffused silicon-planar diodes (arranged in a 6-column, 32-row diode matrix). These diodes emit light to produce "dot" patterns on photographic emulsions by "contact printing." Monolithic construction on large area silicon substrates provide precise positioning of the individual diodes which results in efficiently arranged, easily read photographic data block recordings.



GENERAL

Typical current efficiency of visible light output of:	$\lambda < 0.65\,\mu$, 2×10^{11} photons/amp. sec. 2×10^{-5} lumen/amp. 7×10^{-8} watt/amp.
Uniformity of current efficiency:	$\pm$ 15%
Approximate color temperature	2500°K

INDIVIDUAL DIODE LIGHT SOURCE CONFIGURATION

Light is emitted from the perimeter of a 0.002" square. The light-emitting line width is approximately 20 microinches. The metallization pattern masks 0.001" of the center of two opposite sides of the diode to leave 0.006" of light-emitting line.

INDIVIDUAL LIGHT-EMITTING ELEMENT

Light emission is obtained by operating the diode in the reverse bias avalanche mode. Typical diode operating parameters are:

$5.8 \leq V_R \leq 12.5$ volts

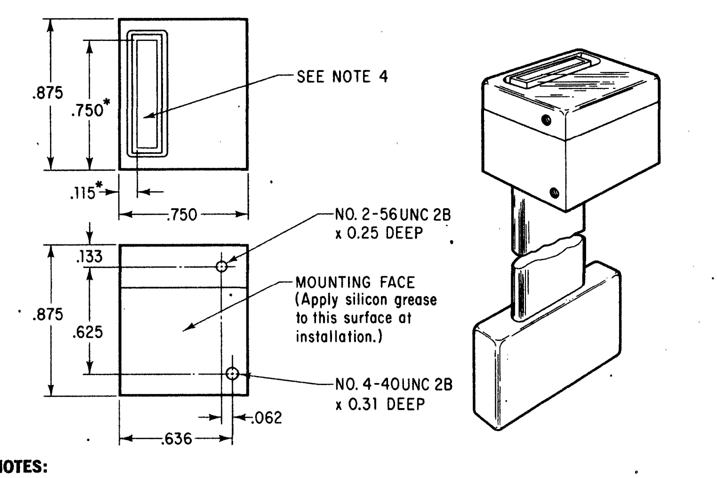
$20 \leq I_R \leq 100$ mA

where

V_R = voltage between any pair of, each, row and column pins at the connector

I_R = current at any row pin of the connector

PACKAGE OUTLINE



NOTES:

(1) Cable Terminates in Connector: U.S. Components, Inc. #SMI-42 F2-HRSL-DM30
(2) Cable length 17" standard.
(3) Starred dimensions indicate center lines of 1st row and 1st column of the light sources in the matrix array.
(4) Handle film plane surface with **EXTREME CARE** to prevent scratching or puncturing thin mylar film.

*Planar is a patented Fairchild process.

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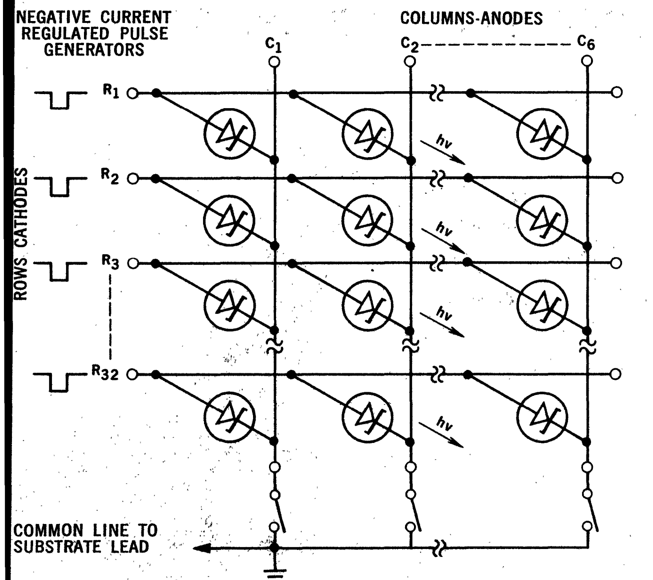
FAIRCHILD DIODE ARRAY FLA611

TYPICAL COLUMN SEQUENTIAL CIRCUIT



MAXIMUM PULSE LENGTH:	160 ms at 25 mA 40 ms at 50 mA 10 ms at 100 mA
MAXIMUM DUTY CYCLE PER DIODE:	50%

DIODE ARRAY

Peak power dissipation:	40 watts
Average power dissipation, maximum:	5.5 watts
Maximum duty cycle per column: @ 100 mA per Diode:	50%
Effective thermal time constant of package:	~ 10 sec.

NORMAL OPERATIONAL MODE

The normal mode of operation of the FLA-610 is column sequential; one column, or 32 anode set, at a time is activated; any combination of the 32-row, or cathodes, is driven simultaneously by negative independent current-regulated pulses. A separate substrate lead is supplied which can be connected to the common column lead. (This is recommended for use with current levels > 70 mA/diode.)

SPECIAL OPERATIONAL MODES

A large number of operating arrangements may be used. For special applications information should be obtained from Fairchild Semiconductor before installation.

PHYSICAL DESCRIPTION

The array is 6 elements wide by 32 elements long. Electrical connection is made via 6 anode leads and 32 cathode leads. Connections to the silicon chip are arranged to minimize current densities in the device metallization. The package body is electrically isolated (> 1.0 megohm at 50 volts) from the array and its connections.

ARRAY

Light emitting diode size:	0.002″ x 0.002″
Center-to-center spacings:	0.018″ each way, (6 x 32)
Array size (to corner-device centers):	0.090″ x 0.558″

PACKAGE

Dimensions, external:	(See physical dimensions drawing)
Distance of silicon surface below package face, equivalent optical path in air:	0.004″ maximum

MOUNTING

The package is designed for minimum thermal resistance from the array to the side mounting surface. When operating near maximum power rating, mounting support should be kept below +55°C.

For film located within 0.001″ of face of the FLA-611 and with emulsion facing same:

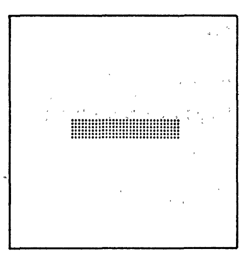
Dot shape:	Circular
Dot diameter, nominal:	0.008″
Peak optical density of dot for prescribed conditions:	> 1.3

Exposure Index: Daylight-20 (Kodak Panatomic - X, Type 4400)

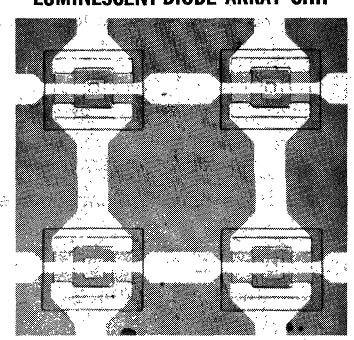
3 ms pulse at 50 mA

Developed in D 19 at +68°F, for 5 min.

TYPICAL TEST EXPOSURE

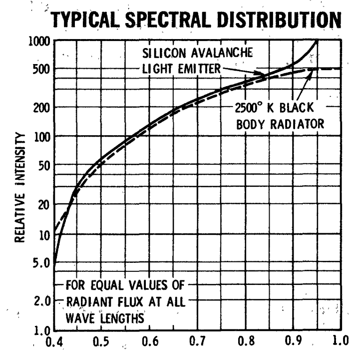


LUMINESCENT DIODE ARRAY CHIP



(ENLARGED 50X)

TYPICAL SPECTRAL DISTRIBUTION

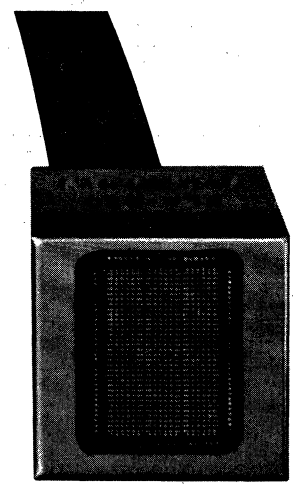


FLA-630

AVALANCHE LUMINESCENT DIODE ARRAY

DIFFUSED SILICON PLANAR* DEVICE

GENERAL DESCRIPTION - The Fairchild Avalanche Luminescent Diode Array, FLA-630 is intended primarily as a data recording device containing 576 light-emitting diffused silicon-planar diodes (arranged in three adjacent 6-column, 32-row arrays to form an 18 by 32 diode matrix). These diodes emit light to produce "dot" patterns on photographic emulsions by "contact printing." Monolithic construction on large area silicon substrates provides precise positioning of the individual diodes, which results in efficiently arranged, non-ambiguous easily read photographic data block recordings.



GENERAL

Typical current efficiency of visible light output of:	$\lambda < 0.65\,\mu$, approximate 2×10^{11} photons/amp. second 2×10^{-5} lumen/amp. 7×10^{-8} watt/amp.
Uniformity of current efficiency:	±15%
Approximate color temperature:	2500°K

INDIVIDUAL DIODE LIGHT SOURCE CONFIGURATION

Light is emitted from the perimeter of a 0.002" square. The light-emitting line width is approximately 20 microinches. The metalization pattern masks 0.001" of the center of two opposite sides of the diode to leave 0.006" of light-emitting line.

INDIVIDUAL LIGHT-EMITTING ELEMENT

Light emission is obtained by operating the diode in the reverse bias mode. Typical diode operating parameters are:

$$5.8 \leq V_R \leq 13.3 \text{ volts}$$

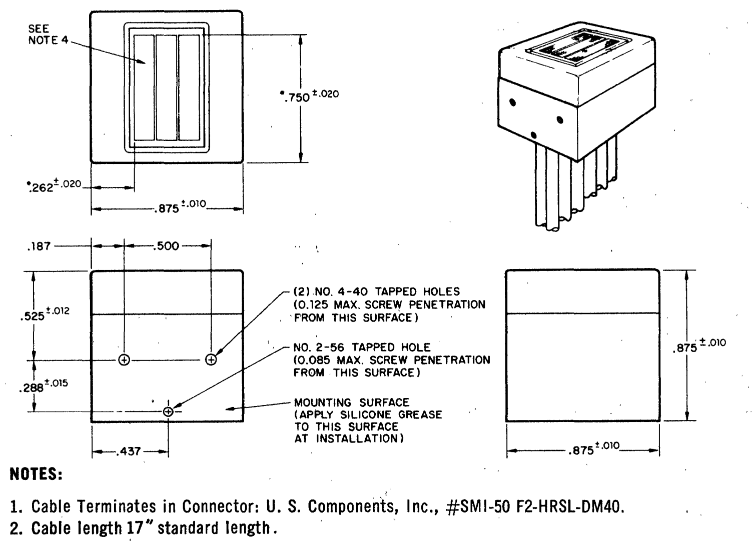
$$0 \leq I_R \leq 100 \text{ mA}$$

where

V_R = voltage between any pair of, each, row and column pins at the connector

I_R = current at any row pin of the connector

PACKAGE OUTLINE



NOTES:

1. Cable Terminates in Connector: U. S. Components, Inc., #SMI-50 F2-HRSL-DM40.
2. Cable length 17" standard length.
3. Starred dimensions indicate center lines of 1st row and 1st column of the light sources in the matrix array.
4. Handle film plane surface with **EXTREME CARE** to prevent scratching or puncturing thin mylar film.

* Planar is a patented Fairchild process.

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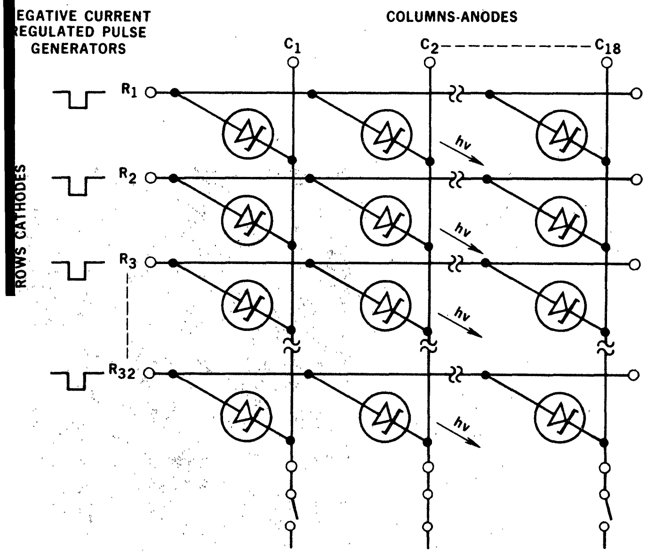
FAIRCHILD DIODE ARRAY FLA-630

'YPICAL COLUMN SEQUENTIAL CIRCUIT



1AXIMUM PULSE LENGTH:	160 ms	at 25 mA
	40 ms	at 50 mA
	10 ms	at 100 mA
1AXIMUM DUTY CYCLE PER)IODE:	50%	

)IODE ARRAY

'eak power dissipation:	40 watts
Average power dissipation, naximum:	15 watts
Aaximum duty cycle per :olumn: @ 100 mA per diode.	50%
Effective thermal time :onstant of package:	~ 10 seconds

NORMAL OPERATIONAL MODE

The normal mode of operation of the FLA-630 is column sequential; one column, or 32 anode set, at a time is activated; any combination of the 32-row, or cathodes, are driven simultaneously by independent negative current-regulated pulses. A separate substrate lead is supplied which can be connected to the common column lead. (This is recommended for use with current levels >70mA/diode).

SPECIAL OPERATIONAL MODES

A large number of operating arrangements may be used. For special applications information should be obtained from Fairchild Semiconductor before installation.

PHYSICAL DESCRIPTION

The array is 18 elements wide by 32 elements long. Electrical connection is made via 18 anode leads and 32 cathode leads. Connections to the silicon chip are arranged to minimize current densities in the device metalization. The package body is electrically isolated (>1.0 megohm at 50 volts) from the array and its connections.

ARRAY

Light emitting diode size:	0.002" x 0.002"
Center-to-center spacings:	0.018" each way in 3 blocks of 6 x 32 devices each
Array size (to corner-device centers):	0.344" x 0.558"

PACKAGE

Dimensions, external:	(See physical dimensions drawing)
Distance of silicon surface below package face, equivalent optical path in air:	0.004" maximum

MOUNTING

The package is designed for minimum thermal resistance from the array to the side mounting surface. When operating near maximum power rating, mounting support should be kept below 55°C.

For film located within 0.001" of face of FLA-630 assembly and with emulsion facing same:

Dot shape:	Circular
Dot diameter, nominal:	0.008"
Peak optical density of dot for prescribed conditions:	>1.3

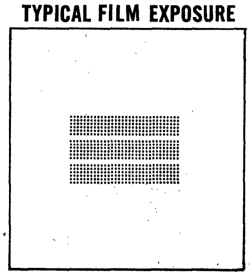
Exposure Index: Daylight-20 (Kodak Panatomic - X, Type 4400)

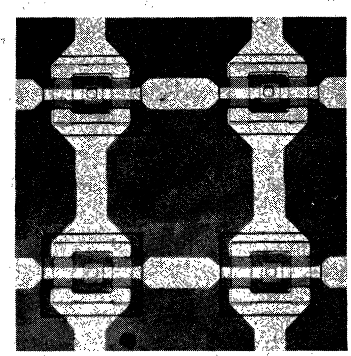
3 msec pulse at 50 mA

Developed in D19 at 68°F for 5 min.

LUMINESCENT DIODE ARRAY CHIP

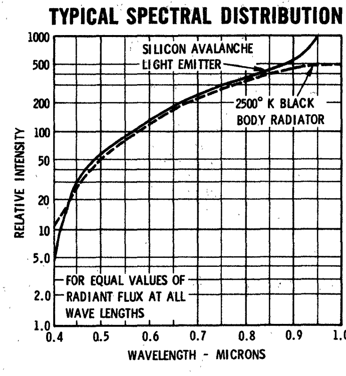
TYPICAL FILM EXPOSURE





(ENLARGED 50X)

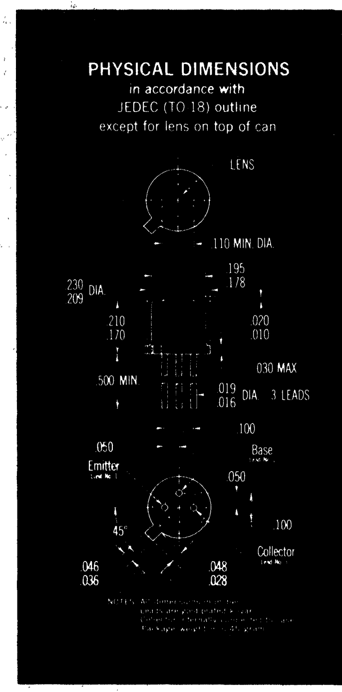
TYPICAL SPECTRAL DISTRIBUTION



2N986 • 2N2452

NPN PLANAR PHOTOTRANSISTORS

GENERAL DESCRIPTION - The 2N986 and 2N2452 are three-terminal NPN Planar phototransistors having exceptionally stable characteristics and high illumination sensitivity. The availability of the base lead gives wide latitude for flexible circuit design.



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 & 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 (Note 7)

V_{CBO}	Collector to Base Voltage		100 Volts
V_{CER}	Collector to Emitter Sustaining Voltage ($R_{BE} \leq 10\,\Omega$)	(Note 4)	80 Volts
V_{CEO}	Collector to Emitter Sustaining 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		2N986 Min.	2N986 Max.	2N2452 Min.	2N2452 Max.	Units	Test Conditions	
I_{CBO}	Collector Dark Current	(Note 7)		10		10	nA	V_{CB} = 80 V	
I_{CBO}(150°C)	Collector Dark Current	(Note 7)		25		25	μA	V_{CB} = 80 V	
S_{CE}	Sensitivity Radiation System	(Notes 5 & 9)	20	60	50	200	μA/mW/cm^2	V_{CE} = 25 V	
S_{CE}	Sensitivity Illumination System	(Notes 6 & 9)	1.0	3.1	2.6	10.3	μA/ft-can	V_{CE} = 25 V	
S_{CB}	Sensitivity Radiation System	(Notes 5 & 10)	0.2	1.0	0.2	1.0	μA/mW/cm^2	V_{CB} = 25 V	
S_{CB}	Sensitivity Illumination System	(Notes 6 & 10)	0.01	0.05	0.01	0.05	μA/ft-can	V_{CB} = 25 V	
t_r	Light Current Rise Time	(Note 8)		1.0		1.0	μsec		
t_f	Light Current Fall Time	(Note 8)		10		10	μsec		
BV_{CBO}	Collector to Base Breakdown Voltage	(Note 7)	100		100		Volts	I_C = 0.1 mA	I_E = 0
V_{CER}	Collector to Emitter Sustaining	(Note 7)	80		80		Volts	I_C = 100 mA (pulsed)	$R_{BE} \leq 10\ \Omega$
V_{CEO}	Collector to Emitter Sustaining Voltage	(Note 7)	60		60		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	(Note 7)	7.0		7.0		Volts	I_C = 0	I_E = 0.1 mA

NOTES:

(1) These ratings are limiting values above which the serviceability of 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 97.2°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.

(NOTES CONTINUED ON PAGE 2)

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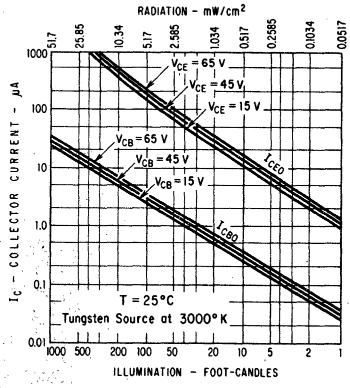
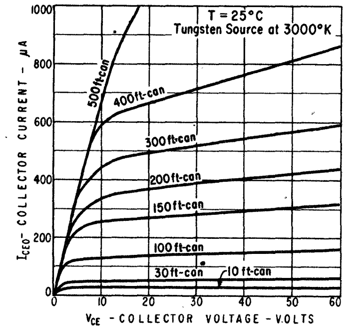
TYPICAL ELECTRICAL CHARACTERISTICS

2N986

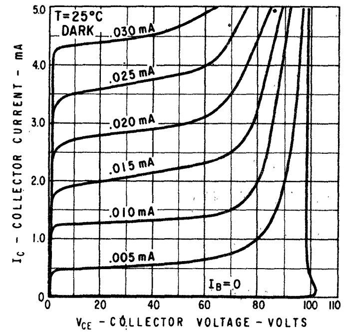
LIGHT CURRENT CHARACTERISTICS



LIGHT CURRENT VERSUS COLLECTOR VOLTAGE

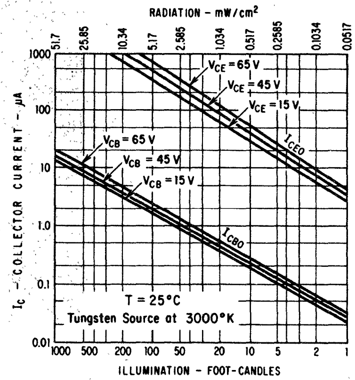


COLLECTOR CHARACTERISTICS*

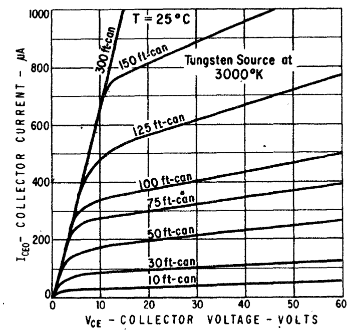


2N2452

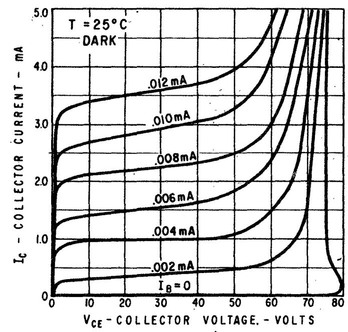
LIGHT CURRENT CHARACTERISTICS



LIGHT CURRENT VERSUS COLLECTOR VOLTAGE

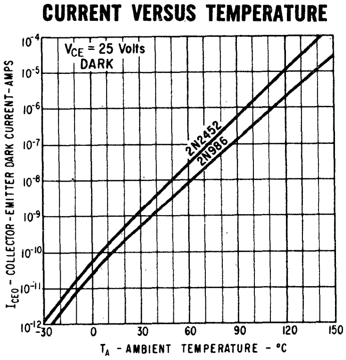


COLLECTOR CHARACTERISTICS*

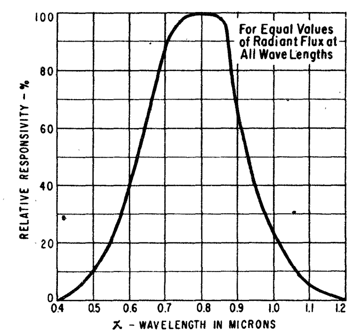


2N986 and 2N2452

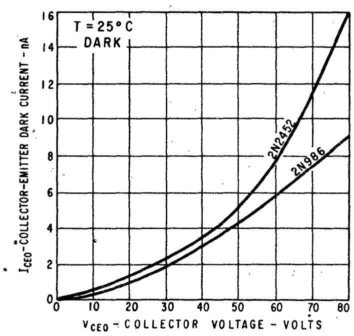
COLLECTOR-EMITTER DARK CURRENT VERSUS TEMPERATURE



SPECTRAL CHARACTERISTICS

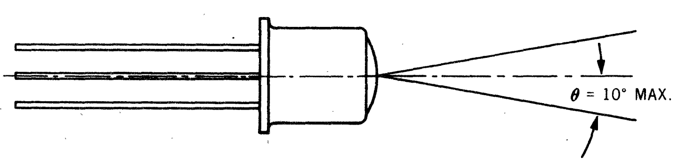


COLLECTOR-EMITTER DARK CURRENT VERSUS VOLTAGE



* Single family characteristics on Transistor Curve Tracer.

AXIAL ALIGNMENT



NOTE: The axis of maximum sensitivity shall be within a 10° cone with reference to the central axis of the device.

NOTES *(continued)*

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

(5) Measured at radiation flux intensity of 5.0 mW/cm^2 as emitted from a tungsten filament lamp at a color temperature of 3000°K.

(6) These are values obtained at an illumination level of 100 foot-candles from a tungsten filament lamp operated at a color temperature of 3000°K. All production tests are performed as stated in Note 5. For more information send for Fairchild Publication APP-47.

(7) Measured with radiation flux intensity of less than 5 μW/cm^2 over the spectrum from 0.1 micron to 1.5 microns.

(8) Rise time is defined as the time required for I_{CE} to rise from 10% to 90% of a peak value of 1.0 milliampere. Fall time is defined as the time required for I_{CE} to decrease from 90% to 10% of a peak value of 1.0 milliampere. For more information send for Fairchild Publication APP-93.

(9) No electrical connection to base lead.

(10) No electrical connection to emitter lead.

2N997

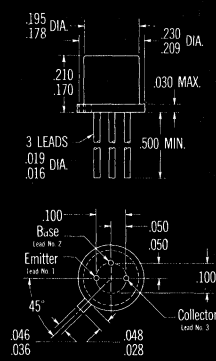
NPN HIGH GAIN COMPOUND AMPLIFIER

DIFFUSED SILICON PLANAR*TRANSISTOR

FOR IMPROVED PERFORMANCE
SEE FAIRCHILD 2N99

GENERAL DESCRIPTION - The Fairchild 2N997 contains two NPN silicon PLANAR transistors connected as a compound amplifier. It is designed primarily for circuits requiring very high gain and high input impedance.

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 0.4 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures		
Storage Temperature		-65°C to +300°C
Maximum Power Dissipation		
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)		1.5 Watts
at 25°C Free Air Temperature (Notes 2 and 3)		0.5 Watt
Maximum Voltages and Currents		
V_{CBO}	Collector to Base Voltage	75 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	40 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts
I_C	Collector Current	300 mA
I_B	Base Current	50 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)	7,000	70,000		I_C = 100 mA	V_{CE} = 10 V
h_{FE}	DC Pulse Current Gain (Note 5)	4,000			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	DC Current Gain	1,000			I_C = 100 μA	V_{CE} = 10 V
h_{FE}(-55°C)	DC Pulse Current Gain (Note 5)	1,000			I_C = 100 mA	V_{CE} = 10 V
V_{CE}(sat)	Collector-Emitter Saturation Voltage (Note 5)		1.6	Volts	I_C = 100 mA	I_B = 1.0 mA
V_{BE}	Base-Emitter Voltage (Note 5)	0.9	1.8	Volts	I_C = 100 mA	V_{CE} = 10 V
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
I_{EBO}	Emitter Cutoff Current		10	nA	I_C = 0	V_{EB} = 5.0 V
BV_{CBO}	Collector to Base Breakdown Voltage	75		Volts	I_C = 100 μA	I_E = 0
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Note 5)	40		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

* 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 100°C/Watt (derating factor of 10 mW/°C); junction-to-ambient thermal resistance of 300°C/Watt (derating factor of 3.33 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%.

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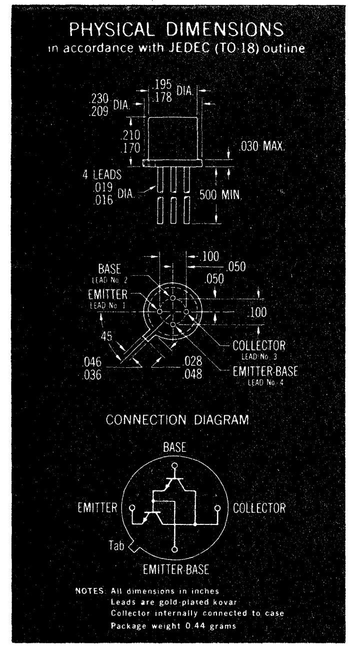
2N998

NPN ULTRA HIGH GAIN COMPOUND AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTOR

GENERAL DESCRIPTION - The 2N998 is a 4 terminal device containing two high gain silicon Planar transistors connected as a Darlington compound amplifier in one hermetically sealed enclosure. This device is particularly useful in circuits requiring a very high gain, high input impedance and low noise unit. A fourth lead is provided making all terminals of both devices accessible.



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 & 3]	1.8 Watts
at 100°C Case Temperature		[Note 2 & 3]	1.0 Watt
at 25°C Ambient Temperature			0.5 Watt
Maximum Voltages			
V_{CBO}	Collector to Base Voltage		100 Volts
V_{CEO}	Collector to Emitter Voltage	[Note 4]	60 Volts
V_{EBO}	Emitter to Base Voltage		15 Volts

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	Pulsed DC Current Gain [Note 5]	1600	8000		I_C = 10 mA	V_{CE} = 5.0 V
h_{FE}	Pulsed DC Current Gain [Note 5]	2000			I_C = 100 mA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	800			I_C = 1.0 mA	V_{CE} = 5.0 V
V_{BE} (sat)	Base Saturation Voltage		1.8	Volts	I_C = 50 mA	I_B = 0.5 mA
V_{CE} (sat)	Collector Saturation Voltage		1.2	Volts	I_C = 50 mA	I_B = 0.5 mA
C_{obo}	Output Capacitance		30	pF	I_E = 0	V_{CB} = 10 V
C_{TE}	Emitter Transition Capacitance		50	pF	I_C = 0	V_{EB} = 0.5 V
I_{CBO}	Collector Cutoff Current		10	mμA	I_E = 0	V_{CB} = 90 V
I_{CBO} (150°C)	Collector Cutoff Current		15	μA	I_E = 0	V_{CB} = 90 V
I_{EBO}	Emitter Cutoff Current		10	mμA	I_C = 0	V_{EB} = 10 V
BV_{CBO}	Collector to Base Breakdown Voltage	100		Volts	I_C = 100 μA	I_E = 0
V_{CEO}	Collector to Emitter Sustaining Voltage [Note 4]	60		Volts	I_C = 30 mA (Pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	15		Volts	I_C = 0	I_E = 100 μA
NF	Noise Figure [Note 6] (Power Bandwidth = 200 Hz)		6.0	dB	I_C = 0.1 mA, f = 1.0 kHz	V_{CE} = 10 V, R_g = 5.0 Kohms

* 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.

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

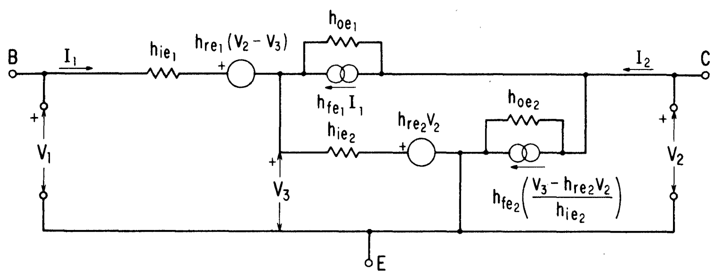
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

(6) Measured with a constant-current supply of 20 μA connected to the emitter of the input transistor.

SMALL SIGNAL ANALYSIS

The common emitter hybrid parameters of the compound amplifier may be determined by analysis of the equivalent circuit shown below.



By definition:

$$h_{ie} = \left.\frac{V_1}{I_1}\right/_{V_2 = 0} \qquad h_{oe} = \left.\frac{I_2}{V_2}\right/_{I_1 = 0} \qquad h_{re} = \left.\frac{V_1}{V_2}\right/_{I_1 = 0} \qquad h_{fe} = \left.\frac{I_2}{I_1}\right/_{V_2 = 0}$$

The exact expressions can be shown to be:

$$h_{ie} = h_{ie_1} + \frac{(1 - h_{re_1})(1 + h_{fe_1})\, h_{ie_2}}{h_{oe_1} h_{ie_2} + 1}$$

$$h_{fe} = h_{fe_1} + \frac{(h_{fe_2} - h_{oe_1} h_{ie_2})(1 + h_{fe_1})}{h_{oe_1} h_{ie_2} + 1}$$

$$h_{oe} = h_{oe_2} + \frac{(1 + h_{fe_2})(1 - h_{re_2})\, h_{oe_1}}{h_{oe_1} h_{ie_2} + 1}$$

$$h_{re} = h_{re_2} + \frac{(h_{ie_2} h_{oe_1} + h_{re_1})(1 - h_{re_2})}{h_{oe_1} h_{ie_2} + 1}$$

Where the subscripts 1 and 2 refer to the input and output transistors, respectively.

By considering typical values of the h parameters of the individual transistors we can make the following statements:

$$h_{oe_1} h_{ie_2} \ll 1 \qquad h_{re_1} \ll 1$$

$$h_{oe_1} h_{ie_2} \ll h_{fe_2} \qquad h_{re_2} \ll 1$$

The above equations suggest these approximate formulas for the h parameters:

$$h_{ie} \simeq h_{ie_1} + h_{ie_2} + h_{fe_1} h_{ie_2} \qquad h_{re} \simeq h_{re_1} + h_{re_2} + h_{ie_2} h_{oe_1}$$

$$h_{oe} \simeq h_{oe_1} + h_{oe_2} + h_{fe_2} h_{oe_1} \qquad h_{fe} \simeq h_{fe_1} + h_{fe_2} + h_{fe_1} h_{fe_2}$$

COMMON EMITTER PARAMETERS MEASURED AT f = 1 kHz, I_C = 1 mA, V_{CE} = 5 V

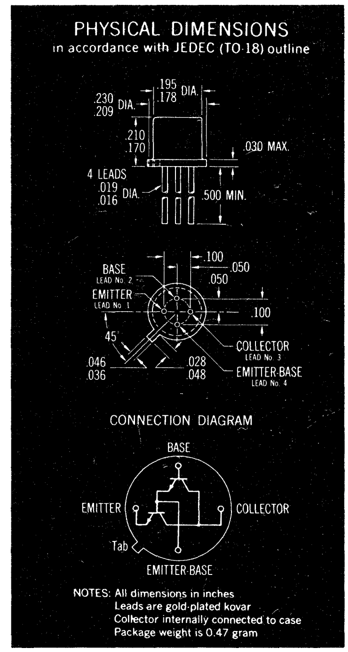
Symbol	Characteristic	Typical Value
h_{ie}	Input resistance, output shorted	40 k ohms
h_{oe}	Output conductance, input open	130 μmhos
h_{re}	Reverse open-circuit voltage amplification factor	4 x 10^{-3}
h_{fe}	Forward short-circuit current amplification factor	1200

2N999

NPN HIGH GAIN COMPOUND AMPLIFIER

DIFFUSED SILICON PLANAR* TRANSISTOR

GENERAL DESCRIPTION - The Fairchild 2N999 is a four terminal device containing two high-gain silicon PLANAR transistors connected as a compound amplifier in one hermetically sealed enclosure. This device is particularly useful in circuits requiring very high gain and high input impedance.



ABSOLUTE MAXIMUM RATINGS AS A COMPOUND AMPLIFIER (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)	1.8 Watts
at 100°C Case Temperature (Notes 2 and 3)	1.0 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.5 Watt

Maximum Voltages and Current

V_{CBO}	Collector to Base Voltage	60 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	60 Volts
V_{EBO}	Emitter to Base Voltage	15 Volts
I_C	Collector Current	500 mA

ELECTRICAL CHARACTERISTICS AS A COMPOUND AMPLIFIER (25°C Free air temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
h_{FE}	Total DC Pulse Current Gain (Note 5)	7,000	70,000		I_C = 100 mA	V_{CE} = 10 V
h_{FE}	Total DC Pulse Current Gain (Note 5)	4,000			I_C = 10 mA	V_{CE} = 10 V
h_{FE}	Total DC Current Gain	1,000			I_C = 100 μA	V_{CE} = 10 V
h_{FE} (-55°C)	Total DC Pulse Current Gain (Note 5)	1,000			I_C = 100 mA	V_{CE} = 10 V
V_{CE} (sat)	Collector Saturation Voltage		1.6	Volts	I_C = 100 mA	I_B = 1.0 mA
V_{BE} (sat)	Base Saturation Voltage		1.8	Volts	I_C = 100 mA	I_B = 1.0 mA
C_{obo}	Output Capacitance		20	pF	I_E = 0	V_{CB} = 10 V
C_{TE}	Emitter Transition Capacitance		10	pF	I_C = 0	V_{EB} = 0.5 V
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
I_{EBO}	Emitter Cutoff Current		10	nA	I_C = 0	V_{EB} = 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)	60		Volts	I_C = 30 mA (pulsed)	I_B = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	15		Volts	I_C = 0	I_E = 100 μA

* 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.

(3) These ratings give a maximum junction temperature of 200°C and junction-to-case thermal resistance of 97.2°C/Watt (derating factor of 10.3 mW/°C); junction-to-ambient thermal resistance of 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 = 1%.

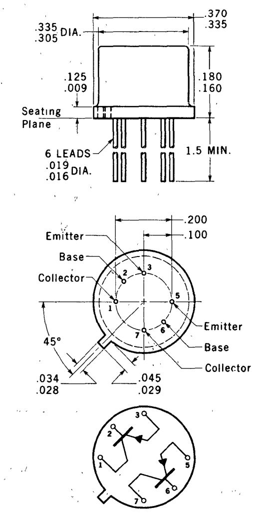
FT1718A THROUGH FT1718E

PNP HIGH-GAIN, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* II EPITAXIAL TRANSISTORS

- **TIGHT BETA MATCH . . . . 10% (MAX) AT 100 μA TO 1.0 mA**
- **LOW V_{BE} DIFFERENTIAL CHANGE . . . 10 μV/°C (MAX) AT 100 μA TO 1.0 mA**
- **LOW V_{BE} DIFFERENTIAL . . . . 1.5 mV (MAX) AT 100 μA**
- **HIGH BETA . . . . 160-350 AT 100 μA**
- **HIGH f_T . . . . 450 MHz (MIN) AT 10 mA**
- **LOW NOISE FIGURE . . . . 6.0 dB (MAX) AT 100 MHz**

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 1.08 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 2 and 3)	**One Side**	**Both Sides**
Total Dissipation at 25°C Case Temperature	0.635 Watt	1.1 Watts
at 25°C Ambient Temperature	0.33 Watt	0.432 Watt
Maximum Voltages and Current for Each Transistor	**FT1718A through FT1718D**	**FT1718E**
V_{CBO} Collector to Base Voltage	−40 Volts	−20 Volts
V_{CEO} Collector to Emitter Voltage (Note 4)	−40 Volts	−20 Volts
V_{EBO} Emitter to Base Voltage	−5.0 Volts	−5.0 Volts
I_C Collector Current	100 mA	100 mA

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

SYMBOL	CHARACTERISTICS	FT1718A FT1718B MIN.	TYP.	MAX.	FT1718C FT1718D MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{FE1}/h_{FE2}	**DC Current Gain Ratio** (Note 5)	**0.9**	**0.95**	**1.0**	0.9	0.95	1.0		**I_C = 100 μA TO 1.0 mA, V_{CE} = −5.0 V**
h_{FE1}/h_{FE2}	DC Current Gain Ratio Change (Note 5) (−55°C < +125°C)	0.85	0.93	1.0	0.85	0.93	1.0		I_C = 100 μA to 1.0 mA, V_{CE} = −5.0 V
$\lvert V_{BE1} - V_{BE2}\rvert$	**Base to Emitter Voltage Differential**		**0.9**	**1.5**		1.8	3.0	mV	**I_C = 100 μA V_{CE} = −5.0 V**
$\lvert V_{BE1} - V_{BE2}\rvert$	Base to Emitter Voltage Differential		1.25	2.0		2.0	3.5	mV	I_C = 100 μA to 1.0 mA, V_{CE} = −5.0 V
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base to Emitter Voltage Differential Change (−55°C to +25°C)**		**0.5**	**0.8**		1.0	1.6	mV	**I_C = 100 μA to 1.0 mA, V_{CE} = −5.0 V**
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base to Emitter Voltage Differential Change (+25°C to +125°C)**		**0.75**	**1.0**		1.5	2.0	mV	**I_C = 100 μA to 1.0 mA, V_{CE} = −5.0 V**

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

SYMBOL	CHARACTERISTICS	FT1718A FT1718C MIN.	TYP.	MAX.	FT1718B FT1718D MIN.	TYP.	MAX.	FT1718E MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS
h_{FE}	DC Current Gain	70	160		20	50		20	50			I_C = 10 μA V_{CE} = −5.0 V
h_{FE}	**DC Current Gain**	**160**	**200**	**350**	70	125	250	70	125	350		**I_C = 100 μA V_{CE} = −5.0 V**
h_{FE}	DC Current Gain	160	225		70	150		70	150			I_C = 1.0 mA V_{CE} = −5.0 V
h_{FE}	DC Pulse Current Gain (Note 6)	160	225		70	150		70	150			I_C = 10 mA V_{CE} = −5.0 V
h_{FE}(−55°C)	DC Current Gain	70	100		30	60		30	60			I_C = 1.0 mA V_{CE} = −5.0 V
h_{fe}	High Frequency Current Gain (f=100 MHz)	2.5	3.2		2.0	2.2		2.0	2.5			I_C = 1.0 mA V_{CE} = −20 V
h_{fe}	**High Frequency Current Gain (f=100 MHz)**	**4.5**	**6.0**		4.0	5.0		4.0	5.0			**I_C = 10 mA V_{CE} = −20 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.)

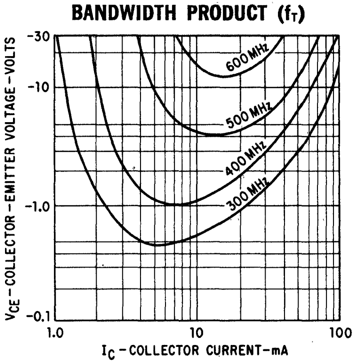
SYMBOL	CHARACTERISTICS	FT1718A FT1718C MIN.	TYP.	MAX.	FT1718B FT1718D MIN.	TYP.	MAX.	FT1718E MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
$V_{CE(sat)}$	Collector Saturation Voltage		−0.07	−0.13		−0.07	−0.13		−0.07	−0.13	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
$V_{CE(sat)}$	**Pulsed Collector Saturation Voltage** (Note 6)		**−0.1**	**−0.14**		−0.1	−0.14		−0.1	−0.14	Volts	**$I_C = 10$ mA**	**$I_B = 1.0$ mA**
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 6)		−0.2	−0.3		−0.2	−0.3		−0.2	−0.3	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
$V_{BE(sat)}$	Base Saturation Voltage		−0.65	−0.75		−0.65	−0.75		−0.65	−0.75	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)	−0.7	−0.77	−0.9	−0.7	−0.77	−0.9	−0.7	−0.77	−0.9	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 6)		−0.88	−1.1		−0.88	−1.1		−0.88	−1.1	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CES}	Collector Reverse Current		0.3	15		0.3	15				nA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES}(+125°C)	Collector Reverse Current		0.04	15		0.04	15				μA	$V_{CE} = -30$ V	$V_{BE} = 0$
I_{CES}	Collector Reverse Current								0.2	15	nA	$V_{CE} = -15$ V	$V_{BE} = 0$
I_{CES}(+125°C)	Collector Reverse Current								0.03	15	μA	$V_{CE} = -15$ V	$V_{BE} = 0$
$V_{CEO(sus)}$	**Collector to Emitter Sustaining Voltage** (Notes 2 and 6)	**−40**			−40			−20			Volts	**$I_C = 10$ mA**	**$I_B = 0$**
BV_{CBO}	Collector to Base Breakdown Voltage	−40			−40			−20			Volts	$I_C = 10$ μA	$I_E = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−40			−40			−20			Volts	$I_C = 10$ μA	$V_{BE} = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0			−5.0			−5.0			Volts	$I_C = 0$	$I_E = 10$ μA
C_{cb}	Collector to Base Capacitance		2.2	3.5		2.2	3.5		2.2	3.5	pF	$I_E = 0$	$V_{CB} = -10$ V
C_{eb}	Emitter to Base Capacitance		4.0	5.5		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**	**6.0**		3.5	6.0		3.5	6.0	dB	**$I_C = 1.0$ mA**	**$V_{CE} = -5.0$ V**
$r_b'C_c$	Collector Base Time Constant (f = 80 MHz)		20	40		20	40		20	40	ps	$I_C = 10$ mA	$V_{CE} = -20$ V

NOTES:

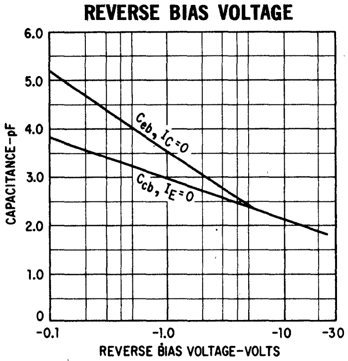
(1) These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction to ambient thermal resistance of 530°C/Watt (derating factor of 1.89 mW/°C) for one side; 405°C/Watt (derating factor of 2.47 mW/°C) for both sides. Junction to case thermal resistance of 275°C/Watt (derating factor of 3.62 mW/°C) for one side; 160°C/Watt (derating factor of 6.29 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FEl} for purposes of this ratio.
(6) Pulse Conditions: length = 300 μs; duty cycle = 1%.

TYPICAL ELECTRICAL CHARACTERISTICS
(FT1718A THROUGH FT1718D)

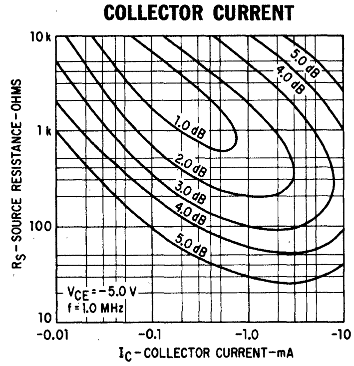
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



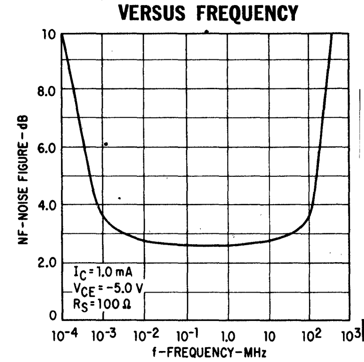
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



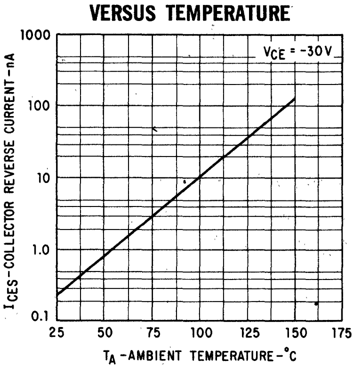
NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT



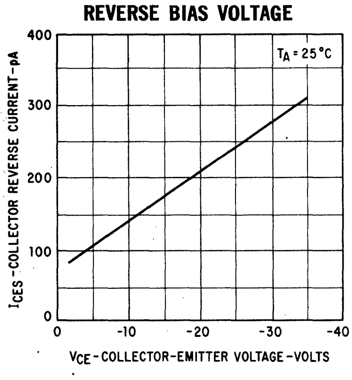
NOISE FIGURE VERSUS FREQUENCY



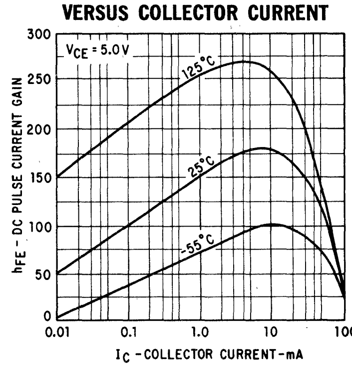
COLLECTOR-BASE REVERSE CURRENT VERSUS TEMPERATURE



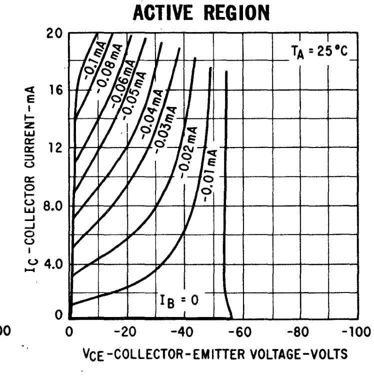
COLLECTOR-BASE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

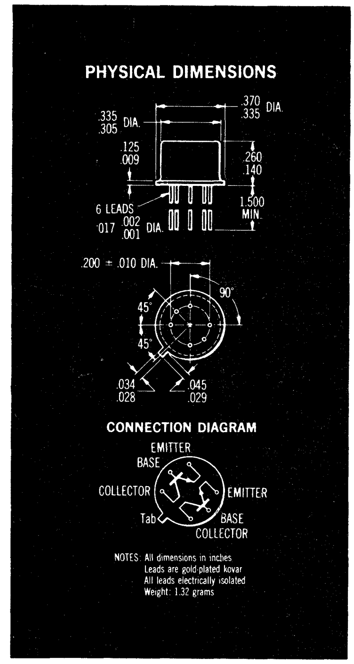


COLLECTOR CHARACTERISTICS ACTIVE REGION



2N2060 • 2N2060A • 2N2060B
NPN DIFFERENTIAL AMPLIFIERS
DIFFUSED SILICON PLANAR TRANSISTORS

TIGHT V_{BE} MATCHING -- 1.5 mV MAX. @ 100 μA to 1.0 mA
h_{FE} MATCH -- 10% MAX. @ 100 μA to 1.0 mA
h_{FE} MATCH -- TEMPERATURE GUARANTEE -- 15% MAX. @ 100 μA to 1.0 mA, $-55°C$ to $+125°C$
TIGHT V_{BE} TRACKING -- 5 μV/°C MAX. @ 100 μA, $-55°C$ to $+125°C$



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

	One Side	Both Sides
Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	1.5 Watts	3.0 Watts
at 100°C Case Temperature [Notes 2 and 3]	0.86 Watt	1.7 Watts
at 25°C Ambient Temperature [Notes 2 and 3]	0.5 Watt	0.6 Watt

Maximum Voltages and Current for Each Transistor

V_{CBO}	Collector to Base Voltage	100 Volts
V_{CER}	Collector to Emitter Voltage (Note 4)	80 Volts
V_{CEO}	Collector to Emitter Voltage (Note 4)	60 Volts
V_{EBO}	Emitter to Base Voltage	7.0 Volts
I_C	Collector Current	500 mA
$V_{C1\,C2}$	Collector$_1$ to Collector$_2$ Voltage	±200 Volts

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

SYMBOL	† FACT Subgroup	CHARACTERISTIC	2N2060 MIN.	2N2060 MAX.	2N2060A MIN.	2N2060A MAX.	2N2060B MIN.	2N2060B MAX.	UNITS	TEST CONDITIONS
* h_{FE1}/h_{FE2}	1a	**DC Current Gain Ratio** (Note 5)	**0.9**	**1.0**	**0.9**	**1.0**	**0.9**	**1.0**		**I_C = 100 μA to 1.0 mA** V_{CE} = 5.0 V
h_{FE1}/h_{FE2}	4	**DC Current Gain Ratio** (Note 5) **(T_A = −55°C to +125°C)**					**0.85**	**1.0**		**I_C = 100 μA to 1.0 mA** V_{CE} = 5.0 V
* $\|V_{BE1} - V_{BE2}\|$	1a	Base-Emitter Voltage Differential		5.0		3.0		1.5	mV	I_C = 100 μA V_{CE} = 5.0 V
$\|V_{BE1} - V_{BE2}\|$	4	Base-Emitter Voltage Differential		5.0		5.0		1.5	mV	I_C = 1.0 mA V_{CE} = 5.0 V
$\|V_{BE1} - V_{BE2}\|$	4	**Base-Emitter Voltage Differential**						**1.5**	**mV**	**I_C = 100 μA to 1.0 mA** V_{CE} = 5.0 V
$\|\Delta (V_{BE1} - V_{BE2})\|$	4	**Base-Emitter Voltage Differential Change (T_A = 25°C to +125°C)**		1.0		0.5		**0.5**	**mV**	**I_C = 100 μA** V_{CE} = 5.0 V
$\|\Delta (V_{BE1} - V_{BE2})\|$	4	**Base-Emitter Voltage Differential Change (T_A = −55°C to +25°C)**		0.8		0.4		**0.4**	**mV**	**I_C = 100 μA** V_{CE} = 5.0 V
NF	4	Narrow Band Noise Figure (Each Transistor) (f = 1.0 kHz)		8.0		8.0		8.0	dB	I_C = 300 μA V_{CE} = 10 V P.B.W. = 200 Hz Rg = 510Ω
NF	4	Broad Band Noise Figure (Each Transistor) (Note 7)		8.0		8.0		8.0	dB	I_C = 300 μA V_{CE} = 10 V BROADBAND Rg = 1.0 kΩ

† **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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ELECTRICAL CHARACTERISTICS FOR EACH TRANSISTOR (25°C Free Air Temperature unless otherwise noted)

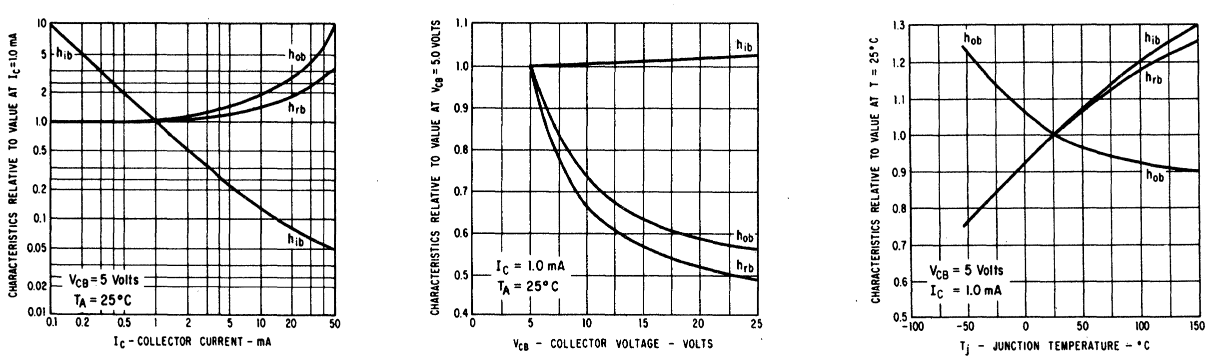
SYMBOL	† FACT Subgroup	CHARACTERISTIC	2N2060 MIN.	2N2060 MAX.	2N2060A MIN.	2N2060A MAX.	2N2060B MIN.	2N2060B MAX.	UNITS	TEST CONDITIONS	
h_{FE}	4	DC Pulse Current Gain (Note 6)	50	150	50	150	50	150		$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{FE}	4	DC Current Gain	40	120	40	120	40	120		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
*h_{FE}	1b	DC Current Gain	30	90	30	90	30	90		$I_C = 100\ \mu$A	$V_{CE} = 5.0$ V
h_{FE}	4	DC Current Gain	25	75	25	75	25	75		$I_C = 10\ \mu$A	$V_{CE} = 5.0$ V
*V_{BE}(sat)	1b	Pulsed Base Saturation Voltage (Note 6)		0.9		0.9		0.9	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
*V_{CE}(sat)	1b	Pulsed Collector Saturation Voltage (Note 6)		1.2		0.6		0.6	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
*I_{CBO}	1b	Collector Cutoff Current		2.0		2.0		2.0	nA	$I_E = 0$	$V_{CB} = 80$ V
I_{CBO}(150°C)	4	Collector Cutoff Current		10		10		10	μA	$I_E = 0$	$V_{CB} = 80$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	100		100		100		Volts	$I_C = 100\ \mu$A	$I_E = 0$
V_{CER}(sust)	4	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	80		80		80		Volts	$I_C = 100$ mA (pulsed)	$R_{BE} \leq 10\,\Omega$
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	60		60		60		Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	1a	Emitter Breakdown Voltage	7.0		7.0		7.0		Volts	$I_C = 0$	$I_E = 100\ \mu$A
*I_{EBO}	1b	Emitter Cutoff Current		2.0		2.0		2.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
h_{fe}	4	High Freqency Current Gain (f = 20 MHz)	3.0		3.0		3.0	8.0		$I_C = 50$ mA	$V_{CE} = 10$ V
C_{obo}	4	Open-Circuit Output Capacitance		15		15		15	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{ibo}	4	Open-Circuit Input Capacitance		85		85		85	pF	$I_C = 0$	$V_{EB} = 0.5$ V

SMALL SIGNAL CHARACTERISTICS FOR EACH TRANSISTOR (f = 1 kHz)

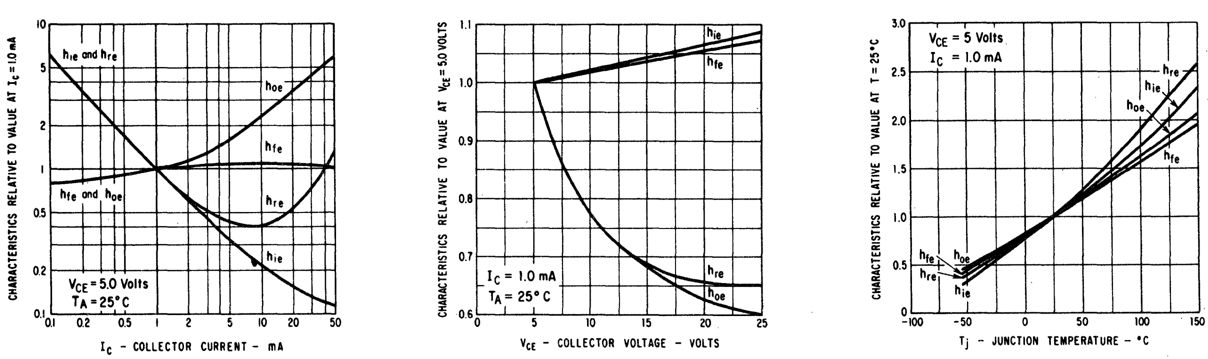
SYMBOL	† FACT Subgroup	CHARACTERISTIC	2N2060 MIN.	2N2060 MAX.	2N2060A MIN.	2N2060A MAX.	2N2060B MIN.	2N2060B MAX.	UNITS	TEST CONDITIONS	
h_{fe}	4	Small Signal Current Gain	50	150	50	150	50	150		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ie}	4	Input Resistance	1.0	4.0	1.0	4.0	1.0	4.0	kOhms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	4	Output Conductance	4.0	16	4.0	16	4.0	16	μmhos	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ib}	4	Input Resistance	20	30	20	30	20	30	Ohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	4	Voltage Feedback Ratio						10	x10^{-4}	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V

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

TYPICAL COMMON BASE CHARACTERISTICS

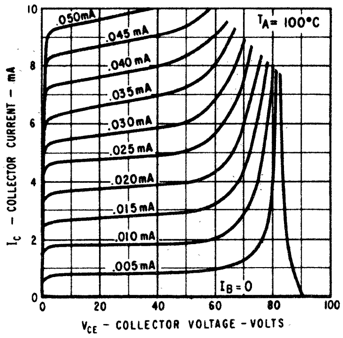


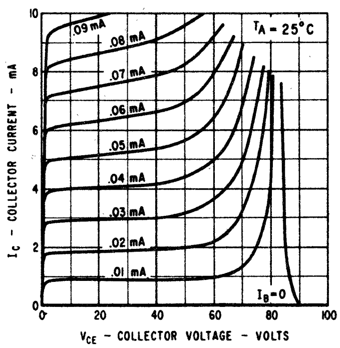
TYPICAL COMMON EMITTER CHARACTERISTICS

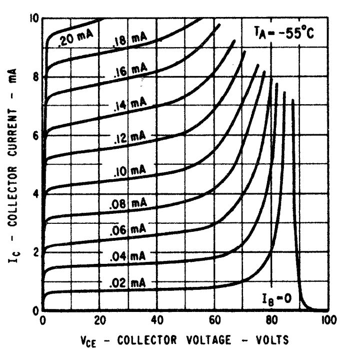


TYPICAL ELECTRICAL CHARACTERISTICS

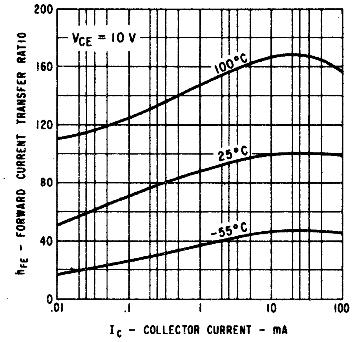
HIGH VOLTAGE COLLECTOR CHARACTERISTICS*



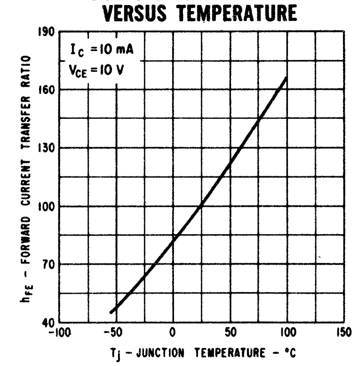




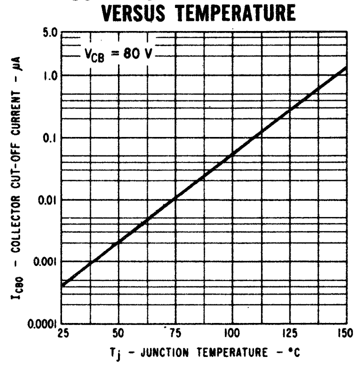
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



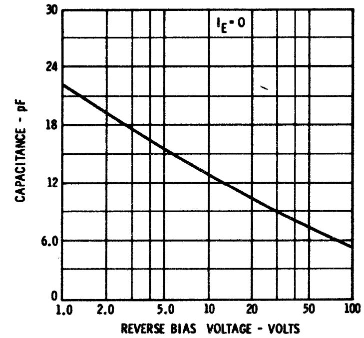
DC PULSE CURRENT GAIN VERSUS TEMPERATURE



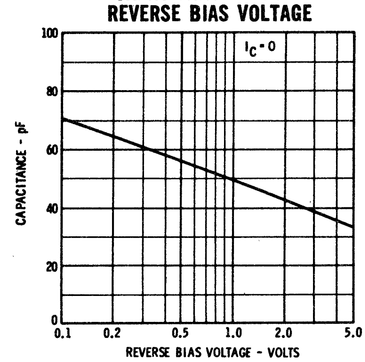
COLLECTOR CUTOFF CURRENT VERSUS TEMPERATURE



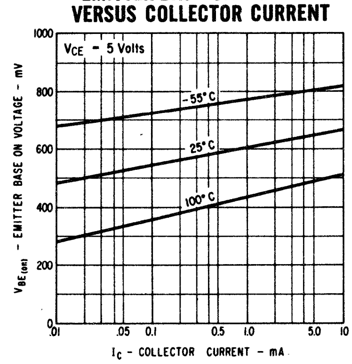
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

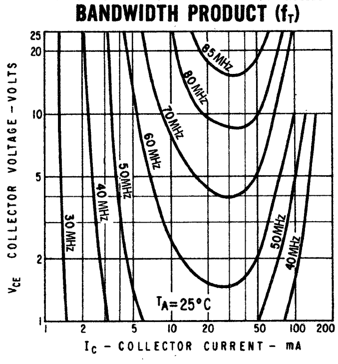


EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT

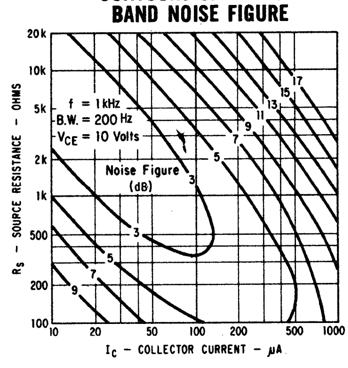


* Single family characteristics on Transistor Curve Tracer

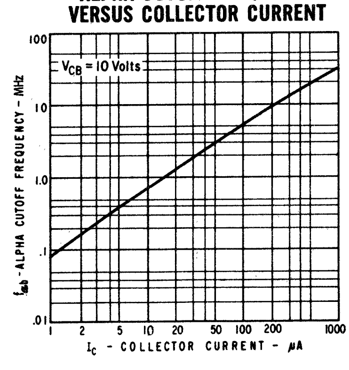
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



CONTOURS OF NARROW BAND NOISE FIGURE



ALPHA CUTOFF FREQUENCY VERSUS COLLECTOR CURRENT



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 117°C/watt (derating factor of 8.6 mW/°C) for one side; 58.3°C/watt (derating factor of 17.2 mW/°C) for both sides. Junction to ambient thermal resistance of 350°C/watt (derating factor of 2.86 mW/°C) for one side; 292°C/watt (derating factor of 3.43 mW/°C) for both sides.

(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) Lowest of the two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

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

(7) The amplifier used for this measurement has a power bandwidth of 15.7 kHz and a response which rolls off 6 dB per octave where the 3 dB points are approximately at 25 Hz and 10 kHz.

FAIRCHILD

SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N2913 • 2N2914 • 2N2972 • 2N2973

NPN LOW LEVEL, LOW NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

These six-terminal devices each contain two isolated high-gain, low-noise NPN double-diffused silicon PLANAR transistors in one hermetically sealed enclosure. They are designed for use in high performance amplifier and differential amplifier circuits requiring high-gain and low-noise at low current levels. The 2N2913 is an exact counterpart to the 2N2972 as is the 2N2914 to the 2N2973, only differences are packages and power ratings.

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	2N2913 2N2914 One Side	2N2913 2N2914 Both Sides	2N2972 2N2973 One Side	2N2972 2N2973 Both Sides
Total Dissipation at 25°C Case Temperature [Notes 2 & 3]	**0.75** Watt	**1.5** Watts	**0.5** Watt	**0.75** Watt
Total Dissipation at 100°C Case Temperature [Notes 2 & 3]	**0.43** Watt	**0.86** Watt	**0.29** Watt	**0.43** Watt
Total Dissipation at 25°C Ambient Temperature [Notes 2 & 3]	**0.3** Watt	**0.6** Watt	**0.25** Watt	**0.30** Watt

Maximum Voltages and Current for Each Transistor

V_{CBO}	Collector to Base Voltage	**45** 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

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

Symbol	Characteristics	2N2913 2N2972 Min.	2N2913 2N2972 Max.	2N2914 2N2973 Min.	2N2914 2N2973 Max.	Units	Test Conditions	
h_{FE}	DC Current Gain	60	240	150	600		$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage		0.35		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
I_{CBO}	Collector Cutoff Current		10		10	nA	$I_E = 0$	$V_{CB} = 45$ V
I_{CBO} (150°C)	Collector Cutoff Current		10		10	μA	$I_E = 0$	$V_{CB} = 45$ V
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 5]	45		45		Volts	$I_C = 10$ mA (pulsed)	$I_B = 0$
NF	Narrow Band Noise Figure [Note 6]		4.0		3.0	dB	$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
NF	Wide Band Noise Figure [Note 7]		4.0		3.0	dB	$I_C = 10\ \mu A$	$V_{CE} = 5.0$ 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-ambient thermal resistance of 584°C/watt (derating factor of 1.71 mW/°C) for one side; 292°C/watt (derating factor of 3.42 mW/°C) for both sides for the 2N2913 and 2N2914. For the 2N2972 and 2N2973 junction-to-ambient thermal resistance of 700°C/watt (derating factor of 1.43 mW/°C) for one side; 584°C/watt (derating factor of 1.71 mW/°C) for both sides.

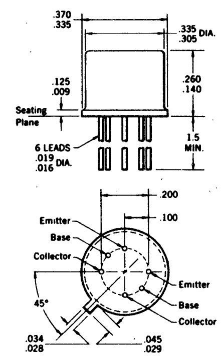
(4) Rating refers to a high current point where collector-to-emitter voltage is lowest. For more information send for Fairchild Publication APP-4.

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

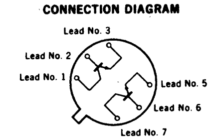
(NOTES CONTINUED ON PAGE 4)

*Planar is a patented Fairchild process.

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM

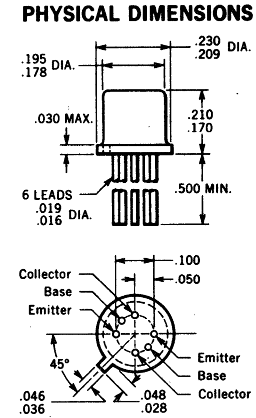


BOTTOM VIEW

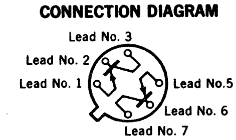
NOTES: All dimensions in inches
Leads are gold plated Kovar
Package weight is 1.23 grams

2N2913 2N2914

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM



BOTTOM VIEW

NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.62 gram

2N2972 2N2973

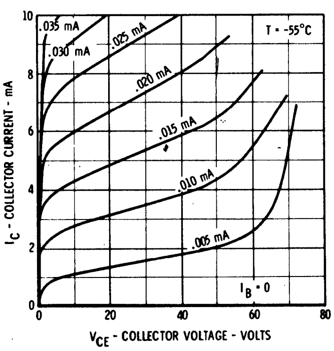
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

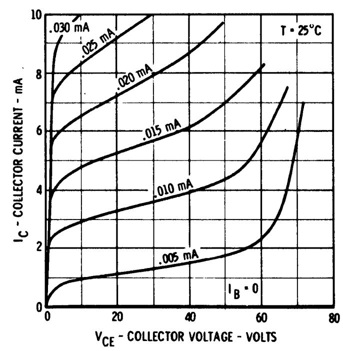
SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	150			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	100			$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	DC Current Gain	15			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
V_{BE} (on)	Emitter-Base On Voltage		0.7	Volts	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
I_{CEO}	Collector 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
C_{obo}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0			$I_C = 0.5$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance (f = 1 kHz)	25	32	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1 kHz)		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		Volts	$I_C = 10\ \mu A$	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$

TYPICAL ELECTRICAL CHARACTERISTICS

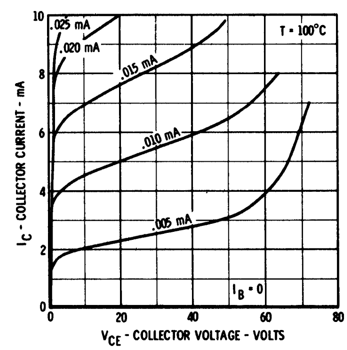
COLLECTOR CHARACTERISTICS



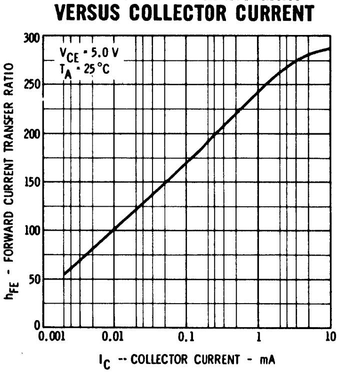
COLLECTOR CHARACTERISTICS



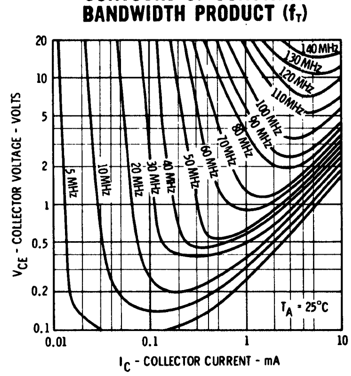
COLLECTOR CHARACTERISTICS



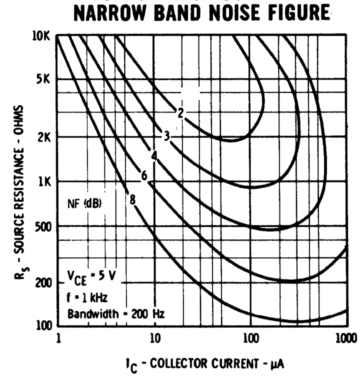
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



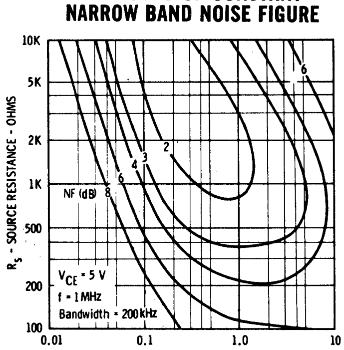
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



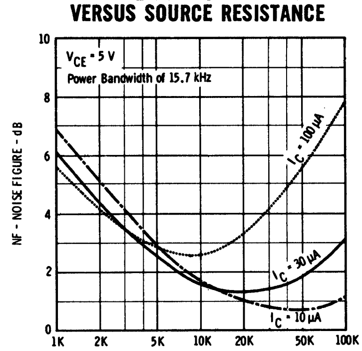
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

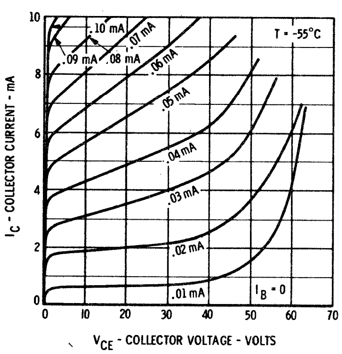


ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise noted)

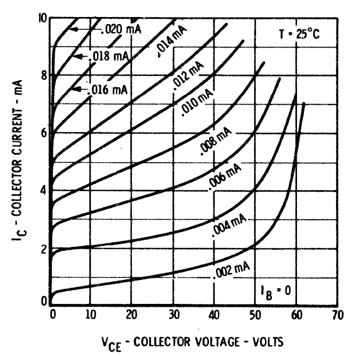
SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	300			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	225			$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	DC Current Gain	30			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
V_{BE} (on)	Emitter-Base On Voltage		0.7	Volts	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
I_{CEO}	Collector 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
C_{obo}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0			$I_C = 0.5$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance (f = 1 kHz)	25	32	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1 kHz)		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		Volts	$I_C = 10\ \mu A$	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$

TYPICAL ELECTRICAL CHARACTERISTICS

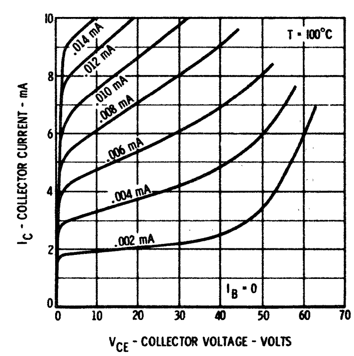
COLLECTOR CHARACTERISTICS



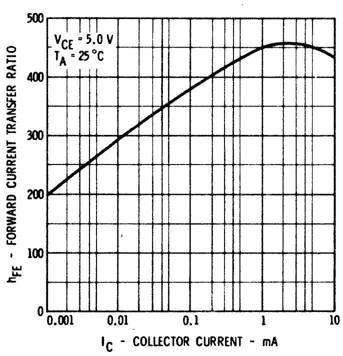
COLLECTOR CHARACTERISTICS



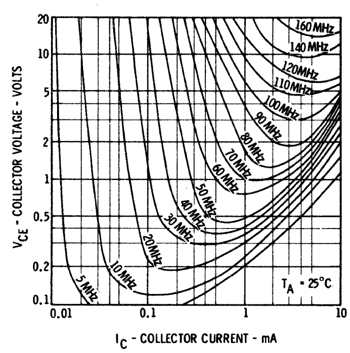
COLLECTOR CHARACTERISTICS



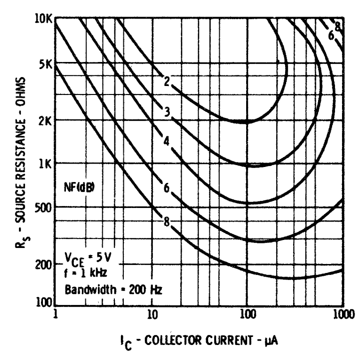
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



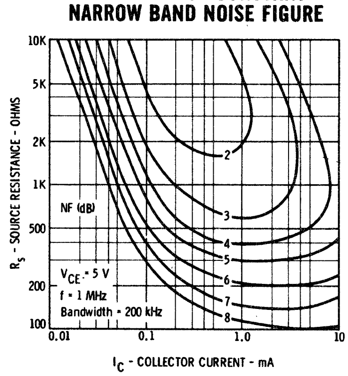
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



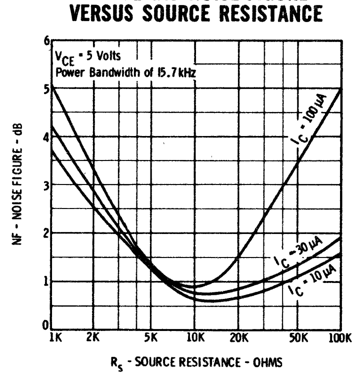
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



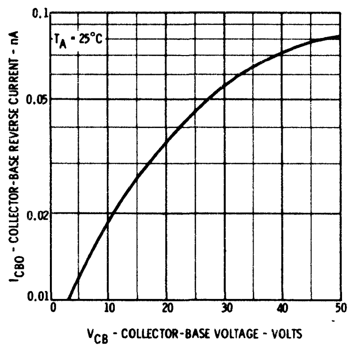
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



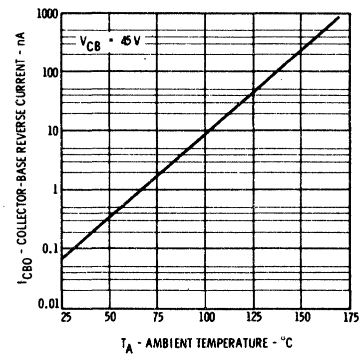
TYPICAL ELECTRICAL CHARACTERISTICS

(THESE CURVES APPLY TO ALL UNITS)

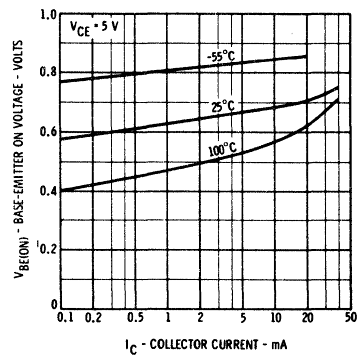
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



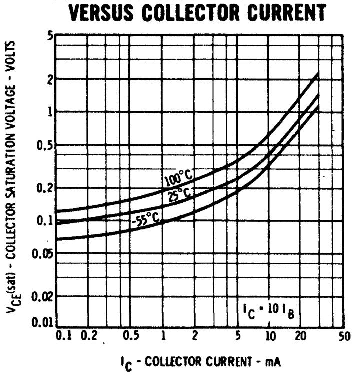
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



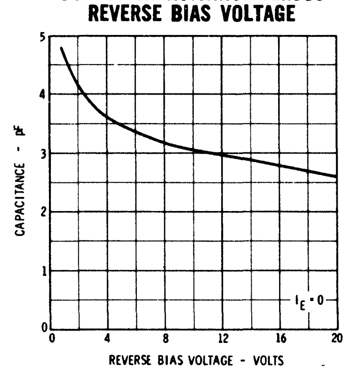
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



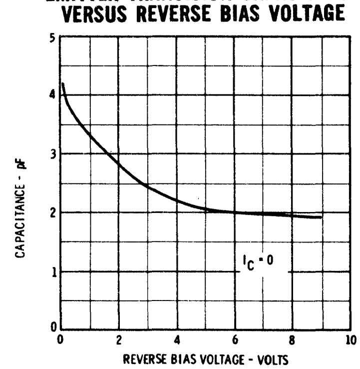
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



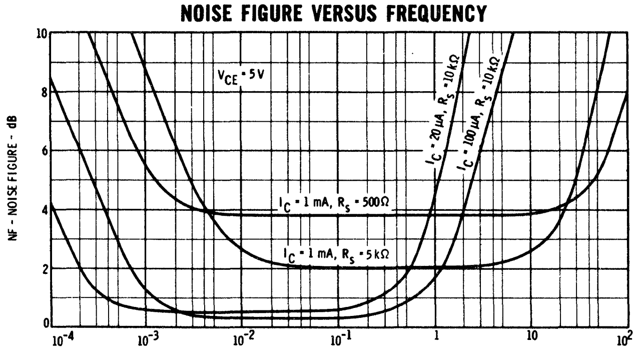
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



NOISE FIGURE VERSUS FREQUENCY



NOTES: (Continued)

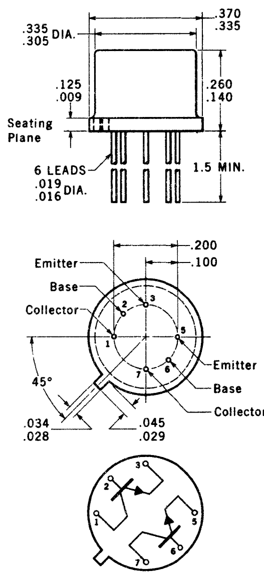
(6) Frequency = 1000 Hz; R_S = 10 kΩ; 200 cycle power bandwidth. For more information send for Fairchild Publication APP-13/2.

(7) The amplifier used for this measurement has a power bandwidth of 15.7 kHz and a response which rolls off 6 dB per octave where the 3 dB points are approximately at 25 Hz and 10 kHz R_S = 10 kΩ.

2N2915/2N2915A • 2N2919/2N2919A
2N2974/FT2974 • 2N2978/FT2978
NPN LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS
DIFFUSED SILICON PLANAR* TRANSISTORS

FEATURES
- **HIGH BREAKDOWN -- 60 VOLT LV_{CEO}**
- **HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT -- 60 MIN AT 10 μA**
- **TIGHT V_{BE} MATCHING -- 1.5 mV MAX AT 100 μA**
- **TIGHT V_{BE} TRACKING -- 5 μV/°C MAX AT 100 μA −55°C to +125°C**
- **BETA MATCH GUARANTEED OVER TEMPERATURE -- 15% MAX FROM 100 μA to 1.0 mA, −55°C to +125°C**
- **LOW NOISE -- 4.0 dB MAX AT 1 kHz**

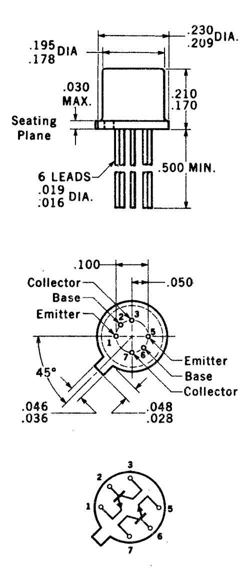
PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 1.27 grams

2N2915/2N2915A • 2N2919/2N2919A

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.59 gram

2N2974/FT2974 • 2N2978/FT2978

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

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

Maximum Power Dissipation [Notes 2 and 3]

	2N2915 **2N2915A** 2N2919 **2N2919A**		2N2974 **FT2974** 2N2978 **FT2978**	
	One Side	Both Sides	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	0.75 W	1.5 W	0.5 W	0.75 W
Total Dissipation at 100°C Case Temperature	0.43 W	0.86 W	0.29 W	0.43 W
Total Dissipation at 25°C Ambient Temperature	0.3 W	0.5 W	0.25 W	0.3 W

Maximum Voltages and Current for Each Transistor

		2N2915 **2N2915A** 2N2974 **FT2974**	2N2919 **2N2919A** 2N2978 **FT2978**
V_{CBO}	Collector to Base Voltage	45 V	60 V
V_{CEO}	Collector to Emitter Voltage [Note 4]	45 V	60 V
V_{EBO}	Emitter to Base Voltage	6.0 V	6.0 V
I_C	Collector Current	30 mA	30 mA

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

SYMBOL	CHARACTERISTIC	**2N2915A 2N2919A FT2974 FT2978** MIN.	MAX.	2N2915 2N2919 2N2974 2N2978 MIN.	MAX.	UNITS	TEST CONDITIONS
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio [Note 5]	0.9	1.0	0.9	1.0		I_C = 100 μA, V_{CE} = 5.0 V
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio (T_A = −55°C to +125°C)** [Note 5]	**0.85**	**1.0**				**I_C = 100 μA to 1.0 mA**, V_{CE} = 5.0 V
$\lvert V_{BE1}-V_{BE2}\rvert$	Base-Emitter Voltage Differential [Note 6]		2.0		5.0	mV	I_C = 10 μA to 1.0 mA, V_{CE} = 5.0 V
$\lvert V_{BE1}-V_{BE2}\rvert$	**Base-Emitter Voltage Differential** [Note 6]		**1.5**		3.0	**mV**	**I_C = 100 μA**, V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1}-V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change (T_A = −55°C to +25°C)**		**0.4 (5 μV/°C)**		0.8 (10 μV/°C)	**mV**	**I_C = 100 μA**, V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1}-V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change** (T_A = +25°C to +125°C)		**0.5 (5 μV/°C)**		1.0 (10 μV/°C)	**mV**	**I_C = 100 μA**, V_{CE} = 5.0 V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	8.0	3.0			I_C = 0.5 mA, V_{CE} = 5.0 V

Notes on page 4 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

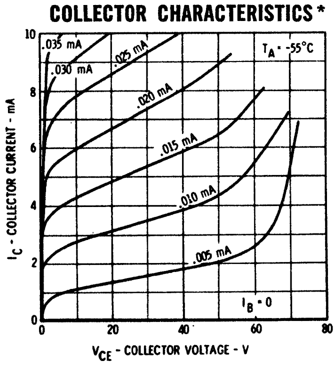
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

(FOR HIGHER CURRENT GAIN DEVICES REFER TO 2N2916 DATA SHEET)

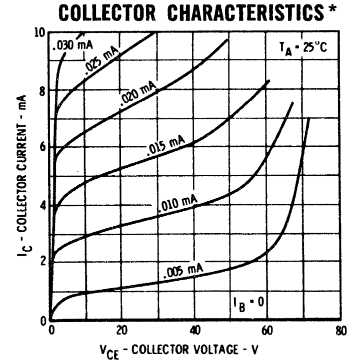
SYMBOL	CHARACTERISTIC	2N2915 **2N2915A** 2N2974 **FT2974** MIN.	MAX.	2N2919 **2N2919A** 2N2978 **FT2978** MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	Dc Current Gain	150		150			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	Dc Current Gain	100		100			$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	**Dc Current Gain**	**60**	**240**	**60**	**240**		**$I_C = 10\ \mu A$**	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	Dc Current Gain	15		15			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage		0.35		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{BE} (ON)	Emitter-Base ON Voltage		0.7		0.7	Volts	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
I_{CBO}	Collector Cutoff Current		10		2.0	nA	$I_E = 0$	$V_{CB} = 45$ V
I_{CBO} (150°C)	Collector Cutoff Current		10		10	μA	$I_E = 0$	$V_{CB} = 45$ V
I_{CEO}	Collector Cutoff Current		2.0		2.0	nA	$I_B = 0$	$V_{CE} = 5.0$ V
I_{EBO}	Emitter Cutoff Current		2.0		2.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{obo}	Output Capacitance (f = 140 kHz)		6.0		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{ib}	Input Resistance (f = 1.0 kHz)	25	32	25	32	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1.0 kHz)		1.0		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		60		Volts	$I_C = 10\ \mu A$	$I_E = 0$
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** (pulsed) [Notes 4 and 7]	**45**		**60**		**Volts**	$I_C = 10$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		6.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		**4.0**		**4.0**	**dB**	$I_C = 10\ \mu A$, $R_S = 10$ kΩ, PBW = 200 Hz,	$V_{CE} = 5.0$ V
NF	Wide Band Noise Figure (f = 10 Hz to 10 kHz)		4.0		4.0	dB	$I_C = 10\ \mu A$, $R_S = 10$ kΩ	$V_{CE} = 5.0$ V, PBW = 15.7 kHz
C_{ibo}	Input Capacitance (f = 1.0 MHz)	2N2915A • FT2974	10	2N2919A • FT2978	10	pF	$I_C = 0$	$V_{EB} = 0.5$ V

TYPICAL ELECTRICAL CHARACTERISTICS

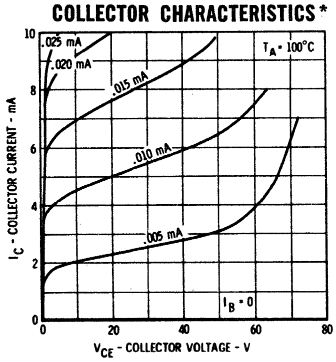
COLLECTOR CHARACTERISTICS*



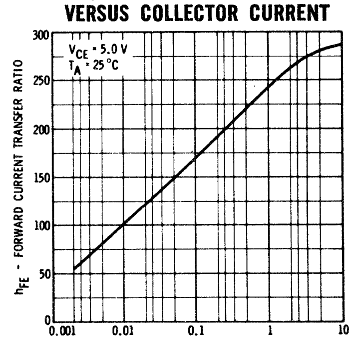
COLLECTOR CHARACTERISTICS*



COLLECTOR CHARACTERISTICS*

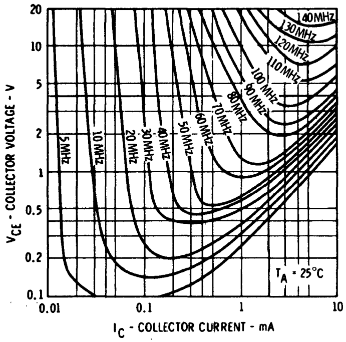


PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT

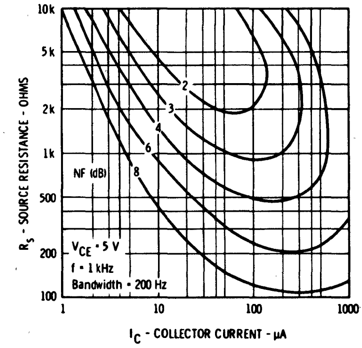


TYPICAL ELECTRICAL CHARACTERISTICS

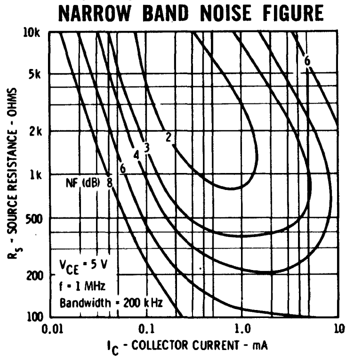
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



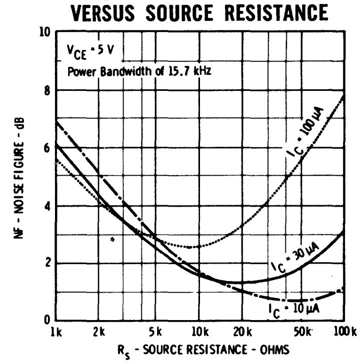
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



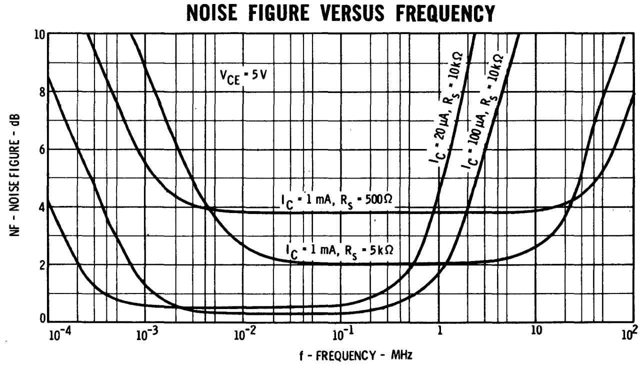
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

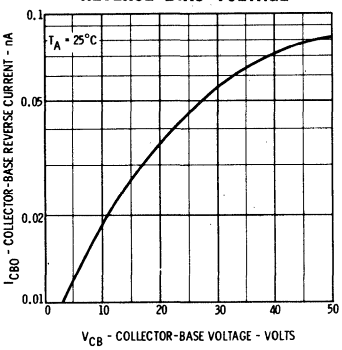


NOISE FIGURE VERSUS FREQUENCY

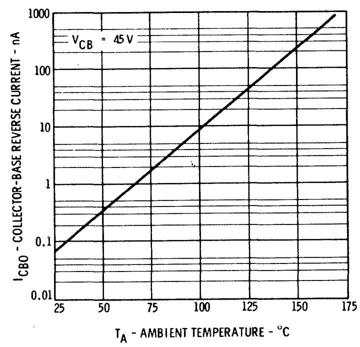


TYPICAL ELECTRICAL CHARACTERISTICS

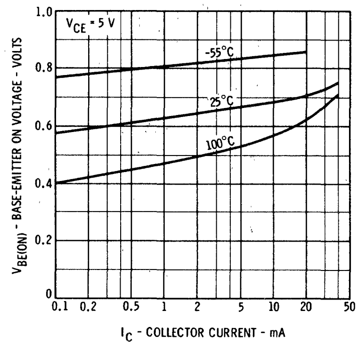
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



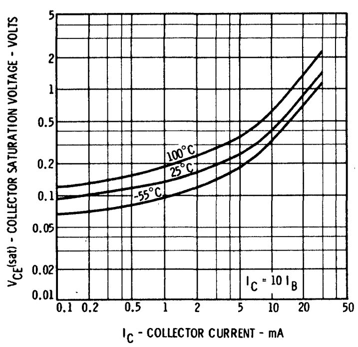
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



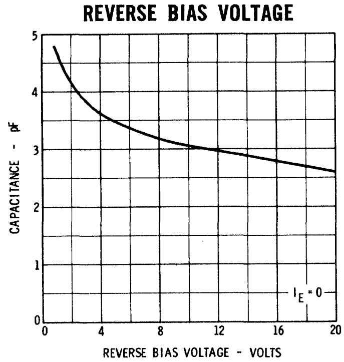
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



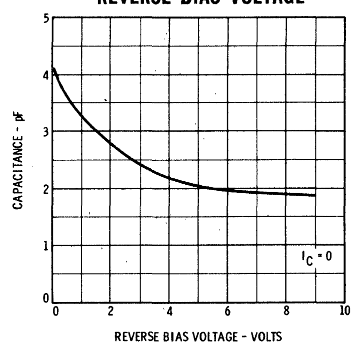
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



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 584°C/watt (derating factor of 1.71 mW/°C) for one side; 350°C/watt (derating factor of 2.86 mW/°C) for both sides for the 2N2915, 2N2915A, 2N2919, and 2N2919A. For the 2N2974, FT2974, 2N2978, and FT2978, junction to ambient thermal resistance of 700°C/watt (derating factor of 1.43 mW/°C) for one side; 584°C/watt (derating factor of 1.71 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Absolute values.
(7) Pulse Conditions: length = 300 μs; duty cycle = 1%.

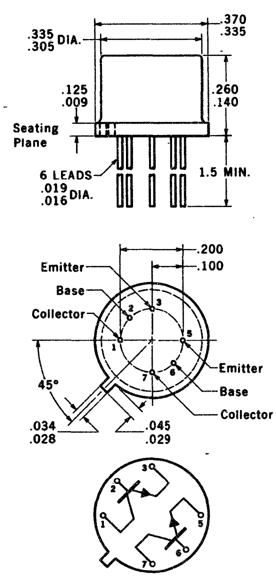
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N2916/2N2916A • 2N2920/2N2920A
2N2975/FT2975 • 2N2979/FT2979
NPN LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS
DIFFUSED SILICON PLANAR* TRANSISTORS

- **HIGH BREAKDOWN — 60 VOLT LV_{CEO}**
- **HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT — 150 MIN AT 10 μA**
- **TIGHT V_{BE} MATCHING — 1.5 mV MAX AT 100 μA**
- **TIGHT V_{BE} TRACKING — 5 μV/°C MAX AT 100 μA −55°C to +125°C**
- **BETA MATCH GUARANTEED OVER TEMPERATURE — 15% MAX FROM 100 μA to 1.0 mA, −55°C to +125°C**
- **LOW NOISE — 3.0 dB MAX AT 1 kHz**

* Planar is a patented Fairchild process.

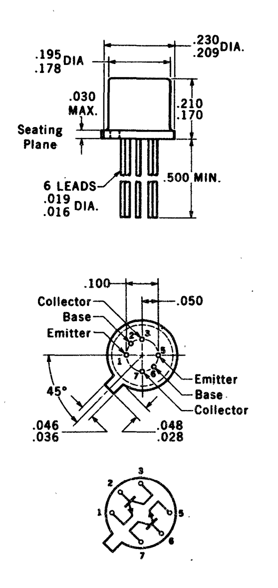
PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 1.27 grams

2N2916/2N2916A • 2N2920/2N2920A

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.59 gram

2N2975/FT2975 • 2N2979/FT2979

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

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

Maximum Power Dissipation [Notes 2 and 3]	2N2916 **2N2916A** 2N2920 **2N2920A**		2N2975 **FT2975** 2N2979 **FT2979**	
	One Side	Both Sides	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	0.75 W	1.5 W	0.5 W	0.75 W
Total Dissipation at 100°C Case Temperature	0.43 W	0.86 W	0.29 W	0.43 W
Total Dissipation at 25°C Ambient Temperature	0.3 W	0.5 W	0.25 W	0.3 W

Maximum Voltages and Current for Each Transistor		2N2916 **2N2916A** 2N2975 **FT2975**	2N2920 **2N2920A** 2N2979 **FT2979**
V_{CBO}	Collector to Base Voltage	45 V	60 V
V_{CEO}	Collector to Emitter Voltage [Note 4]	45 V	60 V
V_{EBO}	Emitter to Base Voltage	6.0 V	6.0 V
I_C	Collector Current	30 mA	30 mA

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

SYMBOL	CHARACTERISTIC	**2N2916A 2N2920A FT2975 FT2979** MIN.	MAX.	2N2916 2N2920 2N2975 2N2979 MIN.	MAX.	UNITS	TEST CONDITIONS
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio [Note 5]	0.9	1.0	0.9	1.0		I_C = 100 μA, V_{CE} = 5.0 V
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio (T_A = −55°C to +125°C)** [Note 5]	**0.85**	**1.0**				**I_C = 100 μA to 1.0 mA, V_{CE} = 5.0 V**
$\lvert V_{BE1}-V_{BE2}\rvert$	Base-Emitter Voltage Differential [Note 6]		2.0		5.0	mV	I_C = 10 μA to 1.0 mA, V_{CE} = 5.0 V
$\lvert V_{BE1}-V_{BE2}\rvert$	**Base-Emitter Voltage Differential** [Note 6]		**1.5**		3.0	**mV**	**I_C = 100 μA, V_{CE} = 5.0 V**
$\Delta(V_{BE1}-V_{BE2})$	**Base-Emitter Voltage Differential Change (T_A = −55°C to +25°C)**		**0.4 (5 μV/°C)**		0.8 (10 μV/°C)	**mV**	**I_C = 100 μA, V_{CE} = 5.0 V**
$\Delta(V_{BE1}-V_{BE2})$	**Base-Emitter Voltage Differential Change** (T_A = +25°C to +125°C)		**0.5 (5 μV/°C)**		1.0 (10 μV/°C)	**mV**	**I_C = 100 μA, V_{CE} = 5.0 V**
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	8.0	3.0			I_C = 0.5 mA, V_{CE} = 5.0 V

Notes on page 4

Additional Electrical Characteristics on page 2

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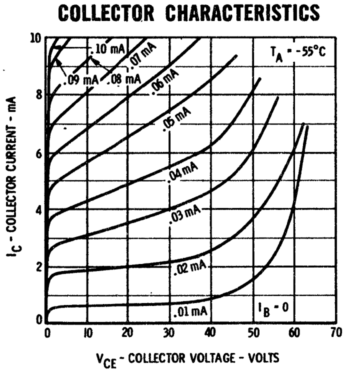
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

(FOR LOWER CURRENT GAIN DEVICES REFER TO 2N2915 DATA SHEET)

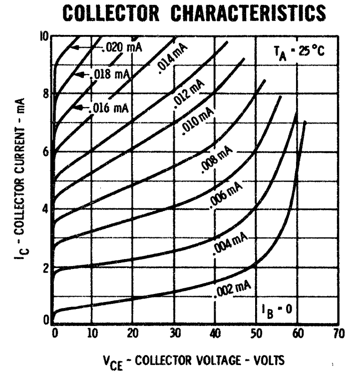
SYMBOL	CHARACTERISTIC	2N2916 **2N2916A** 2N2975 **FT2975** MIN.	MAX.	2N2920 **2N2920A** 2N2979 **FT2979** MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	300		300			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	225		225			$I_C = 100$ μA	$V_{CE} = 5.0$ V
h_{FE}	**DC Current Gain**	**150**	**600**	**150**	**600**		**$I_C = 10$ μA**	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	DC Current Gain 2N2916A • FT2975	40		40			$I_C = 10$ μA	$V_{CE} = 5.0$ V
h_{FE} (−55°C)	DC Current Gain	30					$I_C = 10$ μA	$V_{CE} = 5.0$ V
V_{CE} (sat)	Collector Saturation Voltage		0.35		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{BE} (ON)	Emitter-Base ON Voltage		0.7		0.7	Volts	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
I_{CBO}	Collector Cutoff Current		10		2.0	nA	$I_E = 0$	$V_{CB} = 45$ V
I_{CBO} (150°C)	Collector Cutoff Current		10		10	μA	$I_E = 0$	$V_{CB} = 45$ V
I_{CEO}	Collector Cutoff Current		2.0		2.0	nA	$I_B = 0$	$V_{CE} = 5.0$ V
I_{EBO}	Emitter Cutoff Current		2.0		2.0	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{obo}	Output Capacitance (f = 140 kHz)		6.0		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{ib}	Input Resistance (f = 1.0 kHz)	25	32	25	32	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1.0 kHz)		1.0		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		60		Volts	$I_C = 10$ μA	$I_E = 0$
V_{CEO} (sust)	**Collector to Emitter Sustaining Voltage** (pulsed) [Notes 4 and 7]	45		**60**		**Volts**	$I_C = 10$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		6.0		Volts	$I_E = 10$ μA	$I_C = 0$
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		**3.0**		**3.0**	**dB**	$I_C = 10$ μA, PBW = 200 Hz	$V_{CE} = 5.0$ V, $R_S = 10$ kΩ
NF	Wide Band Noise Figure (f = 10 Hz to 10 kHz)		3.0		3.0	dB	$I_C = 10$ μA, PBW = 15.7 kHz	$V_{CE} = 5.0$ V, $R_S = 10$ kΩ
C_{ibo}	Input Capacitance (f = 1.0 MHz)		2N2916A • FT2975 10		2N2920A • FT2979 10	pF	$I_C = 0$	$V_{EB} = 0.5$ V

TYPICAL ELECTRICAL CHARACTERISTICS

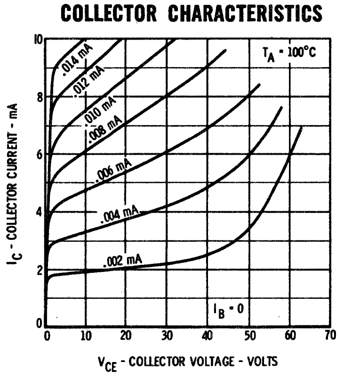
COLLECTOR CHARACTERISTICS



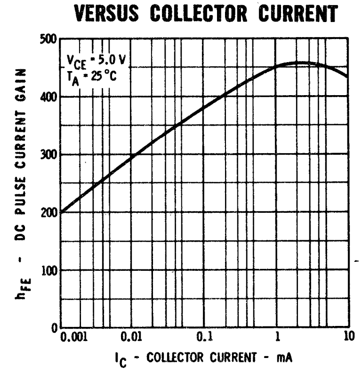
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS

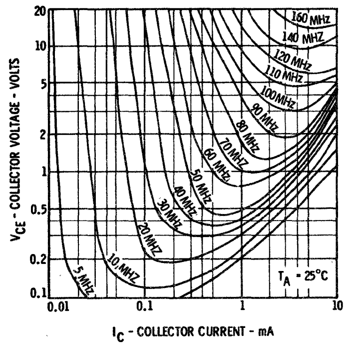


DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT

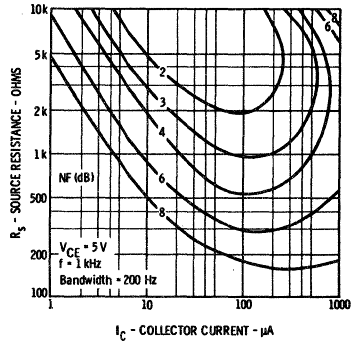


TYPICAL ELECTRICAL CHARACTERISTICS

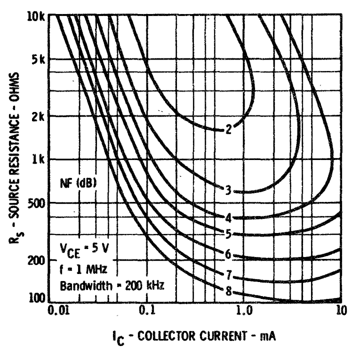
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



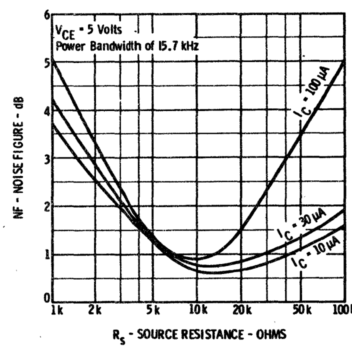
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



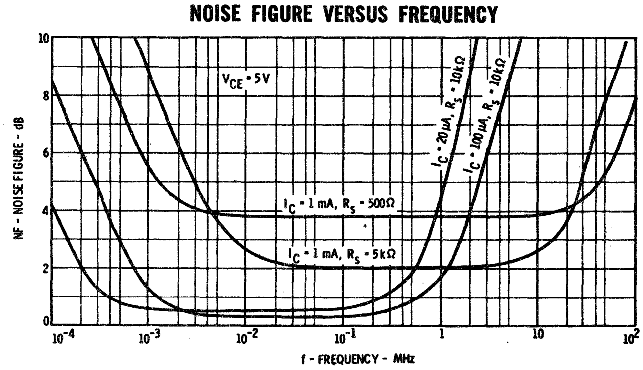
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

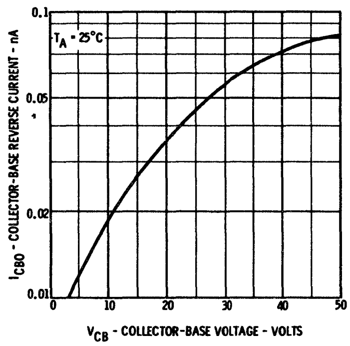


NOISE FIGURE VERSUS FREQUENCY

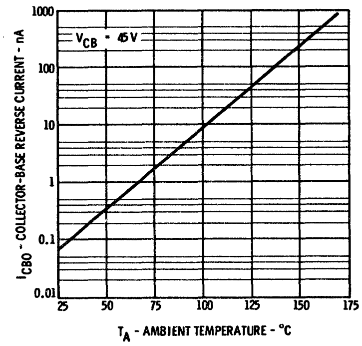


TYPICAL ELECTRICAL CHARACTERISTICS

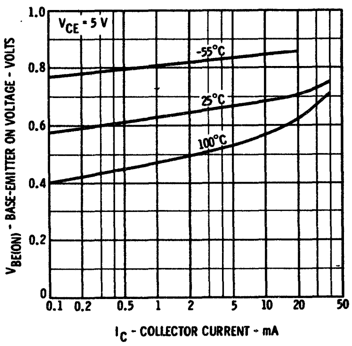
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



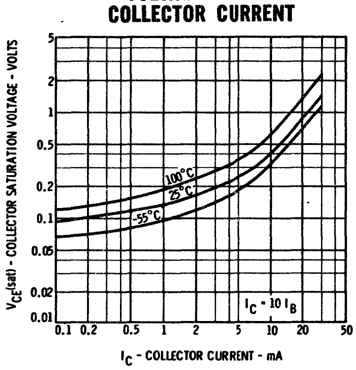
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



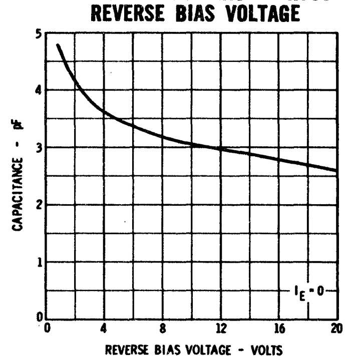
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



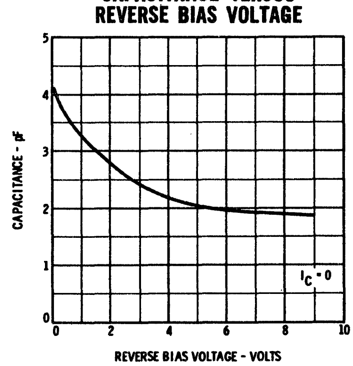
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



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 584°C/watt (derating factor of 1.71 mW/°C) for one side; 350°C/watt (derating factor of 2.86 mW/°C) for both sides for the 2N2916, 2N2916A, 2N2920, and 2N2920A. For the 2N2975, FT2975, 2N2979, and FT2979, junction to ambient thermal resistance of 700°C/watt (derating factor of 1.43 mW/°C) for one side; 584°C/watt (derating factor of 1.71 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Absolute values.
(7) Pulse Conditions: length = 300 μs; duty cycle = 1%.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N2917 • 2N2918 • 2N2976 • 2N2977

NPN LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

- **BETA RATIO** . . . . $\frac{h_{FE1}}{h_{FE2}}$ = 20% (MAX) AT 100 μA
- **V_{BE} MATCH** . . . . $|V_{BE1}-V_{BE2}|$ = 5.0 mV (MAX) AT 100 μA
  $|V_{BE1}-V_{BE2}|$ = 10 mV (MAX) FROM 10 μA TO 1.0 mA
- **V_{BE} TRACKING** . . . . ΔV_{BE} = 20 μV/°C (MAX) AT 100 μA
- **BREAKDOWN VOLTAGE** . . . LV_{CEO} = 45 V (MIN)
- **LOW NOISE** . . . . NF = 3.0 dB (MAX) WIDE BAND AND AT 1.0 kHz

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)	2N2917 2N2918 ONE SIDE	2N2917 2N2918 BOTH SIDES	2N2976 2N2977 ONE SIDE	2N2976 2N2977 BOTH SIDES
Total Dissipation at 25°C Case Temperature	0.75 Watt	1.5 Watts	0.5 Watt	0.75 Watt
at 100°C Case Temperature	0.43 Watt	0.86 Watt	0.29 Watt	0.43 Watt
at 25°C Ambient Temperature	0.3 Watt	0.6 Watt	0.25 Watt	0.30 Watt

Maximum Voltages and Current for Each Transistor

V_{CBO}	Collector to Base Voltage	45 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

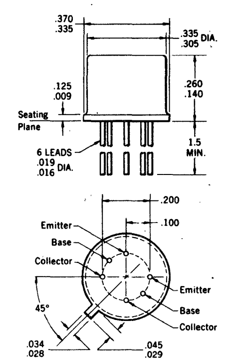
MATCHING AND ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	2N2917 2N2976 MIN.	2N2917 2N2976 MAX.	2N2918 2N2977 MIN.	2N2918 2N2977 MAX.	UNITS	TEST CONDITIONS	
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio** (Note 5)	0.8	1.0	0.8	1.0		I_C = 100 μA	V_{CE} = 5.0 V
$\lvert V_{BE1}-V_{BE2}\rvert$	**Base-Emitter Voltage Differential** (Note 6)		10		10	mV	I_C = 10 μA to 1.0 mA	V_{CE} = 5.0 V
$\lvert V_{BE1}-V_{BE2}\rvert$	**Base-Emitter Voltage Differential** (Note 6)		5.0		5.0	mV	I_C = 100 μA	V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1}-V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change** (T_A = −55°C to +25°C)		1.6 (20 μV/°C)		1.6 (20μV/°C)	mV	I_C = 100 μA	V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1}-V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change** (T_A = +25°C to +125°C)		2.0 (20 μV/°C)		2.0 (20μV/°C)	mV	I_C = 100 μA	V_{CE} = 5.0 V
NF	**Narrow Band Noise Figure** (f = 1.0 kHz)		4.0		3.0	dB	I_C = 10 μA BW = 200 Hz	V_{CE} = 5.0 V R_S = 10 kΩ
NF	**Wide Band Noise Figure** (f = 15.7 kHz)		4.0		3.0	dB	I_C = 10 μA 3 dB pts @ 25 Hz & 10 kHz R_S = 10 kΩ	V_{CE} = 5.0 V

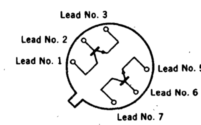
Notes on page 4

*Planar is a patented Fairchild process.

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM

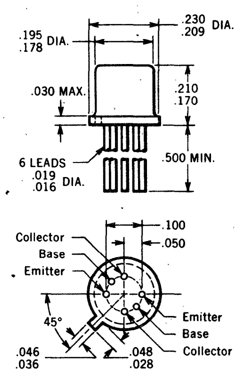


BOTTOM VIEW

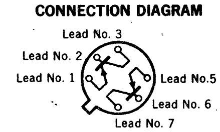
NOTES: All dimensions in inches
Leads are gold-plated Kovar
Package weight is 1.23 grams

2N2917 • 2N2918

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM



BOTTOM VIEW

NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.62 gram

2N2976 • 2N2977

FAIRCHILD SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

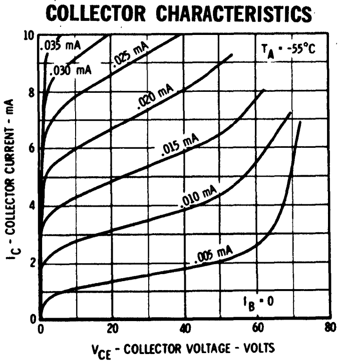
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

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

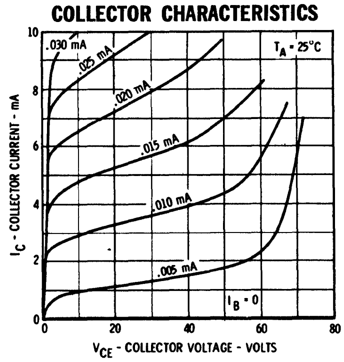
SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	150			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	100			$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	60	240		$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
$h_{FE}(-55°C)$	DC Current Gain	15			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
$V_{CE}(sat)$	Collector Saturation Voltage		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
$V_{BE}(on)$	Emitter-Base On Voltage		0.7	Volts	$I_C = 0.1$ 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_{CEO}	Collector 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
C_{obo}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0			$I_C = 0.5$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance (f = 1 kHz)	25	32	Ω	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1 kHz)		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		Volts	$I_C = 10\ \mu A$	$I_E = 0$
$V_{CEO}(sust)$	**Collector to Emitter Sustaining Voltage** (pulsed, notes 4 and 7)	**45**		**Volts**	**$I_C = 10$ mA**	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$

TYPICAL ELECTRICAL CHARACTERISTICS

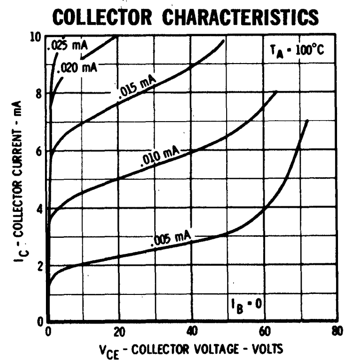
COLLECTOR CHARACTERISTICS



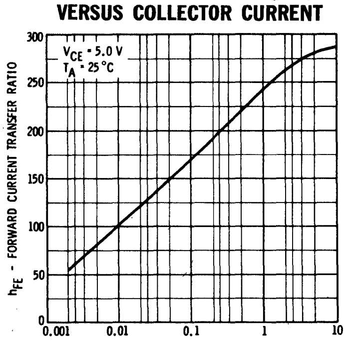
COLLECTOR CHARACTERISTICS



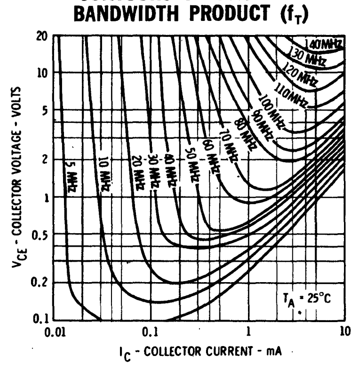
COLLECTOR CHARACTERISTICS



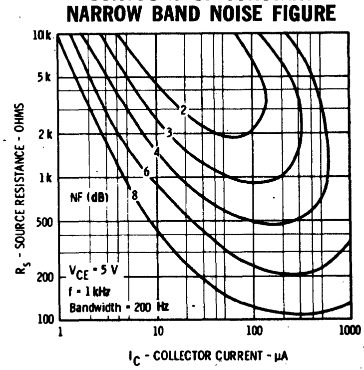
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



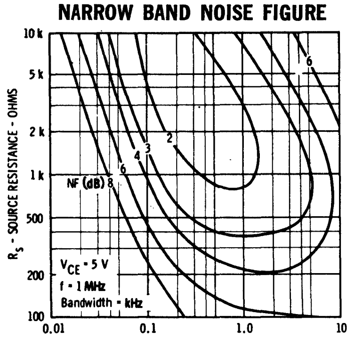
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



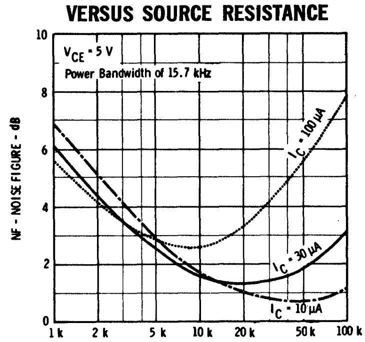
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

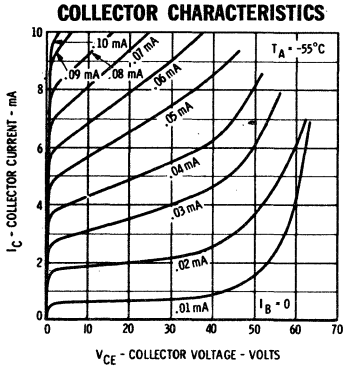


ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

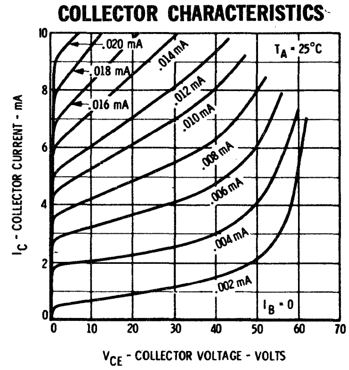
SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	300			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	225			$I_C = 100\ \mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	150	600		$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
$h_{FE}(-55°C)$	DC Current Gain	30			$I_C = 10\ \mu A$	$V_{CE} = 5.0$ V
$V_{CE}(sat)$	Collector Saturation Voltage		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
$V_{BE}(on)$	Emitter-Base On Voltage		0.7	Volts	$I_C = 0.1$ 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_{CEO}	Collector 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
C_{obo}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0			$I_C = 0.5$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance (f = 1 kHz)	25	32	Ω	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance (f = 1 kHz)		1.0	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		Volts	$I_C = 10\ \mu A$	$I_E = 0$
$V_{CEO}(sust)$	Collector to Emitter Sustaining Voltage (pulsed, notes 4 and 7)	45		Volts	$I_C = 10$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$

TYPICAL ELECTRICAL CHARACTERISTICS

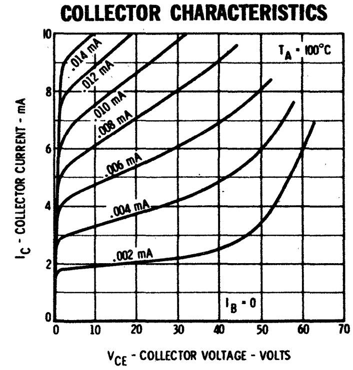
COLLECTOR CHARACTERISTICS



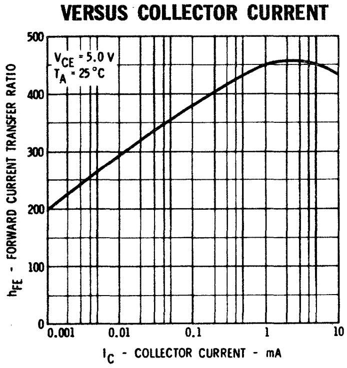
COLLECTOR CHARACTERISTICS



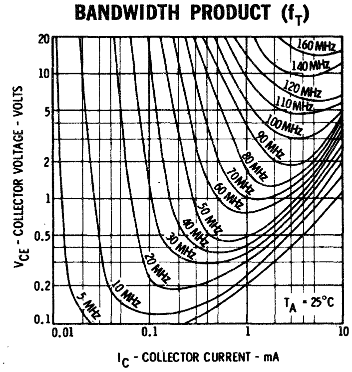
COLLECTOR CHARACTERISTICS



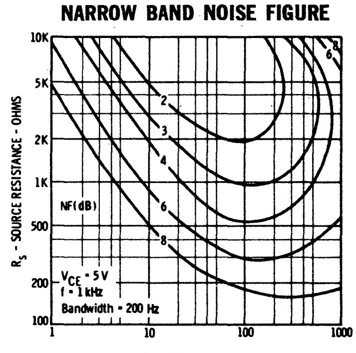
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



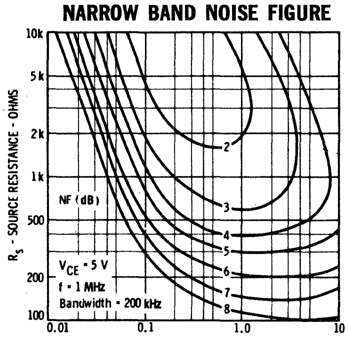
CONTOURS OF CONSTANT BANDWIDTH PRODUCT (f_T)



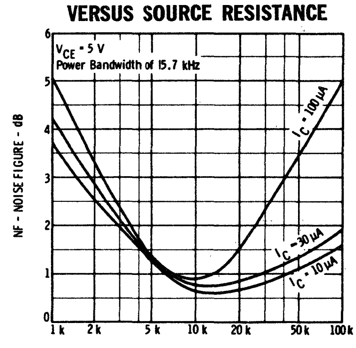
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE

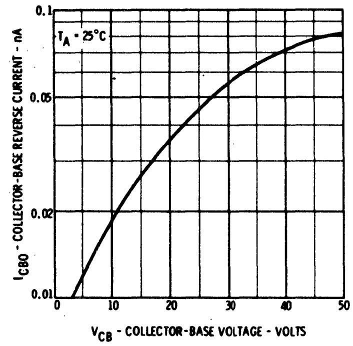


WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE

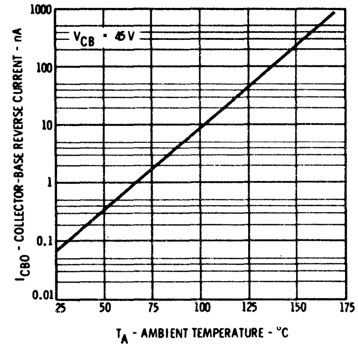


TYPICAL ELECTRICAL CHARACTERISTICS
THESE CURVES APPLY TO ALL UNITS

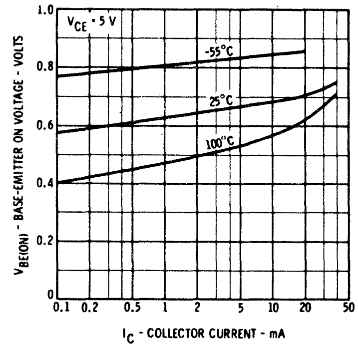
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



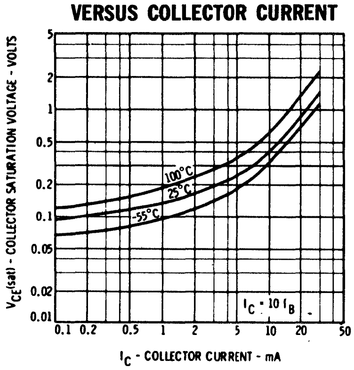
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



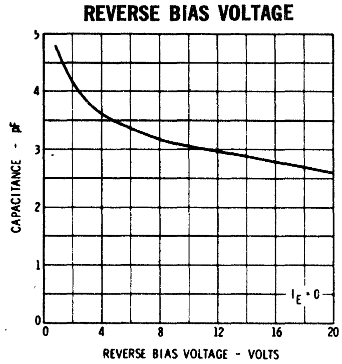
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



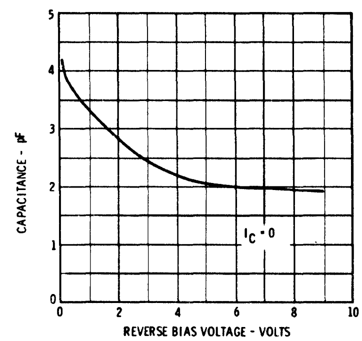
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



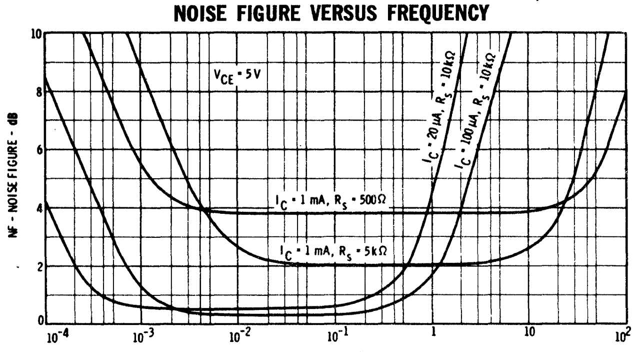
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



INPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



NOISE FIGURE VERSUS FREQUENCY



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 584°C/Watt (derating factor of 1.71 mW/°C) for one side; 292°C/Watt (derating factor of 3.42 mW/°C) for both sides for the 2N2917 and 2N2918. For the 2N2976 and 2N2977 junction to ambient thermal resistance of 700°C/Watt (derating factor of 1.43 mW/°C) for one side; 584°C/Watt (derating factor of 1.71 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Absolute values.
(7) Pulse Conditions: length = 300 μs; duty cycle = 1%.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

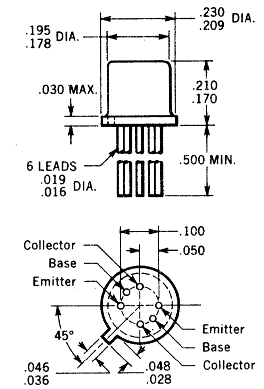
2N2980 • 2N2981 • 2N2982

NPN DIFFERENTIAL AMPLIFIERS

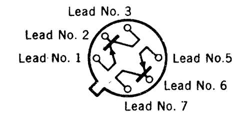
DIFFUSED SILICON PLANAR* TRANSISTORS

These six-terminal devices each contain two isolated high-gain NPN double-diffused silicon PLANAR transistors in one hermetically sealed enclosure. They are designed for use in high-performance differential amplifier circuits.

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM



BOTTOM VIEW

NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 0.62 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

	One Side	Both Sides
Total Dissipation at 25°C Case Temperature [Notes 2 and 3]	**0.5** Watt	**0.75** Watt
at 100°C Case Temperature [Notes 2 and 3]	**0.29** Watt	**0.43** Watt
at 25°C Ambient Temperature [Notes 2 and 3]	**0.25** Watt	**0.30** Watt

Maximum Voltages and Current for Each Transistor

V_{CBO}	Collector to Base Voltage	**100** Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	**60** Volts
V_{EBO}	Emitter to Base Voltage	**7.0** Volts
I_C	Collector Current	**500** mA

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

SYMBOL	CHARACTERISTIC	2N2980 MIN.	2N2980 MAX.	2N2981 MIN.	2N2981 MAX.	2N2982 MIN.	2N2982 MAX.	UNITS	TEST CONDITIONS
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio [Note 5]	**0.9**	**1.0**	**0.8**	**1.0**	**0.9**	**1.0**		$I_C = 100\ \mu A$ $V_{CE} = 5.0\ V$
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio [Note 5]	**0.9**	**1.0**						$I_C = 1.0\ mA$ $V_{CE} = 5.0\ V$
$\lvert V_{BE1}\text{-}V_{BE2}\rvert$	Base-Emitter Voltage Differential		**3.0**		**15**		**5.0**	mV	$I_C = 100\ \mu A$ $V_{CE} = 5.0\ V$
$\lvert V_{BE1}\text{-}V_{BE2}\rvert$	Base-Emitter Voltage Differential		**5.0**					mV	$I_C = 1.0\ mA$ $V_{CE} = 5.0\ V$
$\Delta(V_{BE1}\text{-}V_{BE2})$	Base-Emitter Voltage Differential Change ($T_A = -55°C$ to $+25°C$ or $+25°C$ to $+125°C$)		**10**		**25**		**15**	$\mu V/°C$	$I_C = 100\ \mu A$ $V_{CE} = 5.0\ V$
NF	Narrow Band Noise Figure (f = 1.0 kHz)	**8.0**						dB	$I_C = 0.3\ mA$ $V_{CE} = 10\ V$ B.W. = 200 Hz $R_g = 510\ \Omega$
NF	Broad Band Noise Figure (f = 25 Hz to 10 kHz)	**8.0**						dB	$I_C = 0.3\ mA$ $V_{CE} = 10\ V$ B.W. = 15.7 kHz $R_g = 1.0\ k\Omega$

(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

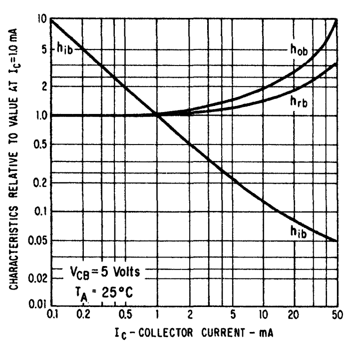
ELECTRICAL CHARACTERISTICS (25°C free air temperature unless otherwise specified)

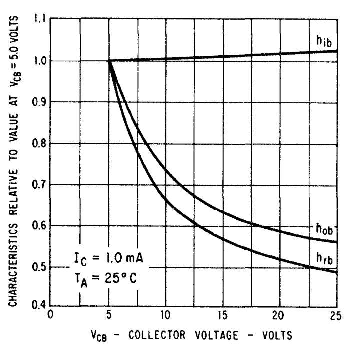
SYMBOL	CHARACTERISTIC	2N2980 MIN.	2N2980 TYP.	2N2980 MAX.	2N2981 2N2982 MIN.	2N2981 2N2982 TYP.	2N2981 2N2982 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Pulse Current Gain [Note 6]	50	100	150	50	125	200		$I_C = 10$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	40	80	120					$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	30	60	90	25	60	150		$I_C = 100\mu A$	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	25	50	75	15	50			$I_C = 10\mu A$	$V_{CE} = 5.0$ V
V_{BE} (sat)	Base Saturation Voltage		0.7	0.9		0.7	0.9	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
V_{CE} (sat)	Collector Saturation Voltage		0.35	1.2		0.35	1.2	Volts	$I_C = 50$ mA	$I_B = 5.0$ mA
I_{CBO}	Collector Cutoff Current		0.4	2.0		0.4	10	nA	$I_E = 0$	$V_{CB} = 80$ V
I_{CBO} (150°C)	Collector Cutoff Current		1.3	10		1.3	15	μA	$I_E = 0$	$V_{CB} = 80$ V
BV_{CBO}	Collector to Base Breakdown Voltage	100			100			Volts	$I_C = 100\mu A$	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage [Notes 4 and 6]	60			60			Volts	$I_C = 30$ mA (pulsed)	$I_B = 0$
BV_{EBO}	Emitter Breakdown Voltage	7.0			7.0			Volts	$I_C = 0$	$I_E = 100$ μA
I_{EBO}	Emitter Cutoff Current		0.1	2.0		0.1	10	nA	$I_C = 0$	$V_{EB} = 5.0$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	5.0		2.5	5.0			$I_C = 50$mA	$V_{CE} = 10$ V
C_{obo}	Output Capacitance	8.0	12	15	8.0	12	15	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{TE}	Emitter Transition Capacitance	30	60	85	30	60	85	pF	$I_C = 0$	$V_{EB} = 0.5$ V

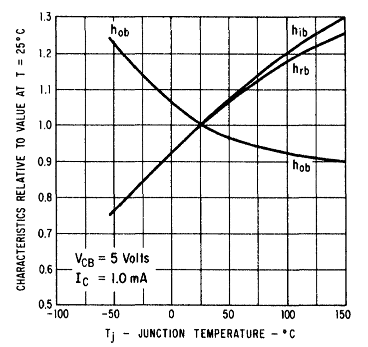
SMALL SIGNAL CHARACTERISTICS (f = 1 kHz)

SYMBOL	CHARACTERISTIC	2N2980 MIN.	2N2980 TYP.	2N2980 MAX.	2N2981 2N2982 MIN.	2N2981 2N2982 TYP.	2N2981 2N2982 MAX.	UNITS	TEST CONDITIONS	
h_{fe}	Small Signal Current Gain	50	80	150	40	125	200		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ie}	Input Resistance	1.25	2.3	5.0	1.0		6.0	kohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance	5.0	9.0	20			30	μmhos	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ib}	Input Resistance	20	27	30	20	27	30	Ohms	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ob}	Output Conductance	0.1		0.5	0.1	0.2	0.5	μmhos	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{rb}	Voltage Feedback Ratio			3.0		0.9	3.0	x10^{-4}	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V

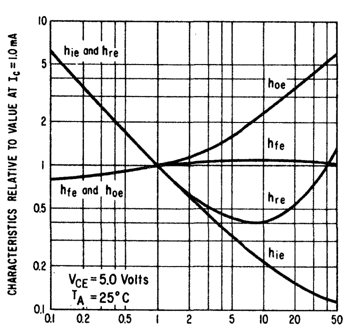
TYPICAL COMMON BASE CHARACTERISTICS

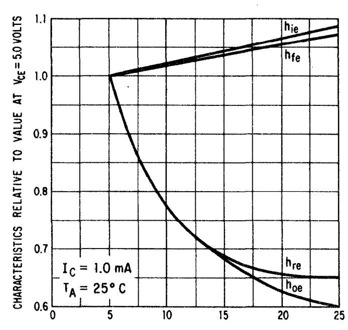


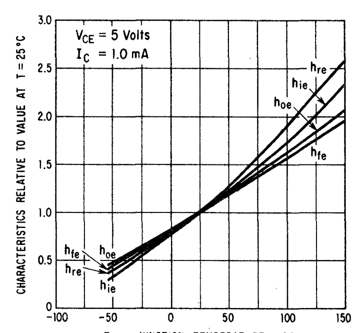




TYPICAL COMMON EMITTER CHARACTERISTICS

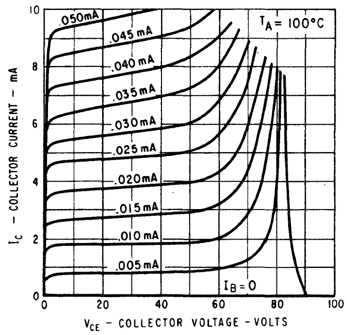


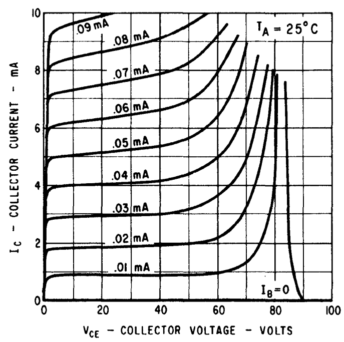


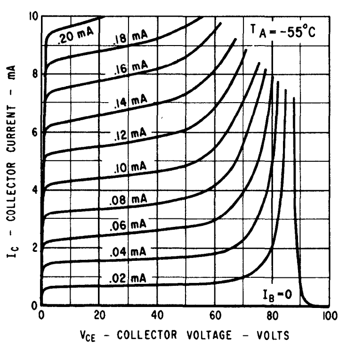


TYPICAL ELECTRICAL CHARACTERISTICS

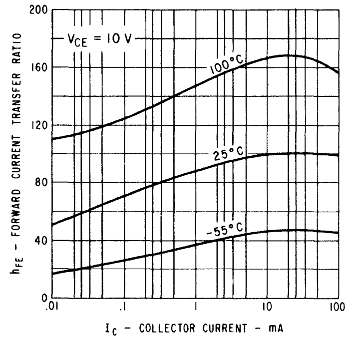
HIGH VOLTAGE
COLLECTOR CHARACTERISTICS*



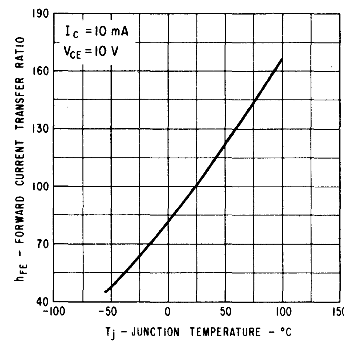




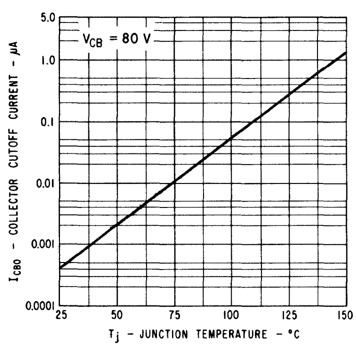
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



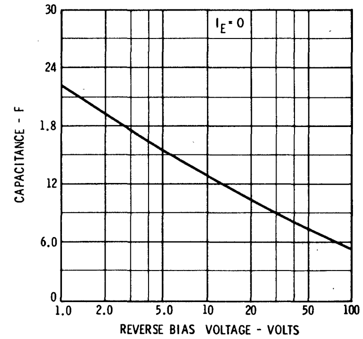
DC PULSE CURRENT GAIN VERSUS TEMPERATURE



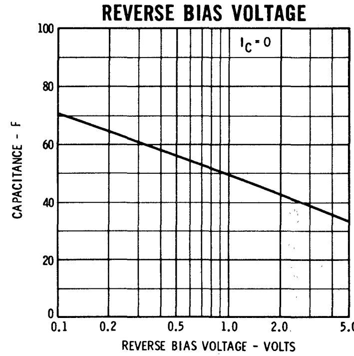
COLLECTOR CUTOFF CURRENT VERSUS TEMPERATURE



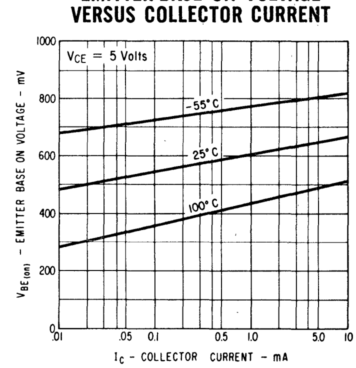
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



EMITTER TRANSITION CAPACITANCE VERSUS REVERSE BIAS VOLTAGE

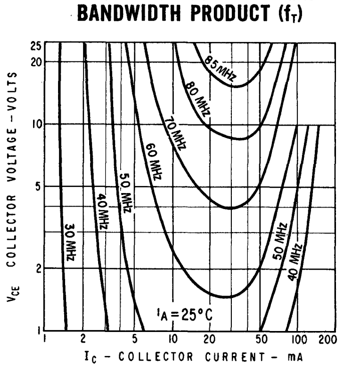


EMITTER-BASE ON VOLTAGE VERSUS COLLECTOR CURRENT

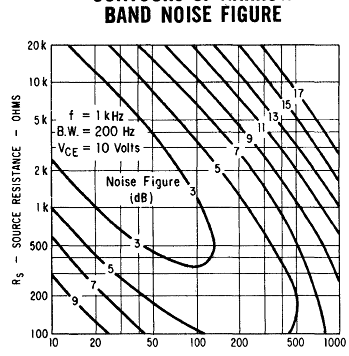


*Single family characteristics on Transistor Curve Tracer.

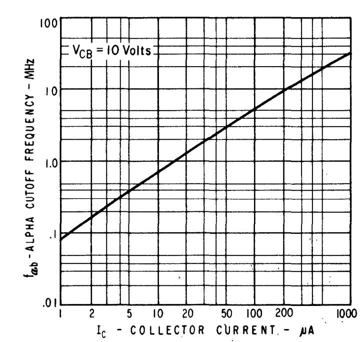
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)

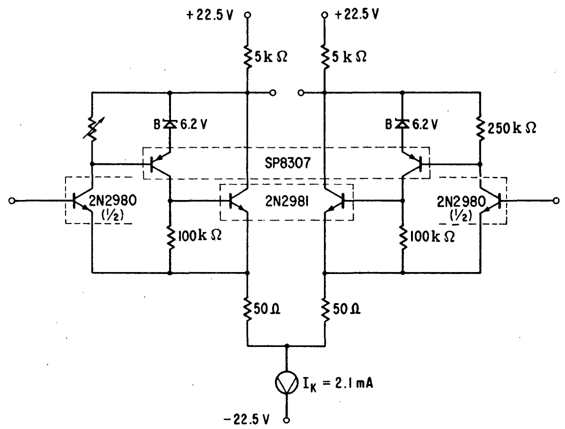


CONTOURS OF NARROW BAND NOISE FIGURE

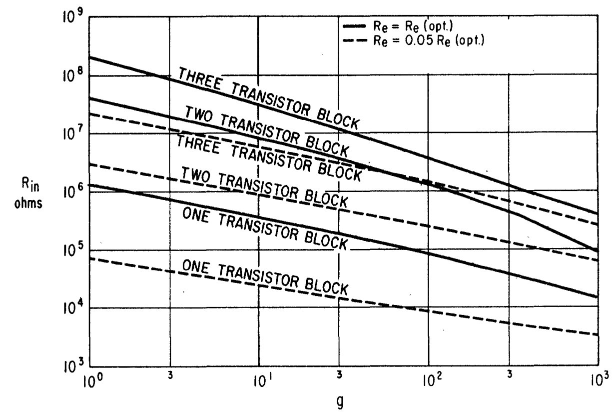


ALPHA CUTOFF FREQUENCY VERSUS COLLECTOR CURRENT

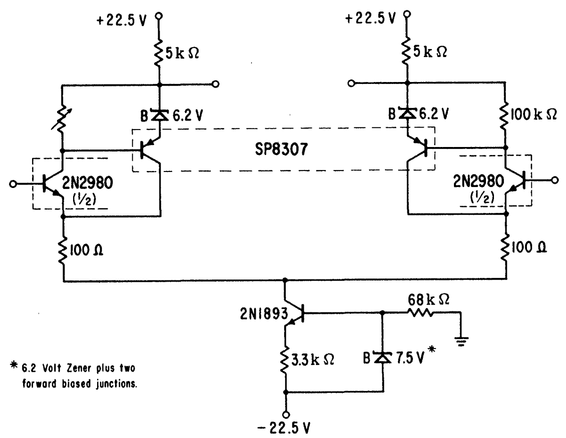




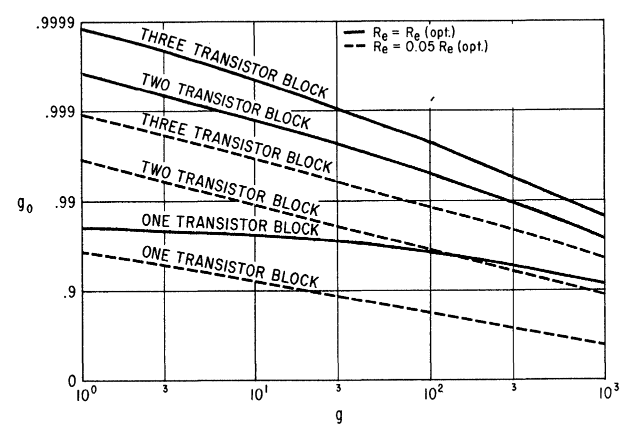
THE IMPROVED DIFFERENTIAL AMPLIFIER USING THE THREE-TRANSISTOR BLOCK.



INPUT RESISTANCE AS A FUNCTION OF g FOR $R_e = R_e$ (OPT.) AND $R_e = .05\ R_e$ (OPT.)



THE IMPROVED DIFFERENTIAL AMPLIFIER USING THE TWO-TRANSISTOR BLOCK.



NORMALIZED GAIN, g_o, AS A FUNCTION of g ($g = R_L/R_e$) FOR $R_e = R_e$(OPT.) AND $R_e = .05\ R_e$ (OPT.)

For additional information on these and other differential amplifier circuits see Fairchild TP-16, APP-23, APP-45, and APP-60.

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 350°C/watt (derating factor of 2.86 mW/°C) for one side; 233°C/watt (derating factor of 4.3 mW/°C) for both sides. Junction-to-ambient thermal resistance of 700°C/watt (derating factor of 1.43 mW/°C) for one side; 583°C/watt (derating factor of 1.72 mW/°C) for both sides.
(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) Lowest of the two h_{FE} readings is taken as h_{FEI} for purposes of this ratio.
(6) Pulse Conditions: length = 300 μsec; duty cycle = 1%.

FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

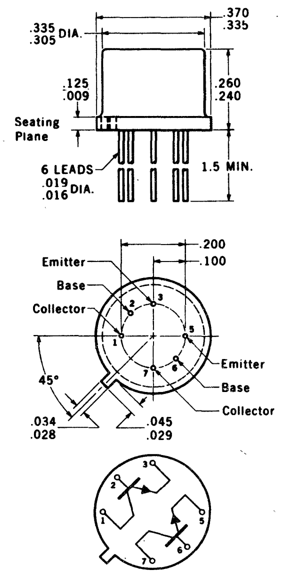
2N3423 • 2N3424

NPN LOW-NOISE, SENSE AND HIGH FREQUENCY DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **BETA MATCH . . . . 10% AT 3.0 mA**
- **V_{BE} DIFFERENTIAL . . . . 5.0 mV (MAX) AT 3.0 mA**
- **V_{BE} DIFFERENTIAL TRACKING . . . 20 μV/°C (MAX) AT 3.0 mA, —55°C TO +125°C**
- **f_T . . . . 600 MHz (MIN) AT 4.0 mA**
- **NF . . . . 3.5 dB (TYP) AT 60 MHz**

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 1.27 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)	**One Side**	**Both Sides**
Total Dissipation at 25°C Case Temperature	0.6 Watt	1.2 Watt
at 100°C Case Temperature	0.25 Watt	0.5 Watt
at 25°C Ambient Temperature	0.3 Watt	0.45 Watt

Maximum Voltages and Current		**2N3423 2N3424**
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
$V_{C1\ C2}$	$Collector_1$ to $Collector_2$ Voltage	±200 Volts
	Voltage rating any lead to case	±200 Volts

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

SYMBOL	CHARACTERISTICS	2N3423 MIN.	2N3423 MAX.	2N3424 MIN.	2N3424 MAX.	UNITS	TEST CONDITIONS	
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio (Note 5)**	0.8	1.0	**0.9**	**1.0**		$I_C = 3.0$ mA	$V_{CE} = 3.0$ V
$\lvert V_{BE1} - V_{BE2} \rvert$	**Base-Emitter Voltage Differential**		10		**5.0**	**mV**	$I_C = 3.0$ mA	$V_{CE} = 3.0$ V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	**Base-Emitter Voltage Differential Change (T_A = —55°C to 25°C)**		3.2 (40 μV/°C)		**1.6 (20 μV/°C)**	**mV**	$I_C = 3.0$ mA	$V_{CE} = 3.0$ V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	**Base-Emitter Voltage Differential Change (T_A = 25°C to 125°C)**		4.0 (40 μV/°C)		**2.0 (20 μV/°C)**	**mV**	$I_C = 3.0$ mA	$V_{CE} = 3.0$ V

Additional Electrical Characteristics on page 2
Notes on page 4

*Planar is a patented Fairchild process.

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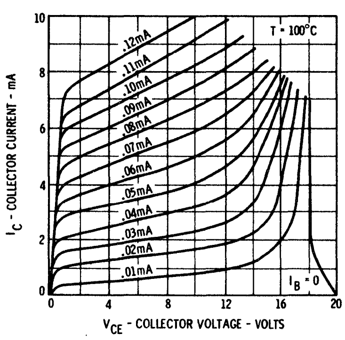
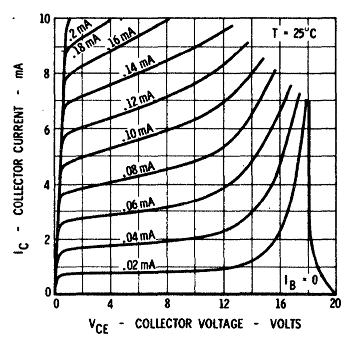
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

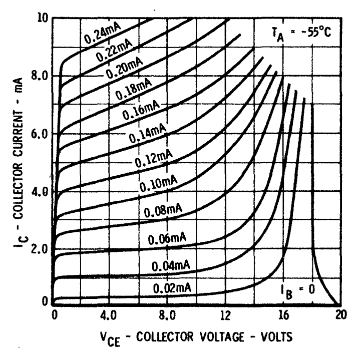
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	20			$I_C = 3.0$ mA	$V_{CE} = 1.0$ V
h_{FE}	DC Current Gain	20	200		$I_C = 3.0$ mA	$V_{CE} = 3.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	30			$I_C = 1.0\mu A$	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	3.0			$I_C = 0$	$I_E = 10\ \mu A$
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	15			$I_C = 3.0$ mA	$I_B = 0$
V_{CE}(sat)	Collector Saturation Voltage		0.4	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
V_{BE}(sat)	Base Saturation Voltage		1.0	Volts	$I_C = 10$ mA	$I_B = 1.0$ mA
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
I_{CBO}	Emitter Cutoff Current		10	μA	$I_C = 0$	$V_{EB} = 3.0$ V
h_{fe}	**High Frequency Current Gain**	**6.0**	**12**		**$I_C = 4.0$ mA, $V_{CE} = 10$ V, f = 100 MHz**	
C_{obo}	Common-Base Output Capacitance		1.7	pF	$I_E = 0$	$V_{CB} = 10$ V
C_{obo}	Common-Base Output Capacitance		3.0	pF	$I_E = 0$	$V_{CB} = 0$
C_{ibo}	Common-Base Input Capacitance		2.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
$R_e(h_{ie})$	Real Part of Common-Emitter Input Impedance		45	Ω	$I_C = 3.0$ mA $V_{CE} = 3.0$ V f = 350 MHz	
NF	**Noise Figure**	**3.5 (Typ.)**		**dB**	**$I_C = 1.0$ mA f = 60 MHz,**	**$V_{CE} = 6.0$ V $R_g = 400\Omega$**

TYPICAL COLLECTOR CHARACTERISTICS*

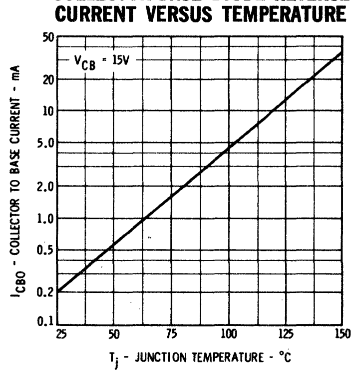




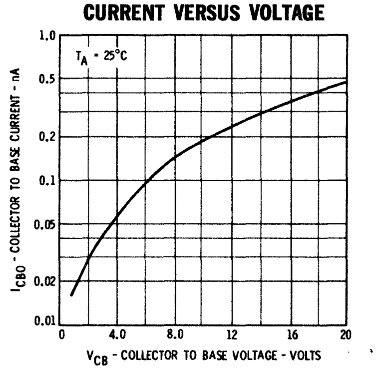


TYPICAL ELECTRICAL CHARACTERISTICS

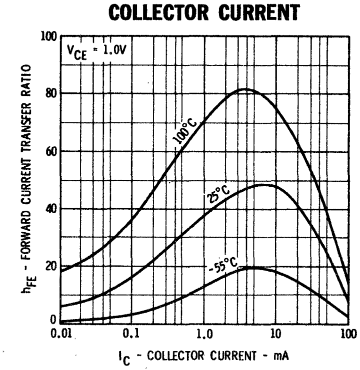
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS TEMPERATURE



COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS VOLTAGE



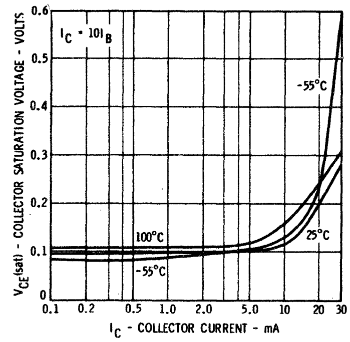
PULSED DC CURRENT GAIN VERSUS COLLECTOR CURRENT



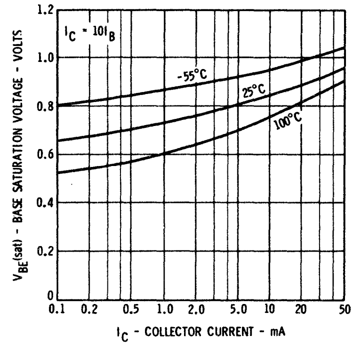
*Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

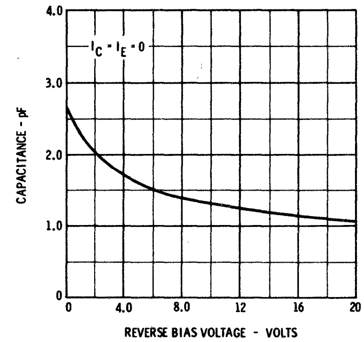
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



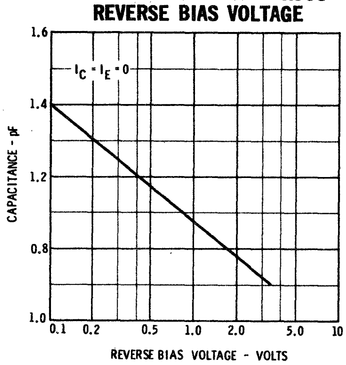
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



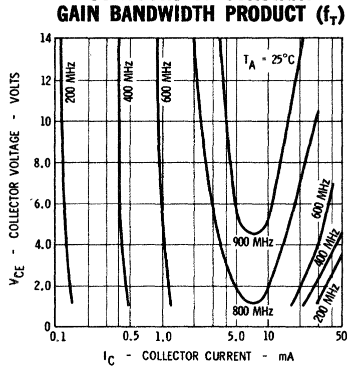
OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



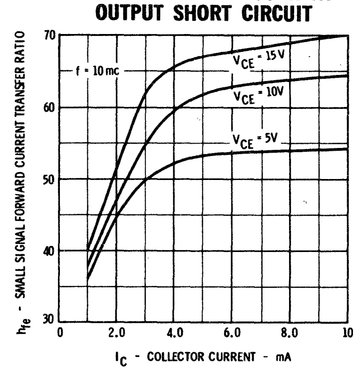
INPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



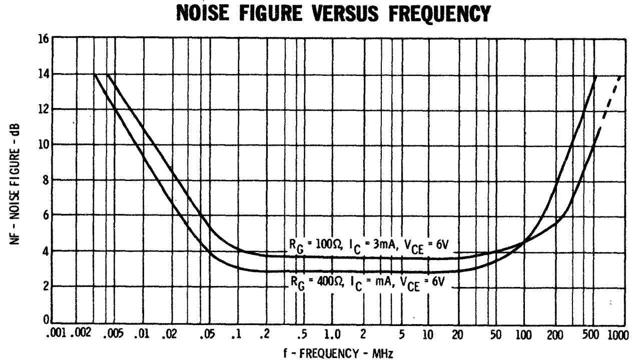
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



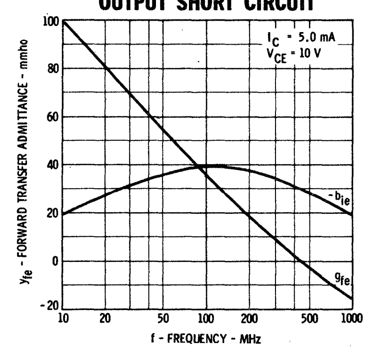
SMALL SIGNAL CURRENT GAIN VERSUS COLLECTOR CURRENT-OUTPUT SHORT CIRCUIT



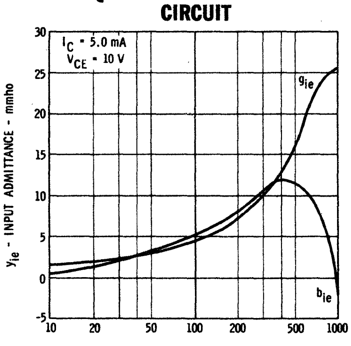
NOISE FIGURE VERSUS FREQUENCY



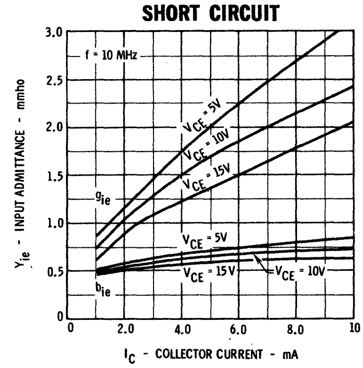
FORWARD TRANSFER ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



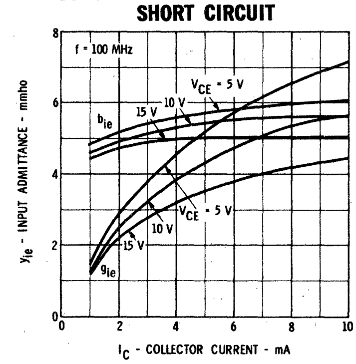
INPUT ADMITTANCE VERSUS FREQUENCY — OUTPUT SHORT CIRCUIT



INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT CIRCUIT



INPUT ADMITTANCE VERSUS COLLECTOR CURRENT — OUTPUT SHORT 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 ambient thermal resistance of 584°C/Watt (derating factor of 1.72 mW/°C) for one side; 389°C/Watt (derating factor of 2.57 mW/°C) for both sides. Junction to case thermal resistance of 290°C/Watt (derating factor of 3.44 mW/°C) for one side; 145°C/Watt (derating factor of 6.85 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Pulse Conditions = 300 μs; duty cycle = 1%.

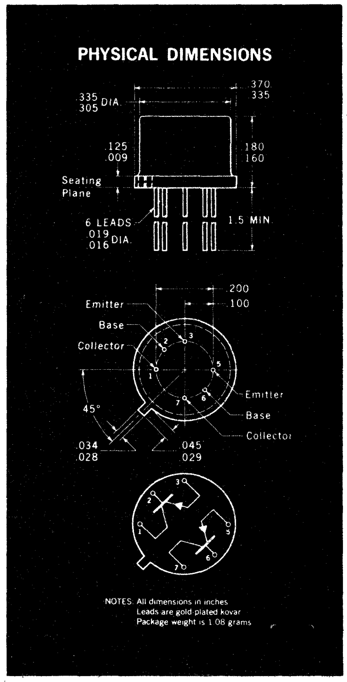
FAIRCHILD SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

2N3726 • 2N3727 • 2N4015 • 2N4016

PNP LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTORS

GENERAL DESCRIPTION - These six-terminal devices each contain two isolated high-gain, low-noise PNP Double-Diffused Silicon Planar Epitaxial Transistors in one hermetically sealed enclosure. They are designed for use in high-performance amplifier and differential amplifier circuits requiring high gain, low noise at low-current levels plus a low base-emitter voltage differential gradient over extreme 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)	300°C Maximum

Maximum Power Dissipation (Notes 2 and 3)	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	0.85 Watt	1.4 Watts
at 100°C Case Temperature	0.48 Watt	0.80 Watt
at 25°C Ambient Temperature	0.40 Watt	0.50 Watt

Maximum Voltages and Current For Each Transistor		2N4015 2N4016	2N3726 2N3727
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	300 mA	300 mA

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

Symbol	† FACT Subgroup	Characteristic	2N3727 2N4016 Min.	2N3727 2N4016 Max.	2N3726 2N4015 Min.	2N3726 2N4015 Max.	Units	Test Conditions
* $\frac{h_{FE1}}{h_{FE2}}$	1a	DC Current Gain Ratio (Note 5)	0.9	1.0	0.9	1.0		I_C = 100 μA to 1.0 mA V_{CE} = -5.0 V
* $V_{BE1} - V_{BE2}$	1a	Base-Emitter Voltage Differential		2.5		5.0	mV	I_C = 100 μA to 1.0 mA V_{CE} = -5.0 V
$\Delta(V_{BE1} - V_{BE2})$	4	Base-Emitter Voltage Differential Change (T_A = -55°C to 25°C)		0.8		1.6	mV	I_C = 100 μA to 1.0 mA V_{CE} = -5.0 V
$\Delta(V_{BE1} - V_{BE2})$	4	Base-Emitter Voltage Differential Change (T_A = 25°C to 125°C)		1.0		2.0	mV	I_C = 100 μA to 1.0 mA V_{CE} = -5.0 V

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

Notes on page 2

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

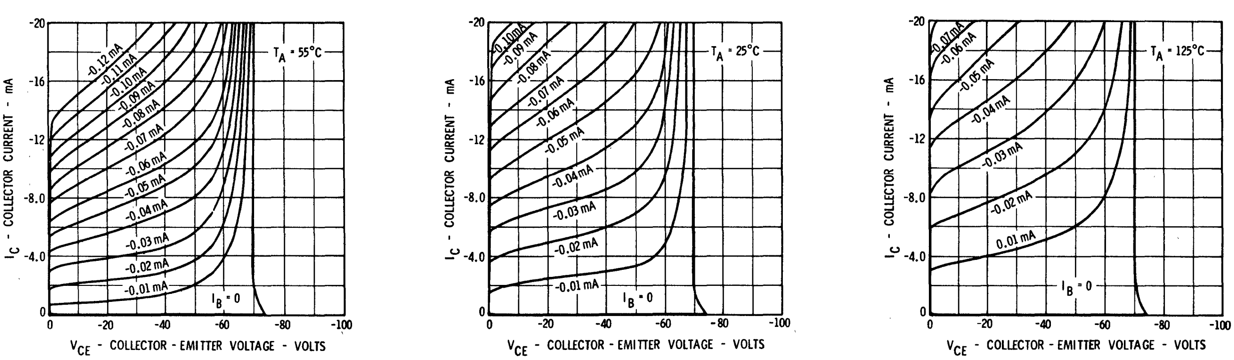
Symbol	† FACT Subgroup	Characteristic	2N3726 2N3727 Min.	2N3726 2N3727 Max.	2N4015 2N4016 Min.	2N4015 2N4016 Max.	Units	Test Conditions
h_{FE}	4	DC Current Gain	80		80			I_C = 10 μA V_{CE} = -5.0 V
h_{FE}	4	DC Current Gain	120		120			I_C = 100 μA V_{CE} = -5.0 V
*h_{FE}	1a	DC Current Gain	135	350	135	350		I_C = 1.0 mA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 6)	115		115			I_C = 50 mA V_{CE} = -5.0 V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-45		-60		Volts	I_C = 10 μA I_E = 0
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-5.0		-5.0		Volts	I_E = 10 μA I_C = 0
V_{CEO}(sust)	1a	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	-45		-60		Volts	I_C = 10 mA (pulsed) I_B = 0
*V_{CE}(sat)	1b	Collector Saturation Voltage (Note 6)		-0.25		-0.25	Volts	I_C = 50 mA I_B = 2.5 mA
*V_{BE}(sat)	1b	Base Saturation Voltage (Note 6)		-1.0		-1.0	Volts	I_C = 50 mA I_B = 2.5 mA
*I_{CBO}	1b	Collector Cutoff Current		10			nA	I_E = 0 V_{CB} = -30 V
*I_{CBO}	1b	Collector Cutoff Current				10	nA	I_E = 0 V_{CB} = -50 V
I_{CBO}(150°C)	4	Collector Cutoff Current		10			μA	I_E = 0 V_{CB} = -30 V
I_{CBO}(150°C)	4	Collector Cutoff Current				10	μA	I_E = 0 V_{CB} = -50 V
I_{EBO}	1b	Emitter Cutoff Current		100		100	nA	I_C = 0 V_{EB} = -3.0 V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	3.0		3.0			I_C = 1.0 mA V_{CE} = -10 V
h_{fe}	4	High Frequency Current Gain (f = 100 Mc)	2.0	6.0	2.0	6.0		I_C = 50 mA V_{CE} = -20 V
C_{obo}	4	Common-Base, Open-Circuit, Output Capacitance		8.0		8.0	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	4	Common-Base, Open-Circuit, Input Capacitance		25		25	pf	I_C = 0 V_{EB} = -0.5 V
NF	4	Noise Figure (Note 7)		4.0		4.0	db	I_C = 30 μA V_{CE} = -5.0 V
h_{ie}	4	Input Impedance (f = 1.0 Kc)		11.5		11.5	KOhm	I_C = 1.0 mA V_{CE} = -10 V
h_{re}	4	Reverse Voltage Feedback Ratio (f = 1.0 Kc)		1500		1500	$x10^{-6}$	I_C = 1.0 mA V_{CE} = -10 V
h_{oe}	4	Output Conductance (f = 1.0 Kc)		80		80	μmho	I_C = 1.0 mA V_{CE} = -10 V
h_{fe}	4	Forward Current Transfer Ratio (f = 1.0 Kc)	135	420	135	420		I_C = 1.0 mA V_{CE} = -10 V

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

*NOTE: FACT Program End-Point Measurement Parameter.

TYPICAL COLLECTOR CHARACTERISTICS* 2N3726 • 2N3727

ACTIVE REGION



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 431°C/Watt (derating factor of 2.29 mW/°C) for one side; 350°C/Watt (derating factor of 2.86 mW/°C) for both sides. Junction-to-case thermal resistance of 206°C/Watt (derating factor of 4.85 mW/°C) for one side; 125°C/Watt (derating factor of 8.0 mW/°C) for both sides.

(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

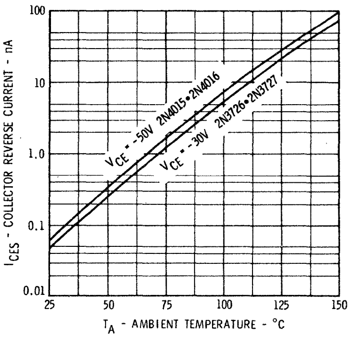
(6) Pulse Conditions = 300 μsec; Duty Cycle = 1%.

(7) f = 1.0 Kc; R_s = 10 KΩ. BW = 200 cps.

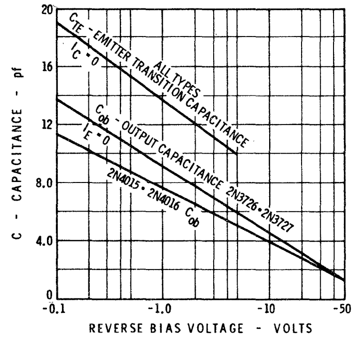
* Single family characteristic on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS
2N3726 • 2N3727 • 2N4015 • 2N4016

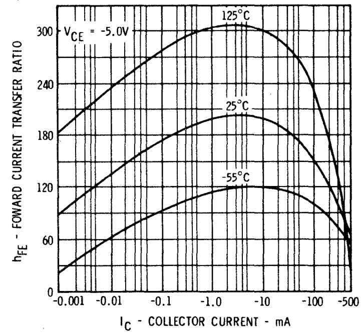
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



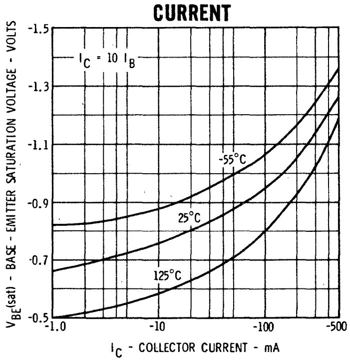
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



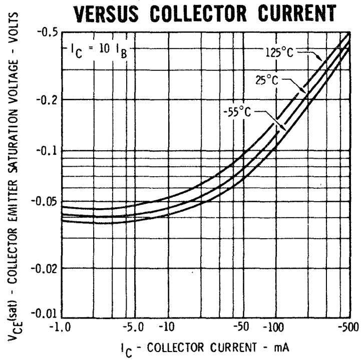
DC PULSED CURRENT GAIN VERSUS COLLECTOR CURRENT



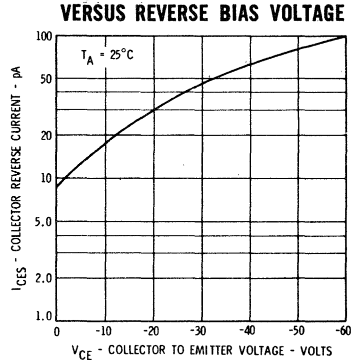
PULSED BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



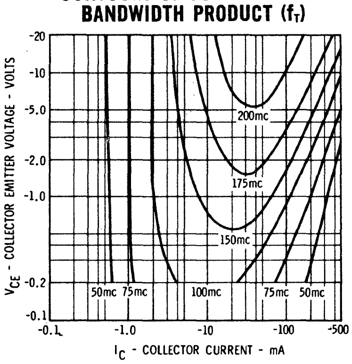
PULSED COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



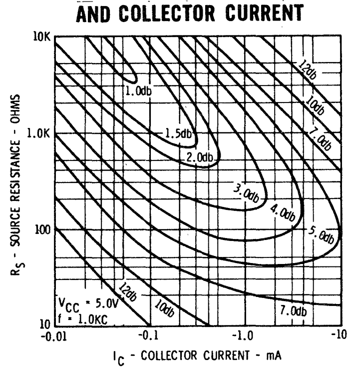
COLLECTOR REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



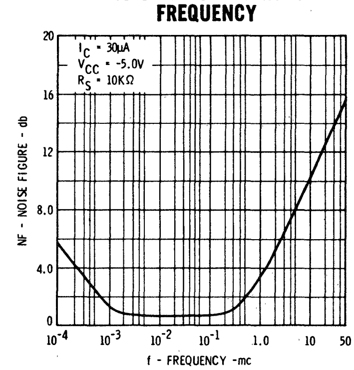
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



NOISE FIGURE VERSUS SOURCE RESISTANCE AND COLLECTOR CURRENT

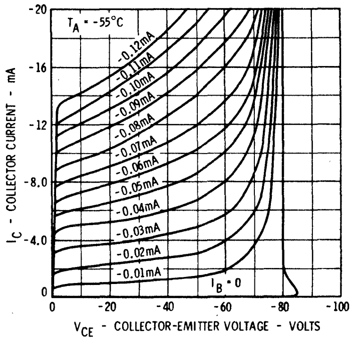


NOISE FIGURE VERSUS FREQUENCY

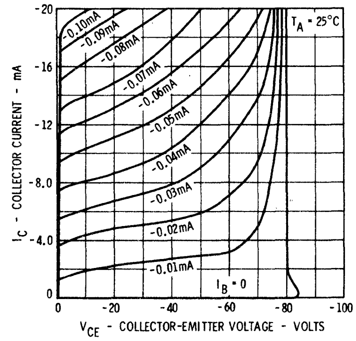


TYPICAL COLLECTOR CHARACTERISTICS*
2N4015 • 2N4016

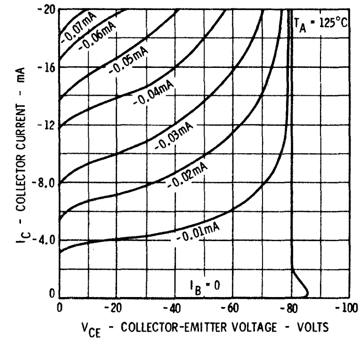
COLLECTOR CHARACTERISTICS



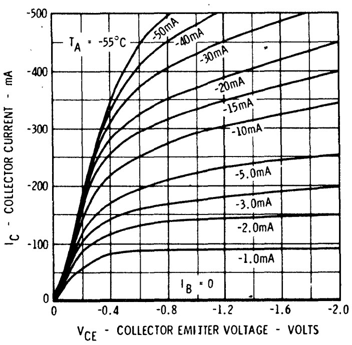
COLLECTOR CHARACTERISTICS

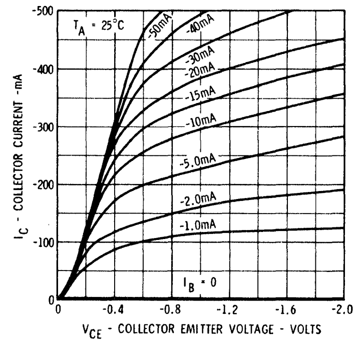


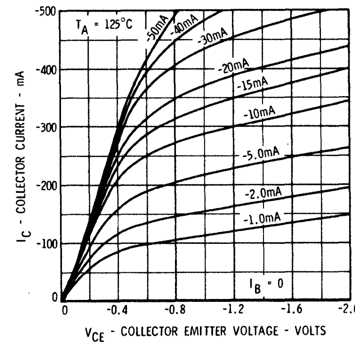
COLLECTOR CHARACTERISTICS

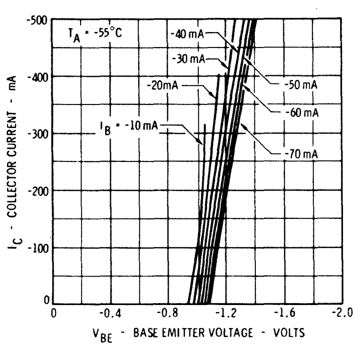


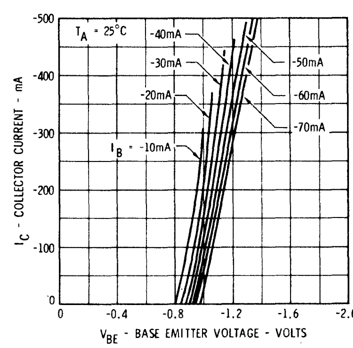
TYPICAL COLLECTOR AND BASE CHARACTERISTICS*
SATURATION REGION
2N3726 • 2N3727 • 2N4015 • 2N4016

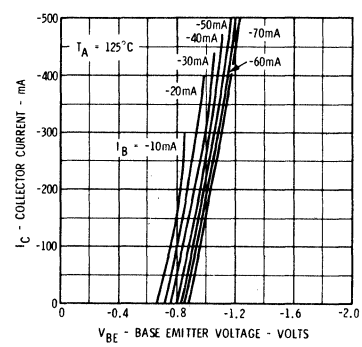












* Single family characteristic on Transistor Curve Tracer.

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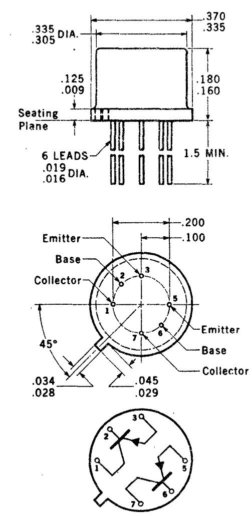
2N3728 • 2N3729

NPN HIGH PERFORMANCE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **BETA RATIO -- $\frac{h_{FE1}}{h_{FE2}}$ = 0.9-1.0 FROM 100 μA to 1.0 mA**
  $\frac{h_{FE1}}{h_{FE2}}$ = 0.8-1.0 FROM 100 μA to 1.0 mA, −55°C to +125°C
- **V_{BE} MATCHING -- $|V_{BE1} - V_{BE2}|$ = 3.0 mV (MAX) FROM 100 μA to 1.0 mA**
- **V_{BE} TRACKING -- ΔV_{BE} = 10 μV/°C (MAX) FROM 100 μA to 1.0 mA, −55°C to +125°C**
- **MEDIUM VOLTAGE -- LV_{CEO} = 30 V (MIN)**

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is 1.08 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	**One Side**	**Both Sides**
Total Dissipation at 25°C Case Temperature (Notes 2 and 3)	1.0 Watt	1.6 Watt
at 100°C Case Temperature (Notes 2 and 3)	0.57 Watt	0.91 Watt
at 25°C Ambient Temperature (Notes 2 and 3)	0.45 Watt	0.55 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	500 mA
$V_{C1\,C2}$	$Collector_1$ to $Collector_2$ Voltage	±200 Volts
	Voltage rating any lead to case	±200 Volts

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

SYMBOL	CHARACTERISTICS	2N3728 MIN.	2N3728 MAX.	2N3729 MIN.	2N3729 MAX.	UNITS	TEST CONDITIONS	
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio** (Note 5)	0.8	1.0	**0.9**	**1.0**		I_C = 100 μA to 1.0 mA	V_{CE} = 5.0 V
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio** (Note 5) **(T_A = −55°C to 125°C)**			**0.8**	**1.0**		I_C = 100 μA to 1.0 mA	V_{CE} = 5.0 V
$\lvert V_{BE1} - V_{BE2}\rvert$	**Base-Emitter Voltage Differential**		5.0		**3.0**	**mV**	I_C = 100 μA to 1.0 mA	V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change (T_A = −55°C to 25°C)**		1.6 (20 μV/°C)		**0.8 (10 μV/°C)**	**mV**	I_C = 100 μA to 1.0 mA	V_{CE} = 5.0 V
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change (T_A = 25°C to 125°C)**		2.0 (20 μV/°C)		**1.0 (10 μV/°C)**	**mV**	I_C = 100 μA to 1.0 mA	V_{CE} = 5.0 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 ambient thermal resistance of 384°C/Watt (derating factor of 2.57 mW/°C) for one side; 318°C/Watt (derating factor of 3.14 mW/°C) for both sides. Junction to case thermal resistance of 175°C/Watt (derating factor of 5.71 mW/°C) for one side; 109°C/Watt (derating factor of 9.15 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Pulse Conditions: length = 300 μs; duty cycle = 1%.

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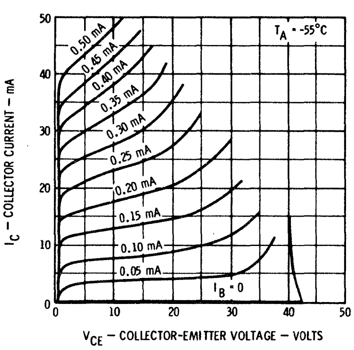
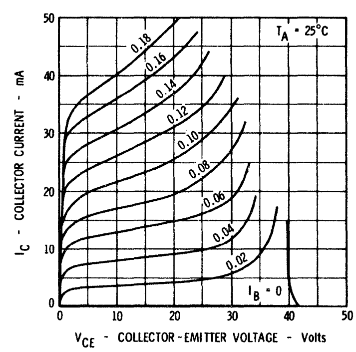
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

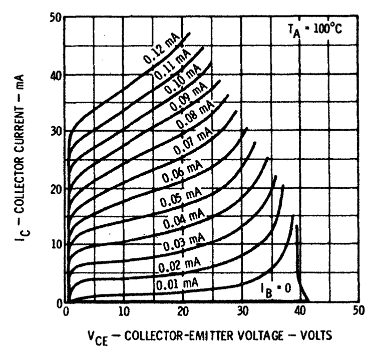
SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	30			$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain	45	180		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	DC Current Gain (Note 6)	80	280		$I_C = 150$ mA	$V_{CE} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	60			$I_C = 10\ \mu A$	$I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0			$I_C = 0$	$I_E = 10\ \mu A$
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 6)	30			$I_C = 10$ mA	$I_B = 0$
V_{CE}(sat)	Collector Saturation Voltage (Note 6)		0.22	Volts	$I_C = 150$ mA	$I_B = 15$ mA
V_{BE}(sat)	Base Saturation Voltage (Note 6)		1.1	Volts	$I_C = 150$ mA	$I_B = 15$ mA
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_{EBO}	Emitter Cutoff Current		10	nA	$I_C = 0$	$V_{EB} = 3.0$ V
h_{fe}	High Frequency Current Gain	4.0			$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 20 MHz	
h_{fe}	High Frequency Current Gain	2.5	6.0		$I_C = 50$ mA, $V_{CE} = 10$ V, f = 100 MHz	
C_{obo}	Common-Base, Open-Circuit Output Capacitance		8.0	pF	$I_E = 0$, $V_{CB} = 10$ V, f = 140 kHz	
C_{ibo}	Common-Base, Open-Circuit Input Capacitance		20	pF	$I_C = 0$, $V_{EB} = 2.0$ V, f = 140 kHz	
h_{ie}	Input Impedance	1.2	4.0	kΩ	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	
h_{re}	Reverse Voltage Feedback Ratio		200	$x10^{-6}$	$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	
h_{oe}	Output Conductance		10		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	
h_{fe}	Forward Current Transfer Ratio	50	200		$I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz	
NF	Wideband Noise Figure (f = 15.7 kHz)		7.0	dB	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
					3 dB pts @ 25 Hz and 10 kHz $R_S = 1.0$ kΩ	

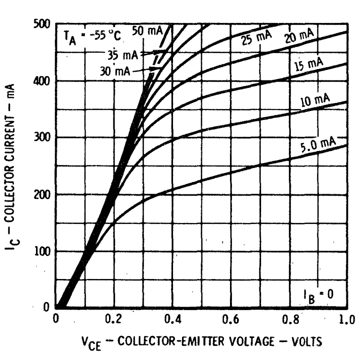
TYPICAL COLLECTOR CHARACTERISTICS*

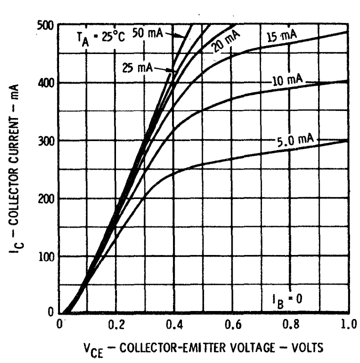
Active Region

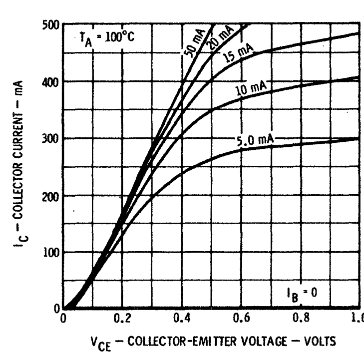








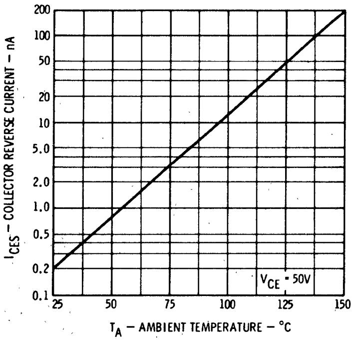




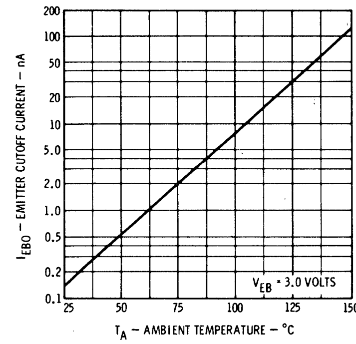
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS

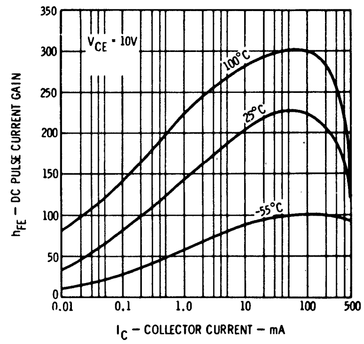
COLLECTOR REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



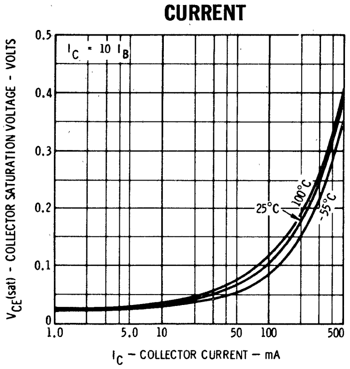
EMITTER CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



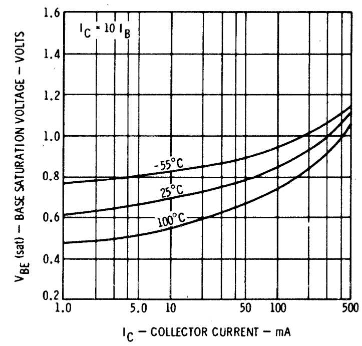
PULSE DC CURRENT GAIN VERSUS COLLECTOR CURRENT



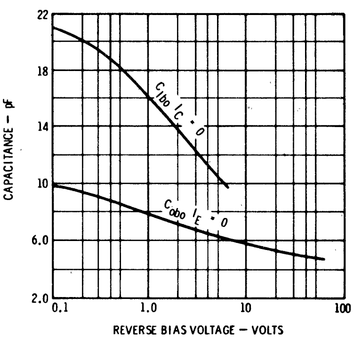
COLLECTOR SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



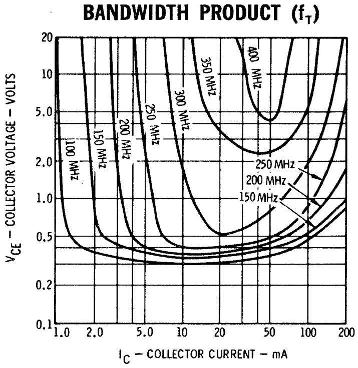
BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



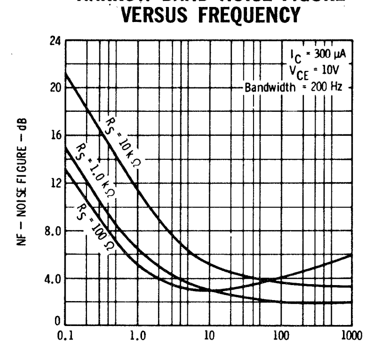
INPUT AND OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



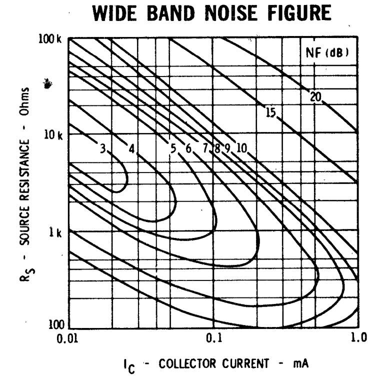
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



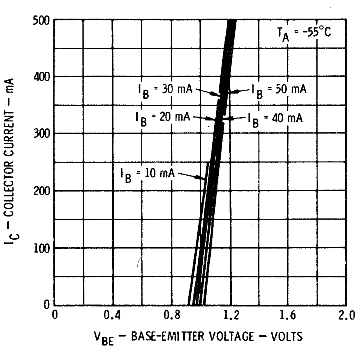
NARROW BAND NOISE FIGURE VERSUS FREQUENCY

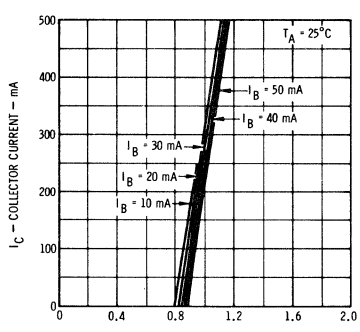


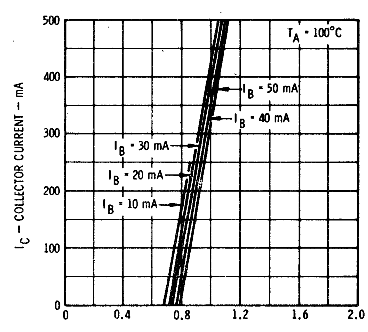
CONTOURS OF CONSTANT WIDE BAND NOISE FIGURE



TYPICAL BASE CHARACTERISTICS





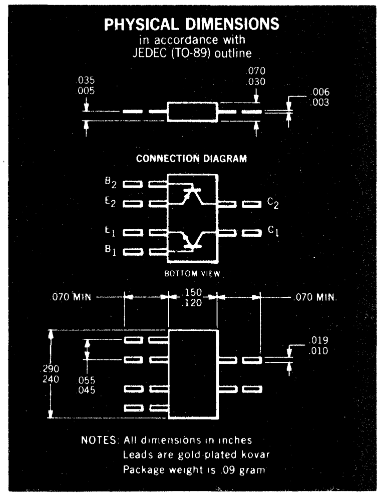


FT3838 • 2N3838

NPN-PNP GENERAL PURPOSE COMPLEMENTARY DUAL TYPE

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The FT3838 and 2N3838 each contain an NPN-PNP Complementary Pair of Silicon Planar Triode Transistors designed primarily for switching and general purpose amplifier applications in industrial service.



ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

Storage Temperature: -65°C to +200°C

Maximum Power Dissipation		One Side	Both Sides
Total Dissipation at 25°C Case Temperature	(Notes 2 & 3)	0.7 Watt	1.4 Watts
at 25°C Ambient Temperature	(Notes 2 & 3)	0.25 Watt	0.35 Watt

Maximum Voltages and Current for Each Transistor

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	600 mA
V_{C1-C2}	Collector 1 to Collector 2 Voltage	±120 Volts

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions (Note 6)
h_{FE}	DC Pulse Current Gain (Note 5)	100	300		I_C = 150 mA V_{CE} = 10 V
h_{FE}	DC Current Gain	35			I_C = 100 μA 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)	50			I_C = 150 mA V_{CE} = 1.0 V
V_{CE}(sat)	Collector Saturation Voltage (Note 5)		0.4	Volts	I_C = 150 mA (pulsed) I_B = 15 mA
V_{BE}(sat)	Base Saturation Voltage (Note 5)	0.85	1.3	Volts	I_C = 150 mA (pulsed) I_B = 15 mA
I_{CEV}	Collector Cut-off Current		10	nA	V_{CE} = 50 V V_{BE} = -0.5 V
I_{BEV}	Base Cut-off Current		-10	nA	V_{CE} = 50 V V_{BE} = -0.5 V
BV_{CBO}	Collector to Base Breakdown Voltage	60		Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	5		Volts	I_C = 0 I_E = 10 μA
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 and 5)	40		Volts	I_C = 10 mA (pulsed) I_E = 0
h_{fe}	High Frequency Current Gain (f = 100 Mc) (2N3838) only	2.0			I_C = 20 mA V_{CE} = 10 V
h_{fe}	High Frequency Current Gain (f = 100 Mc) (FT3838) only	2.0			I_C = 50 mA V_{CE} = 20 V
C_{obo}	Output Capacitance		8	pf	I_E = 0 V_{CB} = 10 V
h_{ie}	Input Resistance (f = 1.0 Kc)	1.5	9.0	K Ω	I_C = 1.0 mA V_{CE} = 10 V
h_{oe}	Output Conductance (f = 1.0 Kc)		50	μmho	I_C = 1.0 mA V_{CE} = 10 V
h_{fe}	Small Signal Current Gain (f = 1.0 Kc)	60	300		I_C = 1.0 mA V_{CE} = 10 V
NF	Spot Noise Figure (f = 1.0 Kc)		8	db	I_C = 100 μA V_{CE} = 10 V R_S = 1.0 KΩ

NOTES:

Additional Electrical Characteristics on page 2

(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-ambient thermal resistance of 600°C/Watt (derating factor of 1.67 mW/°C) for one side; 428°C/Watt (derating of 2.3 mW/°C) for both sides. Junction-to-case thermal resistance of 214°C/Watt (derating factor of 4.67 mW/°C) for one side; 107 °C/Watt (derating factor of 9.3 mW/°C) for both sides.

(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 = 300 μsec; Duty cycle = 1%.

(6) Voltages and currents apply to the NPN triode. For the PNP triode the values are the same, but the signs are reversed.

(7) This characteristic is the highest value of collector supply voltage which may be safely used with a resistive load switching circuit in which the collector current approaches 600 mA.

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
I_{CEV}(150°C)	Collector Cutoff Current		10	μA	V_{CE} = 50 V V_{BE} = -0.5 V
I_{EBO}	Emitter Cutoff Current		10	nA	V_{EB} = 3.0 V I_C = 0
t_d	Turn-On Delay Time (see Fig. 1)		10	nsec	I_C = 150 mA I_{B1} = 15 mA
t_r	Rise Time (see Fig. 1)		40	nsec	I_C = 150 mA I_{B1} = 15 mA
t_s	Storage Time (see Fig. 2)		250	nsec	I_C = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA
t_f	Fall Time (see Fig. 2)		90	nsec	I_C = 150 mA, I_{B1} = 15 mA, I_{B2} = -15 mA
$V_{CEO(NL)}$	Collector-Emitter Nonlatching Voltage (see Fig. 3) (Note 7)	40		Volts	$I_{C(on)}$ = 600 mA, $I_{B(on)}$ = 120 mA, $I_{B(off)}$ = 0

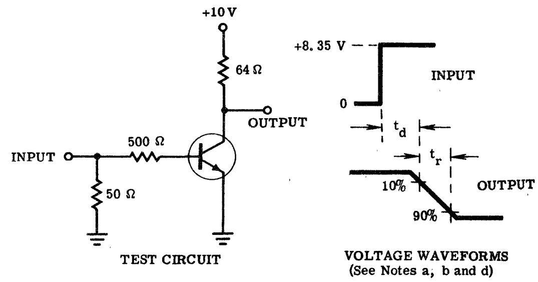


FIGURE 1

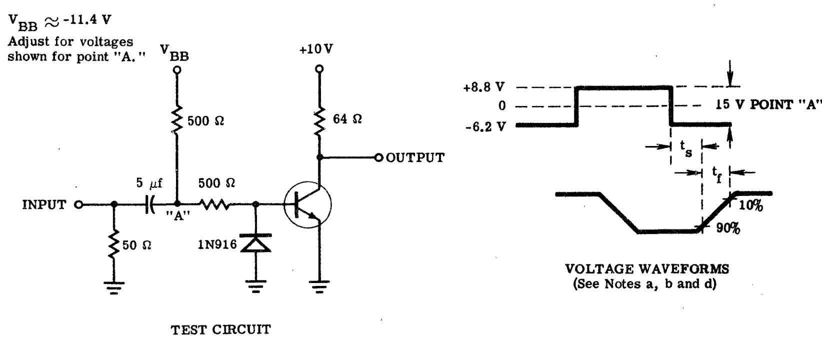


FIGURE 2

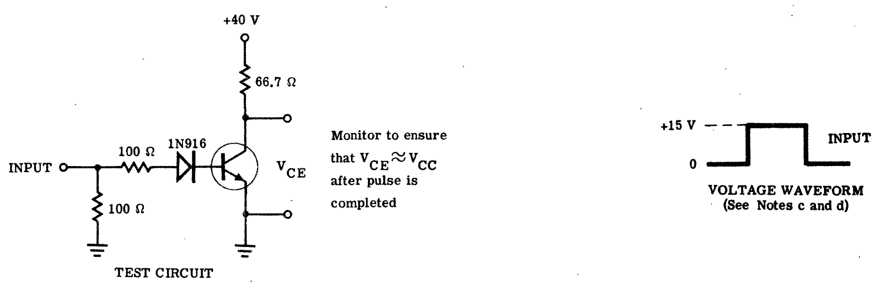


FIGURE 3 — COLLECTOR-EMITTER NONLATCHING VOLTAGE TEST CIRCUIT

NOTES:

a. The input waveforms are supplied by a generator with the following characteristics: For Figure 1, Z_{out} = 50 Ω, $t_r \leq 1$ nsec, PW $\geq$ 400 nsec, Duty Cycle $\leq$ 2%; for Figure 2, Z_{out} = 50 Ω, $t_r \leq 10$ nsec, PW = 10 μsec, Duty Cycle $\leq$ 2%.

b. The waveforms are monitored on an oscilloscope with the following characteristics: For Figure 1, $t_r \leq 1$ nsec, $R_{IN} \geq 100$ KΩ, $C_{IN} \leq 5$ pf; for Figure 2, $t_r \leq 5$ nsec, $R_{IN} \geq 100$ KΩ, $C_{IN} \leq 12$ pf.

c. The input waveform in Figure 3 has the following characteristics: PW $\leq$ 10 μsec, Duty Cycle $\leq$ 2%.

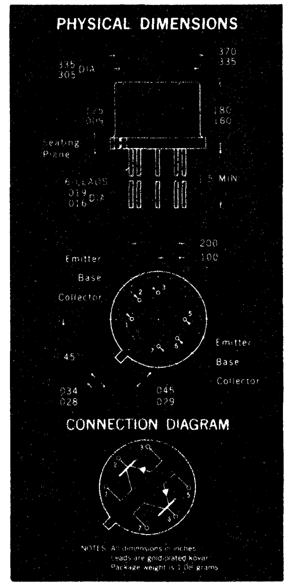
d. The signs and polarity symbols shown are for the N-P-N triode; the signs and polarity symbols are reversed for the P-N-P triode.

2N4017 • 2N4018 • 2N4019

DUAL PNP HIGH-GAIN, LOW-NOISE AMPLIFIERS

DIFFUSED SILICON PLANAR II EPITAXIAL TRANSISTORS

- **HIGH BREAKDOWN -- 80 VOLT LV_{CEO}**
- **HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT --250 Min. @ 10uA**
- **GUARANTEED BETA @ -55 AND +100°C**
- **LOW NOISE -- 4.0 db Max. @ 100 cps; 8.0 db Max. @ 10 cps**
- **FLAT BETA FROM 1.0uA TO 50 mA**



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

		One Side	Both Sides
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.80 Watt	1.3 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.40 Watt	0.60 Watt

Maximum Voltages and Current for Each Transistor

			2N4017	2N4018	2N3019
V_{CBO}	Collector to Base Voltage		-80 Volts	-60 Volts	-45 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-80 Volts	-60 Volts	-45 Volts
V_{EBO}	Emitter to Base Voltage		-6.0 Volts	-6.0 Volts	-6.0 Volts
I_C	Collector Current		200 mA	200 mA	200 mA

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

Symbol	† FACT Subgroup	Characteristic	2N4017 Min.	2N4017 Max.	2N4018 Min.	2N4018 Max.	2N4019 Min.	2N4019 Max.	Units	Test Conditions
h_{FE}	4	**DC Current Gain**	**60**		**60**		**180**			**I_C = 1.0 µA V_{CE} = -5.0 V**
***h_{FE}**	1a	**DC Current Gain**	**100**	**350**	**100**	**500**	**250**	**500**		**I_C = 10 µA V_{CE} = -5.0 V**
h_{FE}	4	DC Current Gain	100		100		250			I_C = 100 µA V_{CE} = -5.0 V
h_{FE}	4	DC Current Gain	100	500	100	600	250	600		I_C = 1.0 mA V_{CE} = -5.0 V
h_{FE}(100°C)	4	**DC Current Gain**		**600**		**800**		**800**		**I_C = 1.0 mA V_{CE} = -5.0 V**
h_{FE}	4	DC Pulse Current Gain (Note 5)	100		100		200			I_C = 10 mA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	90		90		180			I_C = 50 mA V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 5)	40		40		80			I_C = 50 mA V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Current Gain	40		40		100			I_C = 10 µA V_{CE} = -5.0 V
NF	4	Noise Figure		3.0		3.0		2.0	db	I_C = 20 µA V_{CE} = -5.0 V f = 1.0 Kc BW = 150 cps, R_S = 10 KΩ
NF	4	**Noise Figure**						**8.0**	**db**	I_C = 20 µA V_{CE} = -5.0 V **f = 10 cps, BW = 2.0 cps, R_S = 10 KOhm**
NF	4	**Noise Figure**		10		10		**4.0**	**db**	I_C = 20 µA V_{CE} = -5.0 V **f = 100 cps BW = 15 cps, R_S = 10 KOhm**

† 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 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 437°C/Watt (derating factor of 2.3 mW/°C) for one side; 292°C/Watt (derating factor of 3.4 mW/°C) for both sides. Junction-to-case thermal resistance of 219°C/Watt (derating factor of 4.57 mW/°C) for one side; 135°C/Watt (derating factor of 7.4 mW/°C) for both sides.

(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
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

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

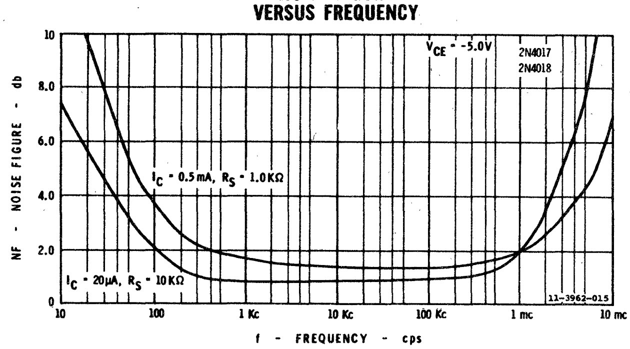
Symbol	† FACT Subgroup	Characteristic	2N4017 Min.	2N4017 Max.	2N4018 Min.	2N4018 Max.	2N4019 Min.	2N4019 Max.	Units	Test Conditions
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-80		-60		-45		Volts	I_C = 10 μA I_E = 0
V_{CEO}(sust)	1a	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**−80**		**−60**		**−45**		**Volts**	**I_C = 5.0 mA** I_B = 0 (pulsed)
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-6.0		-6.0		-6.0		Volts	I_E = 10 μA I_C = 0
*V_{CE}(sat)	1a	Collector Saturation Voltage (pulsed, Note 5)		-0.25		-0.25		-0.25	Volts	I_C = 10 mA I_B = 0.5 mA
V_{CE}(sat)	4	Collector Saturation Voltage (pulsed, Note 5)		-0.4		-0.4		-0.4	Volts	I_C = 50 mA I_B = 5.0 mA
*V_{BE}(sat)	1a	Base Saturation Voltage (pulsed, Note 5)		-0.9		-0.9		-0.9	Volts	I_C = 10 mA I_B = 0.5 mA
V_{BE}(sat)	4	Base Saturation Voltage (pulsed, Note 5)		-0.95		-0.95		-0.95	Volts	I_C = 50 mA I_B = 5.0 mA
*I_{CBO}	1b	Collector Cutoff Current		10					nA	I_E = 0 V_{CB} = -70 V
*I_{CBO}	1b	Collector Cutoff Current				10			nA	I_E = 0 V_{CB} = -50 V
*I_{CBO}	1b	Collector Cutoff Current						10	nA	I_E = 0 V_{CB} = -30 V
I_{CBO}(125°C)	4	Collector Cutoff Current		10					μA	I_E = 0 V_{CB} = -70 V
I_{CBO}(125°C)	4	Collector Cutoff Current				10			μA	I_E = 0 V_{CB} = -50 V
I_{CBO}(125°C)	4	Collector Cutoff Current						10	μA	I_E = 0 V_{CB} = -30 V
*I_{EBO}	1b	Emitter Cutoff Current		10		10		10	nA	I_C = 0 V_{EB} = -4.0 V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.0	8.0	2.0	8.0	2.5	8.0		I_C = 0.5 mA V_{CE} = -5.0 V
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		6.0		6.0		6.0	pf	I_E = 0 V_{CB} = -5.0 V
h_{fe}	4	Small Signal Current Gain (f = 1.0 Kc)	100	550	100	700	250	700		I_C = 1.0 mA V_{CE} = -5.0 V
h_{ie}	4	Input Resistance (f = 1.0 Kc)	2.5	17	2.5	20	6.0	20	Kohm.	I_C = 1.0 mA V_{CE} = -5.0 V
h_{oe}	4	Output Conductance (f = 1.0 Kc)	5.0	40	5.0	50	5.0	50	μmho	I_C = 1.0 mA V_{CE} = -5.0 V
h_{re}	4	Voltage Feedback Ratio (f = 1.0 Kc)		10		10		10	$x10^{-4}$	I_C = 1.0 mA V_{CE} = -5.0 V

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

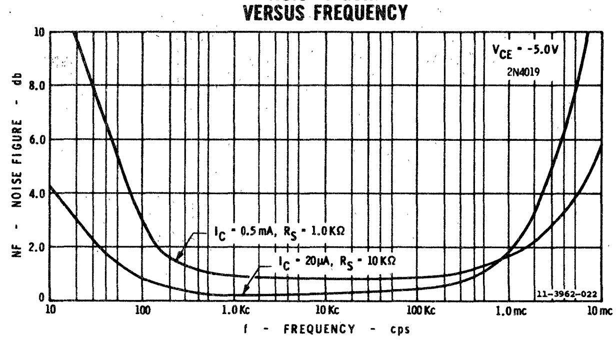
*NOTE: **FACT** Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

NOISE FIGURE VERSUS FREQUENCY

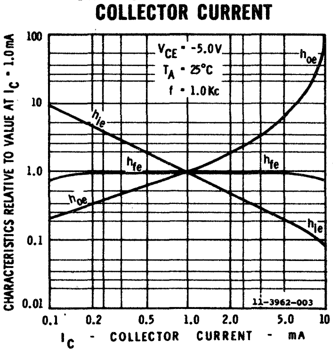


NOISE FIGURE VERSUS FREQUENCY

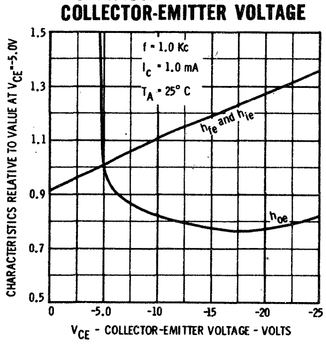


THESE CURVES APPLY TO ALL TYPES

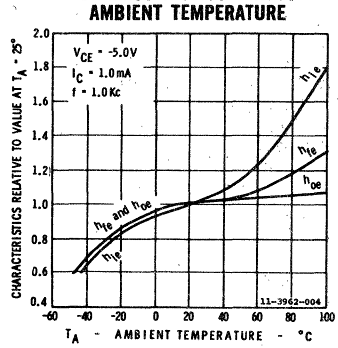
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



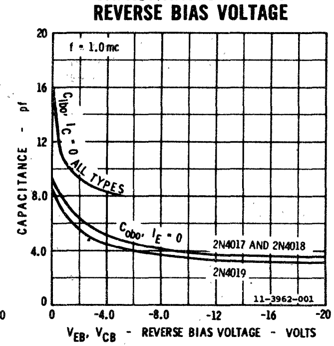
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE

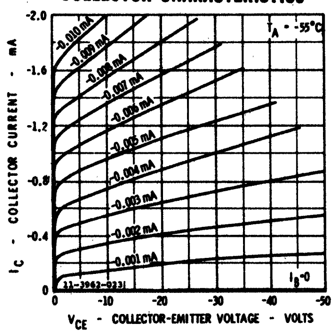


INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE

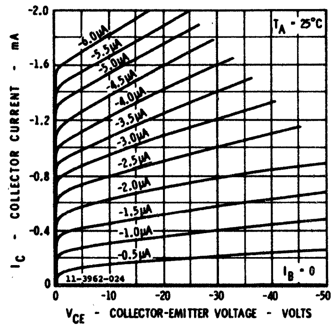


TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4017 AND 2N4018

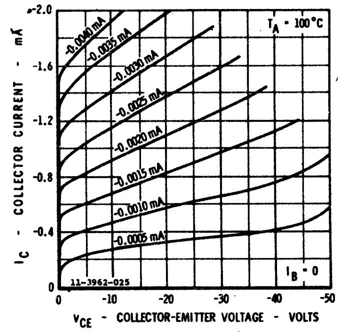
COLLECTOR CHARACTERISTICS*



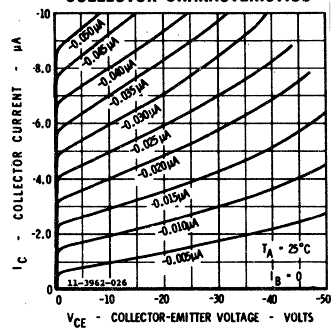
COLLECTOR CHARACTERISTICS



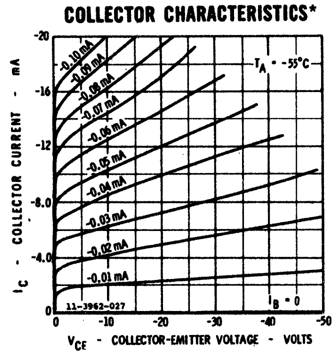
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS*



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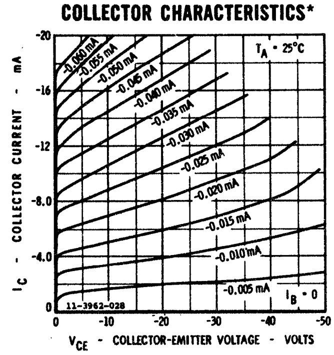

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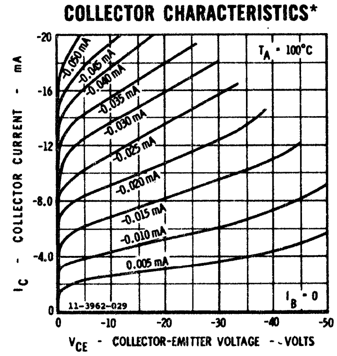
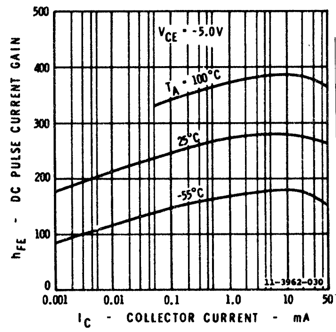
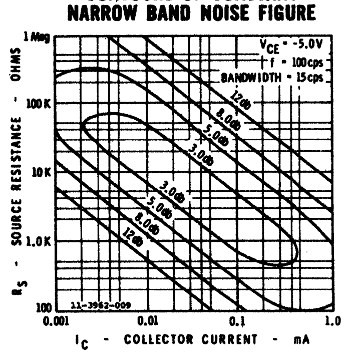


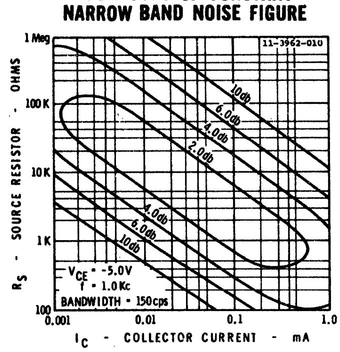
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



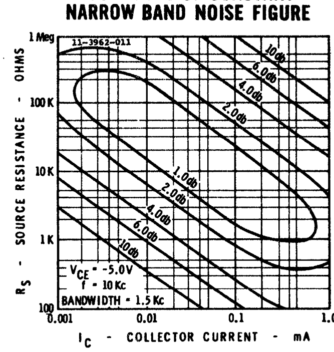
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



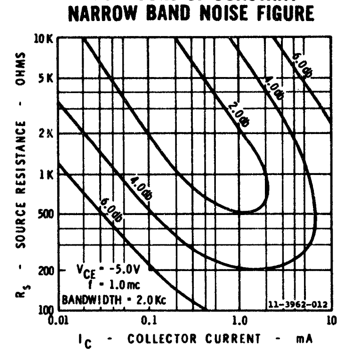
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



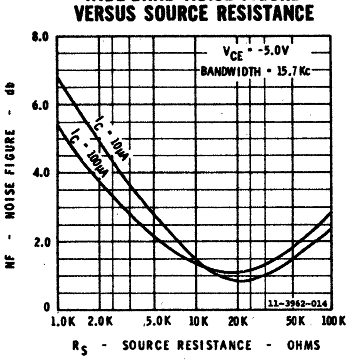
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



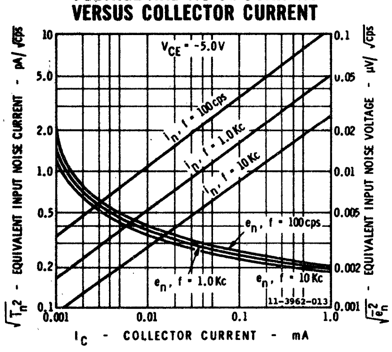
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



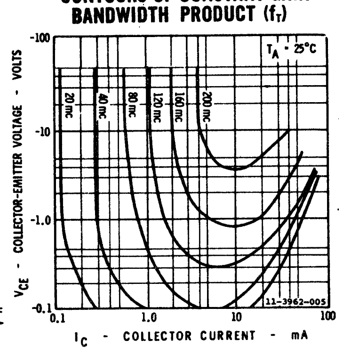
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



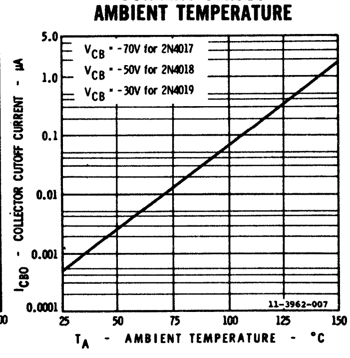
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



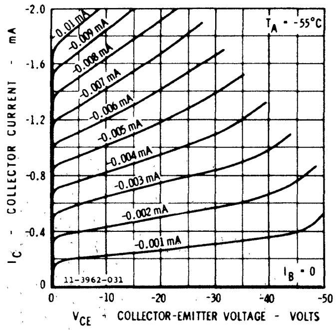
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



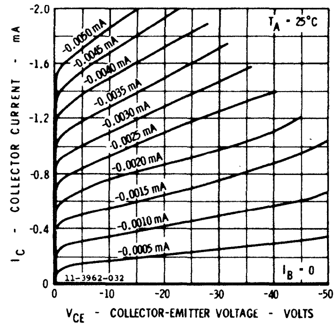
*** Single family characteristic on Transistor Curve Tracer.**

TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4019

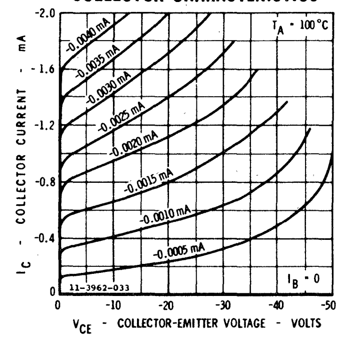
COLLECTOR CHARACTERISTICS*



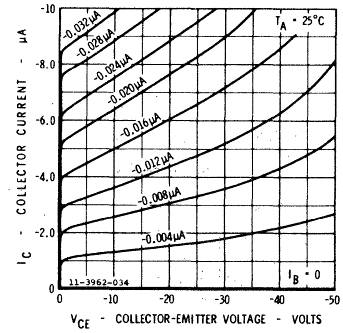
COLLECTOR CHARACTERISTICS



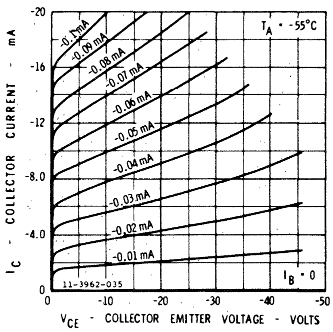
COLLECTOR CHARACTERISTICS



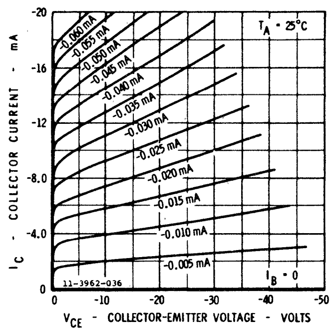
COLLECTOR CHARACTERISTICS



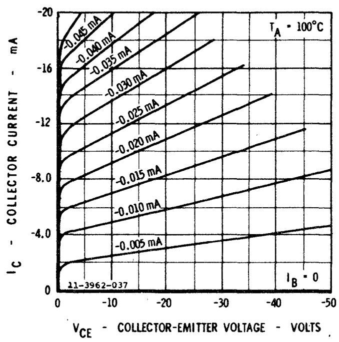
COLLECTOR CHARACTERISTICS*



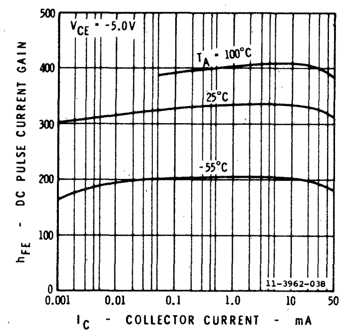
COLLECTOR CHARACTERISTICS*



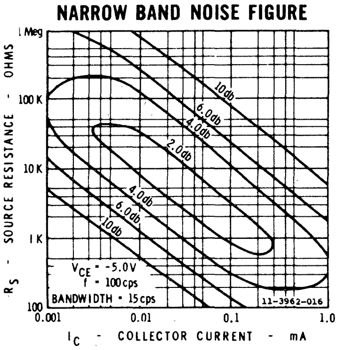
COLLECTOR CHARACTERISTICS*



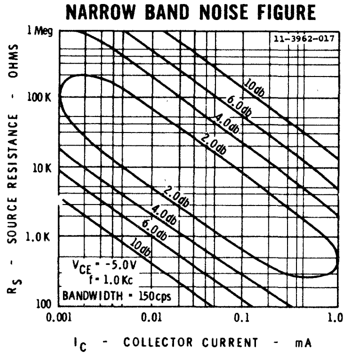
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



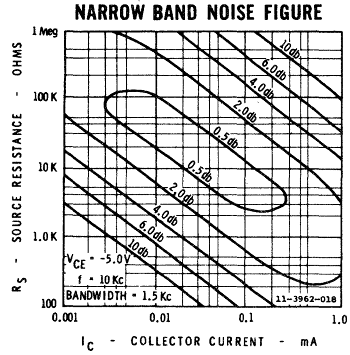
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



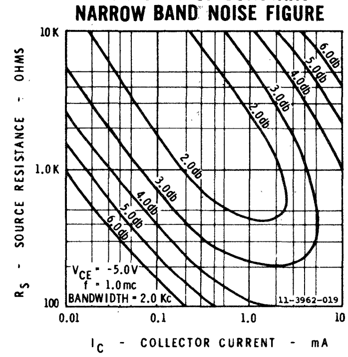
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



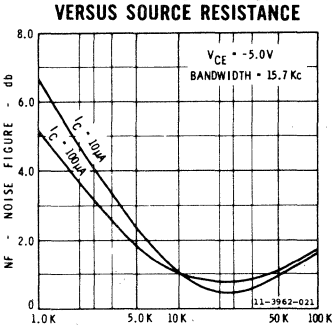
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



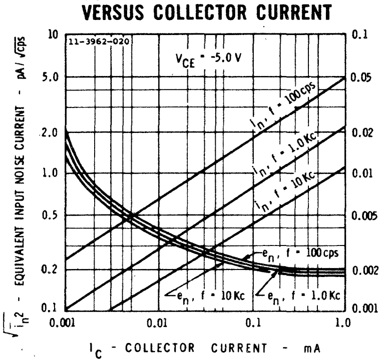
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



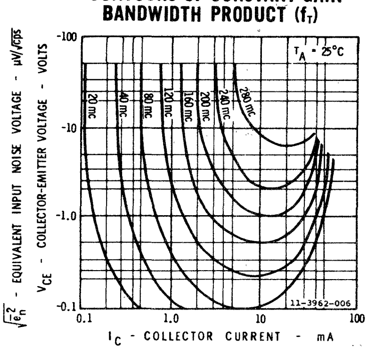
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



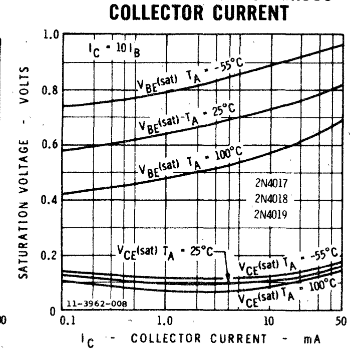
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



* Single family characteristics on Transistor Curve Tracer.

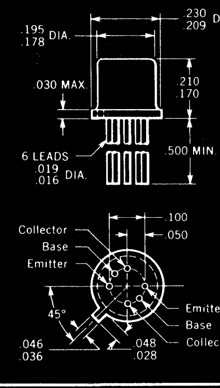
FT4017 • FT4018 • FT4019

DUAL PNP HIGH-GAIN, LOW-NOISE AMPLIFIERS

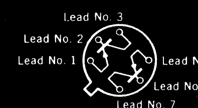
DIFFUSED SILICON PLANAR II EPITAXIAL TRANSISTORS

- **HIGH BREAKDOWN -- 80 VOLT LV_{CEO}**
- **HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT --250 Min. @ 10uA**
- **GUARANTEED BETA @ -55 AND +100°C**
- **LOW NOISE -- 4.0 db Max. @ 100 cps; 8.0 db Max. @ 10 cps**
- **FLAT BETA FROM 1.0uA TO 50 mA**

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM



BOTTOM VIEW

NOTES: All dimensions in inches. Leads are gold plated kovar. Package weight is 0.62 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

		One Side	Both Sides
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.70 Watt	1.10 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.40 Watt	0.50 Watt

Maximum Voltages and Current for Each Transistor

			FT4017	FT4018	FT4019
V_{CBO}	Collector to Base Voltage		-80 Volts	-60 Volts	-45 Volts
V_{CEO}	Collector to Emitter Voltage	(Note 4)	-80 Volts	-60 Volts	-45 Volts
V_{EBO}	Emitter to Base Voltage		-6.0 Volts	-6.0 Volts	-6.0 Volts
I_C	Collector Current		200 mA	200 mA	200 mA

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

Symbol	† FACT Subgroup	Characteristic	FT4017 Min.	FT4017 Max.	FT4018 Min.	FT4018 Max.	FT4019 Min.	FT4019 Max.	Units	Test Conditions
h_{FE}	4	**DC Current Gain**	**60**		**60**		**180**			**I_C = 1.0 μA V_{CE} = -5.0 V**
***h_{FE}**	1a	**DC Current Gain**	**100**	**350**	**100**	**500**	**250**	**500**		**I_C = 10 μA V_{CE} = -5.0 V**
h_{FE}	4	DC Current Gain	100		100		250			I_C = 100 μA V_{CE} = -5.0 V
h_{FE}	4	DC Current Gain	100	500	100	600	250	600		I_C = 1.0 mA V_{CE} = -5.0 V
h_{FE}(100°C)	4	**DC Current Gain**		**600**		**800**		**800**		**I_C = 1.0 mA V_{CE} = -5.0 V**
h_{FE}	4	DC Pulse Current Gain (Note 5)	100		100		200			I_C = 10 mA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 5)	90		90		180			I_C = 50 mA V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 5)	40		40		80			I_C = 50 mA V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Current Gain	40		40		100			I_C = 10 μA V_{CE} = -5.0 V
NF	4	Noise Figure		3.0		3.0		2.0	db	I_C = 20 μA V_{CE} = -5.0 V f = 1.0 Kc BW = 150 cps, R_S = 10 KΩ
NF	4	**Noise Figure**						**8.0**	**db**	I_C = 20 μA V_{CE} = -5.0 V **f = 10 cps, BW = 2.0 cps, R_S = 10 KOhm**
NF	4	**Noise Figure**		10		10		**4.0**	**db**	I_C = 20 μA V_{CE} = -5.0 V **f = 100 cps BW = 15 cps, R_S = 10 KOhm**

† 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 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 437°C/Watt (derating factor of 2.3 mW/°C) for one side; 350°C/Watt (derating factor of 2.8 mW/°C) for both sides. Junction-to-case thermal resistance of 250°C/Watt (derating factor of 4.0 mW/°C) for one side; 159°C/Watt (derating factor of 6.2 mW/°C) for both sides.

(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%.

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

FAIRCHILD SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

FAIRCHILD TRANSISTORS FT4017 • FT4018 • FT4019

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

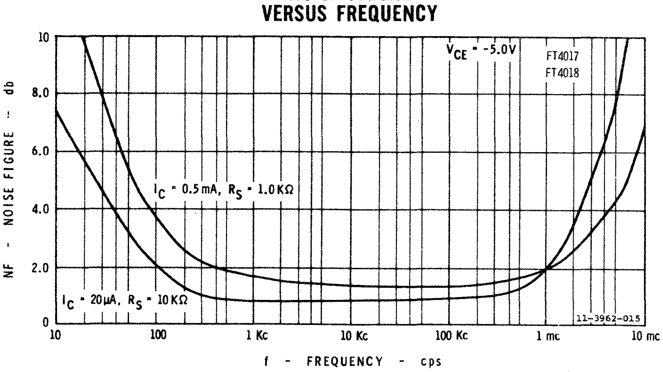
Symbol	† FACT Subgroup	Characteristic	FT4017 Min.	FT4017 Max.	FT4018 Min.	FT4018 Max.	FT4019 Min.	FT4019 Max.	Units	Test Conditions
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-80		-60		-45		Volts	I_C = 10 μA I_E = 0
V_{CEO}(sust)	1a	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**−80**		**−60**		**−45**		**Volts**	**I_C = 5.0 mA** I_B = 0 (pulsed)
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-6.0		-6.0		-6.0		Volts	I_E = 10 μA I_C = 0
*V_{CE}(sat)	1a	Collector Saturation Voltage (pulsed, Note 5)		-0.25		-0.25		-0.25	Volts	I_C = 10 mA I_B = 0.5 mA
V_{CE}(sat)	4	Collector Saturation Voltage (pulsed, Note 5)		-0.4		-0.4		-0.4	Volts	I_C = 50 mA I_B = 5.0 mA
*V_{BE}(sat)	1a	Base Saturation Voltage (pulsed, Note 5)		-0.9		-0.9		-0.9	Volts	I_C = 10 mA I_B = 0.5 mA
V_{BE}(sat)	4	Base Saturation Voltage (pulsed, Note 5)		-0.95		-0.95		-0.95	Volts	I_C = 50 mA I_B = 5.0 mA
*I_{CBO}	1b	Collector Cutoff Current		10					nA	I_E = 0 V_{CB} = -70 V
*I_{CBO}	1b	Collector Cutoff Current				10			nA	I_E = 0 V_{CB} = -50 V
*I_{CBO}	1b	Collector Cutoff Current						10	nA	I_E = 0 V_{CB} = -30 V
I_{CBO}(125°C)	4	Collector Cutoff Current		10					μA	I_E = 0 V_{CB} = -70 V
I_{CBO}(125°C)	4	Collector Cutoff Current				10			μA	I_E = 0 V_{CB} = -50 V
I_{CBO}(125°C)	4	Collector Cutoff Current						10	μA	I_E = 0 V_{CB} = -30 V
*I_{EBO}	1b	Emitter Cutoff Current		10		10		10	nA	I_C = 0 V_{EB} = -4.0 V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.0	8.0	2.0	8.0	2.5	8.0		I_C = 0.5 mA V_{CE} = -5.0 V
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		6.0		6.0		6.0	pf	I_E = 0 V_{CB} = -5.0 V
h_{fe}	4	Small Signal Current Gain (f = 1.0 Kc)	100	550	100	700	250	700		I_C = 1.0 mA V_{CE} = -5.0 V
h_{ie}	4	Input Resistance (f = 1.0 Kc)	2.5	17	2.5	20	6.0	20	Kohm.	I_C = 1.0 mA V_{CE} = -5.0 V
h_{oe}	4	Output Conductance (f = 1.0 Kc)	5.0	40	5.0	50	5.0	50	μmho	I_C = 1.0 mA V_{CE} = -5.0 V
h_{re}	4	Voltage Feedback Ratio (f = 1.0 Kc)		10		10		10	$x10^{-4}$	I_C = 1.0 mA V_{CE} = -5.0 V

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

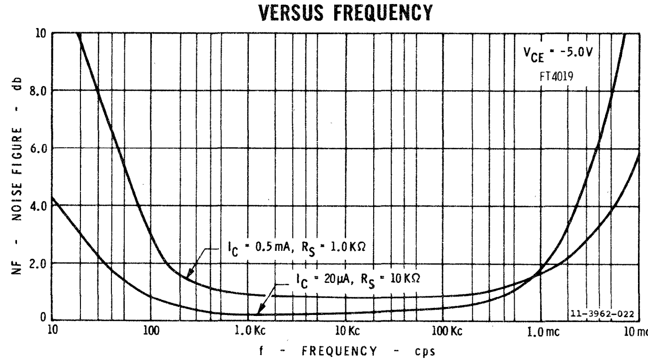
*NOTE: **FACT** Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

NOISE FIGURE VERSUS FREQUENCY

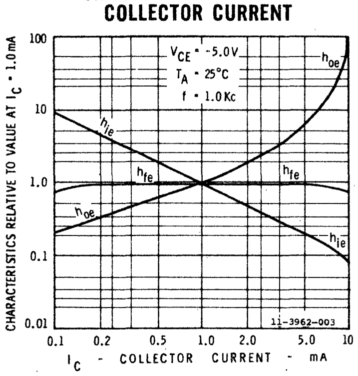


NOISE FIGURE VERSUS FREQUENCY

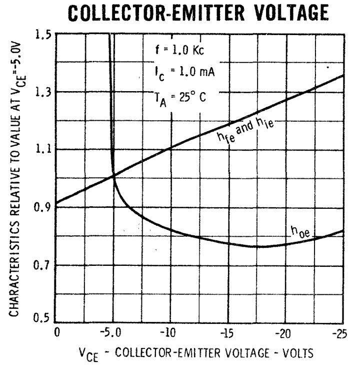


THESE CURVES APPLY TO ALL TYPES

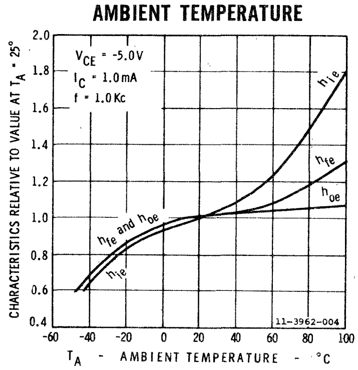
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



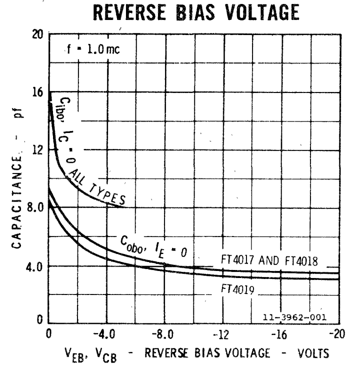
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE



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

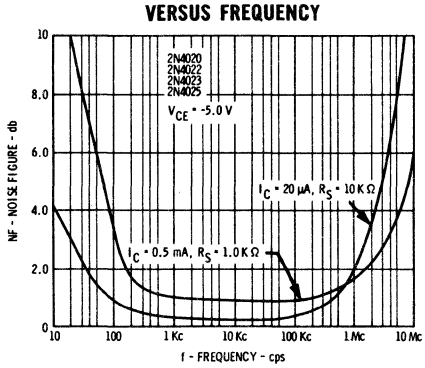
Symbol	† FACT Subgroup	Characteristic	2N4021, 2N4024 Min.	2N4021, 2N4024 Max.	2N4020, 2N4022, 2N4023, 2N4025 Min.	2N4020, 2N4022, 2N4023, 2N4025 Max.	Units	Test Conditions
h_{FE}	4	**DC Current Gain**	**60**		**180**			**I_C = 1.0 μA** V_{CE} = -5.0 V
h_{FE}	4	**DC Current Gain**	**100**	**350**	**250**	**500**		**I_C = 10 μA** V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Current Gain	40		100			I_C = 10 μA V_{CE} = -5.0 V
*h_{FE}	1a	**DC Current Gain**	100	400	250	550		I_C = 100 μA V_{CE} = -5.0 V
h_{FE}	4	DC Current Gain	100	500	250	600		I_C = 1.0 mA V_{CE} = -5.0 V
h_{FE}(100°C)	4	DC Current Gain		**600**		**800**		**I_C = 1.0 mA** V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 6)	100		200			I_C = 10 mA V_{CE} = -5.0 V
h_{FE}	4	DC Pulse Current Gain (Note 6)	90		180			I_C = 50 mA V_{CE} = -5.0 V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 6)	40		80			I_C = 50 mA V_{CE} = -5.0 V
NF	4	Noise Figure		3.0		2.0	db	I_C = 20 μA, V_{CE} = -5.0 V, f = 1.0 Kc, BW = 150 cps, R_S = 10 KΩ
NF	4	**Noise Figure**				**8.0**	**db**	I_C = 20 μA, V_{CE} = -5.0 V, **f = 10 cps, BW = 2.0 cps, R_S = 10 Kohm**
NF	4	**Noise Figure**		10		**4.0**	**db**	I_C = 20 μA, V_{CE} = -5.0 V, **f = 100 cps, BW = 15 cps, R_S = 10 Kohm**
*V_{CE}(sat)	1b	Collector Saturation Voltage		-0.25		-0.25	Volts	I_C = 10 mA I_B = 0.5 mA
V_{CE}(sat)	4	Collector Saturation Voltage (Note 6)		-0.4		-0.4	Volts	I_C = 50 mA (pulsed) I_B = 5.0 mA
*V_{BE}(sat)	1b	Base Saturation Voltage		-0.9		-0.9	Volts	I_C = 10 mA I_B = 0.5 mA
V_{BE}(sat)	4	Base Saturation Voltage (Note 6)		-0.95		-0.95	Volts	I_C = 50 mA (pulsed) I_B = 5.0 mA
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		6.0		6.0	pf	I_E = 0 V_{CB} = -5.0 V
C_{ibo}	4	Common-Base, Open-Circuit Input Capacitance		15		15	pf	I_C = 0 V_{EB} = -0.5 V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.0	8.0	2.5	8.0		I_C = 0.5 mA V_{CE} = -5.0 V
h_{ie}	4	Input Resistance (f = 1.0 Kc)	2.5	17	6.0	20	KOhm	I_C = 1.0 mA V_{CE} = -5.0 V
h_{oe}	4	Output Conductance (f = 1.0 Kc)	5.0	40	5.0	50	μmho	I_C = 1.0 mA V_{CE} = -5.0 V
h_{re}	4	Reverse Voltage Feedback Ratio (f = 1.0 Kc)		10		10	$x10^{-4}$	I_C = 1.0 mA V_{CE} = -5.0 V
h_{fe}	4	Small Signal Current Gain (f = 1.0 Kc)	100	550	250	700		I_C = 1.0 mA V_{CE} = -5.0 V

Symbol	† FACT Subgroup	Characteristic	2N4020, 2N4023 Min.	2N4020, 2N4023 Max.	2N4021, 2N4022, 2N4024, 2N4025 Min.	2N4021, 2N4022, 2N4024, 2N4025 Max.	Units	Test Conditions
*I_{CBO}	1b	Collector Cutoff Current		10			nA	I_E = 0 V_{CB} = -30 V
*I_{CBO}	1b	Collector Cutoff Current				10	nA	I_E = 0 V_{CB} = -50 V
*I_{CBO}(125°C)	1b	Collector Cutoff Current		10			μA	I_E = 0 V_{CB} = -30 V
*I_{CBO}(125°C)	1b	Collector Cutoff Current				10	μA	I_E = 0 V_{CB} = -50 V
*I_{EBO}	1b	Emitter Cutoff Current		10		10	nA	I_C = 0 V_{EB} = -4.0 V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-45		-60		Volts	I_E = 0 I_C = 10 μA
V_{CEO}(sust)	1a	**Collector to Emitter Sustaining Voltage** Voltage (Notes 4 and 5)	**—45**		**—60**		**Volts**	**I_C = 5.0 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

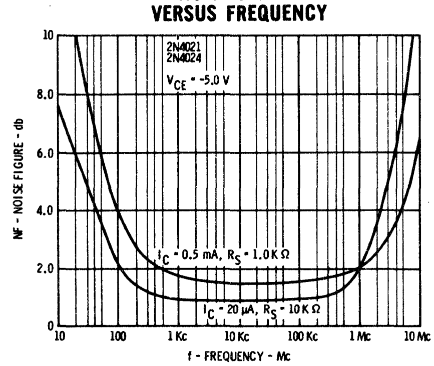
†NOTE: These Numerals Apply to the Fairchild **FACT** Program.
*NOTE: **FACT** Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

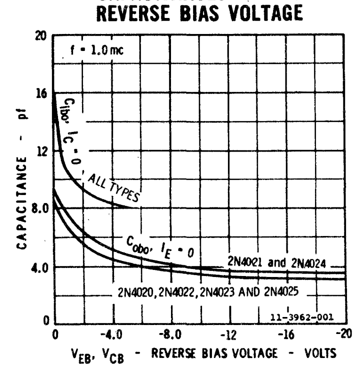
NOISE FIGURE VERSUS FREQUENCY



NOISE FIGURE VERSUS FREQUENCY

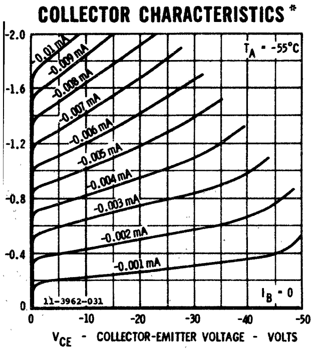


INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE

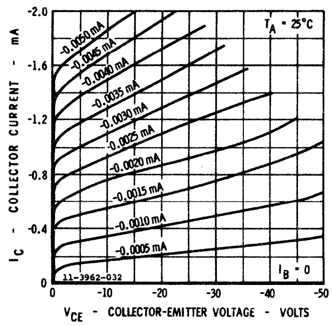


TYPICAL ELECTRICAL CHARACTERISTICS FOR FT4019

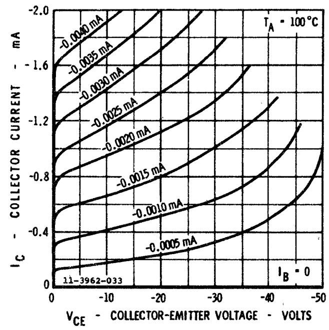
COLLECTOR CHARACTERISTICS *



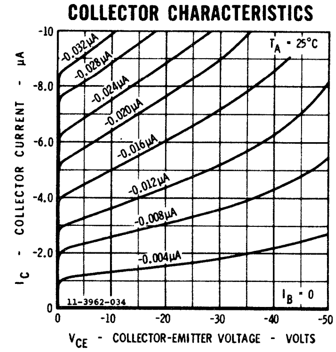
COLLECTOR CHARACTERISTICS



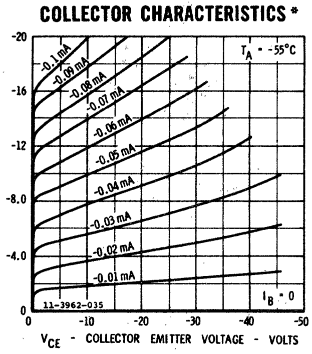
COLLECTOR CHARACTERISTICS



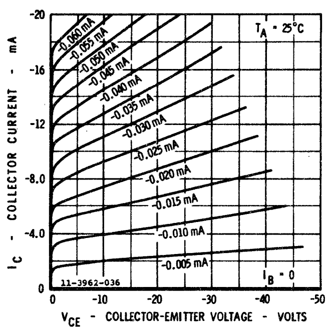
COLLECTOR CHARACTERISTICS



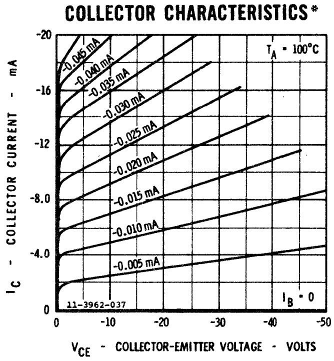
COLLECTOR CHARACTERISTICS *



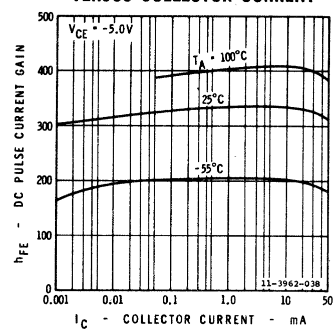
COLLECTOR CHARACTERISTICS *



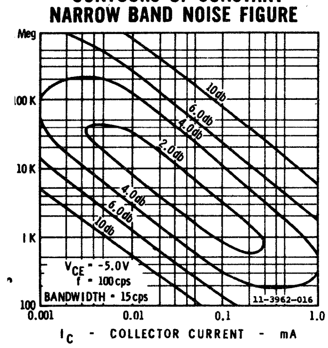
COLLECTOR CHARACTERISTICS *



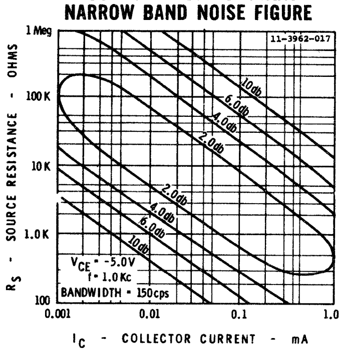
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



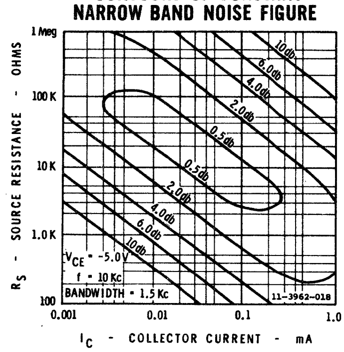
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



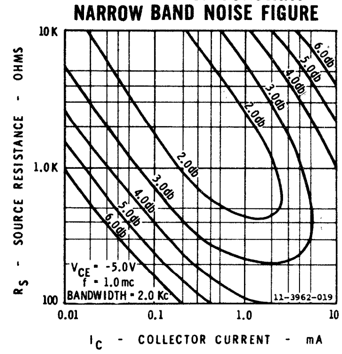
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



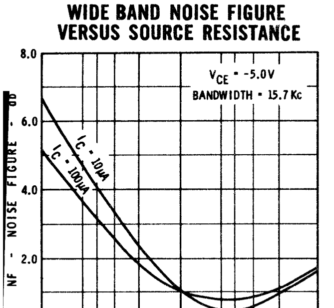
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



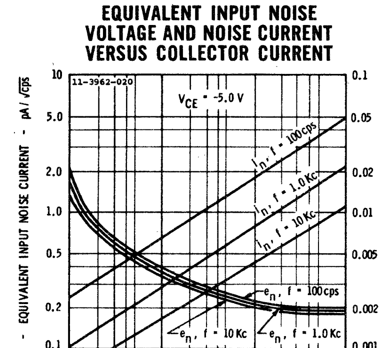
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



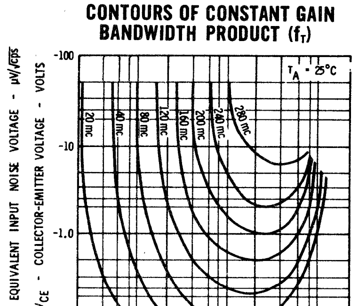
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



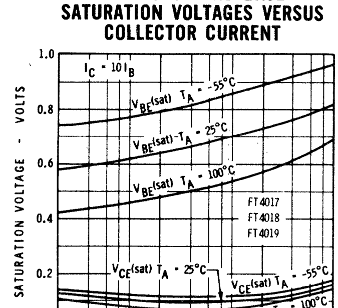
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



* Single family characteristics on Transistor Curve Tracer.

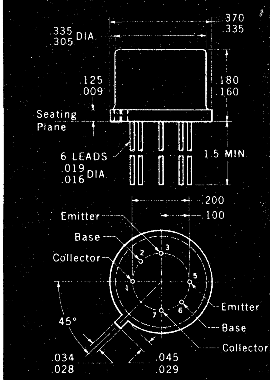
2N4020 THROUGH 2N4025

PNP HIGH-GAIN, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR II EPITAXIAL TRANSISTORS

- HIGH BREAKDOWN -- 45 AND 60 VOLT LV_{CEO}
- HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT -- 250 Min. @ 10 uA
- GUARANTEED BETA AT -55 AND +100°C
- 10% BETA MATCH FROM 100µA TO 1.0 mA
- LOW NOISE -- 4.0 db Max. @ 100 cps; 8.0 db Max. @ 10 cps
- FLAT BETA FROM 1.0 uA TO 50 mA

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM

BOTTOM VIEW

NOTES: All dimensions in inches
Leads are gold plated kovar
Package weight is 1.08 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

		One Side	Both Sides
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.80 Watt	1.3 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.40 Watt	0.60 Watts

Maximum Voltages and Current for each Transistor

			2N4021 2N4022 2N4024 2N4025	2N4020 2N4023
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		-6.0 Volts	-6.0 Volts
I_C	Collector Current		200 mA	200 mA

MATCHING CHARACTERISTICS

(25°C Free Air Temperature unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic	2N4020 2N4021 2N4022 Min.	2N4020 2N4021 2N4022 Max.	**2N4023 2N4024** 2N4025 Min.	**2N4023 2N4024** 2N4025 Max.	Units	Test Conditions	
$*\frac{h_{FE1}}{h_{FE2}}$	1a	**DC Current Gain Ratio** (Note 5)	0.8	1.0	**0.9**	**1.0**		I_C = **100 µA to 1.0 mA**	V_{CE} = -5.0 V
$*\lvert V_{BE1} - V_{BE2} \rvert$	1a	**Base-Emitter Voltage Differential**		5.0		**3.0**	**mV**	I_C = **100 µA**	V_{CE} = -5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	4	**Base-Emitter Voltage Differential**		10		**5.0**	**mV**	I_C = **100 µA to 1.0 mA**	V_{CE} = -5.0 V
$\lvert \Delta (V_{BE1} - V_{BE2}) \rvert$	4	Base-Emitter Voltage Differential Change (T_A = -55°C to +25°C)		1.6		0.8	mV	I_C = 100 µA	V_{CE} = -5.0 V
$\lvert \Delta (V_{BE1} - V_{BE2}) \rvert$	4	Base-Emitter Voltage Differential Change (T_A = 25°C to +125°C)		2.0		1.0	mV	I_C = 100 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 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 437°C/Watt (derating factor of 2.3 mW/°C) for one side; 292°C/Watt (derating factor of 3.4 mW/°C) for both sides. Junction-to-case thermal resistance of 219°C/Watt (derating factor of 4.57 mW/°C) for one side; 135°C/Watt (derating factor of 7.4 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Pulse Conditions: length = 300 µsec; duty cycle = 1%.

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LECTRICAL CHARACTERISTICS
25°C Free Air Temperature unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic	2N4021 2N4024 Min.	2N4021 2N4024 Max.	2N4020 2N4022 2N4023 2N4025 Min.	2N4020 2N4022 2N4023 2N4025 Max.	Units	Test Conditions
h_{FE}	4	**DC Current Gain**	**60**		**180**			**$I_C = 1.0\ \mu A$ $V_{CE} = -5.0$ V**
h_{FE}	4	**DC Current Gain**	**100**	**350**	**250**	**500**		**$I_C = 10\ \mu A$ $V_{CE} = -5.0$ V**
$h_{FE}(-55°C)$	4	DC Current Gain	40		100			$I_C = 10\ \mu A$ $V_{CE} = -5.0$ V
*h_{FE}	1a	**DC Current Gain**	100	400	250	550		$I_C = 100\ \mu A$ $V_{CE} = -5.0$ V
h_{FE}	4	DC Current Gain	100	500	250	600		$I_C = 1.0$ mA $V_{CE} = -5.0$ V
$h_{FE}(100°C)$	4	DC Current Gain		**600**		**800**		**$I_C = 1.0$ mA** $V_{CE} = -5.0$ V
h_{FE}	4	DC Pulse Current Gain (Note 6)	100		200			$I_C = 10$ mA $V_{CE} = -5.0$ V
h_{FE}	4	DC Pulse Current Gain (Note 6)	90		180			$I_C = 50$ mA $V_{CE} = -5.0$ V
$h_{FE}(-55°C)$	4	DC Pulse Current Gain (Note 6)	40		80			$I_C = 50$ mA $V_{CE} = -5.0$ V
NF	4	Noise Figure		3.0		2.0	db	$I_C = 20\ \mu A$, $V_{CE} = -5.0$ V, f = 1.0 Kc, BW = 150 cps, $R_S = 10\ K\Omega$
NF	4	**Noise Figure**				**8.0**	**db**	$I_C = 20\ \mu A$, $V_{CE} = -5.0$ V, **f = 10 cps, BW = 2.0 cps, R_S = 10 Kohm**
NF	4	**Noise Figure**		10		**4.0**	**db**	$I_C = 20\ \mu A$, $V_{CE} = -5.0$ V, **f = 100 cps, BW = 15 cps, R_S = 10 Kohm**
*$V_{CE}(sat)$	1b	Collector Saturation Voltage		-0.25		-0.25	Volts	$I_C = 10$ mA $I_B = 0.5$ mA
$V_{CE}(sat)$	4	Collector Saturation Voltage (Note 6)		-0.4		-0.4	Volts	$I_C = 50$ mA (pulsed) $I_B = 5.0$ mA
*$V_{BE}(sat)$	1b	Base Saturation Voltage		-0.9		-0.9	Volts	$I_C = 10$ mA $I_B = 0.5$ mA
$V_{BE}(sat)$	4	Base Saturation Voltage (Note 6)		-0.95		-0.95	Volts	$I_C = 50$ mA (pulsed) $I_B = 5.0$ mA
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		6.0		6.0	pf	$I_E = 0$ $V_{CB} = -5.0$ V
C_{ibo}	4	Common-Base, Open-Circuit Input Capacitance		15		15	pf	$I_C = 0$ $V_{EB} = -0.5$ V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.0	8.0	2.5	8.0		$I_C = 0.5$ mA $V_{CE} = -5.0$ V
h_{ie}	4	Input Resistance (f = 1.0 Kc)	2.5	17	6.0	20	KOhm	$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{oe}	4	Output Conductance (f = 1.0 Kc)	5.0	40	5.0	50	μmho	$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{re}	4	Reverse Voltage Feedback Ratio (f = 1.0 Kc)		10		10	$x10^{-4}$	$I_C = 1.0$ mA $V_{CE} = -5.0$ V
h_{fe}	4	Small Signal Current Gain (f = 1.0 Kc)	100	550	250	700		$I_C = 1.0$ mA $V_{CE} = -5.0$ V

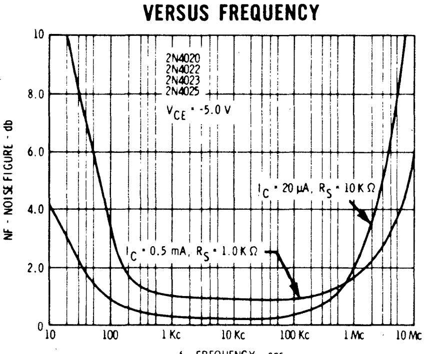
Symbol	† FACT Subgroup	Characteristic	2N4020 2N4023 Min.	2N4020 2N4023 Max.	2N4021 2N4022 2N4024 2N4025 Min.	2N4021 2N4022 2N4024 2N4025 Max.	Units	Test Conditions
*I_{CBO}	1b	Collector Cutoff Current		10			nA	$I_E = 0$ $V_{CB} = -30$ V
*I_{CBO}	1b	Collector Cutoff Current				10	nA	$I_E = 0$ $V_{CB} = -50$ V
*$I_{CBO}(125°C)$	1b	Collector Cutoff Current		10			μA	$I_E = 0$ $V_{CB} = -30$ V
*$I_{CBO}(125°C)$	1b	Collector Cutoff Current				10	μA	$I_E = 0$ $V_{CB} = -50$ V
*I_{EBO}	1b	Emitter Cutoff Current		10		10	nA	$I_C = 0$ $V_{EB} = -4.0$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-45		-60		Volts	$I_E = 0$ $I_C = 10\ \mu A$
$V_{CEO}(sust)$	1a	**Collector to Emitter Sustaining Voltage** Voltage (Notes 4 and 5)	**—45**		**—60**		**Volts**	**$I_C = 5.0$ mA** (pulsed) $I_B = 0$
BV_{EBO}	1a	Emitter to Base Breakdown Voltage	-6.0		-6.0		Volts	$I_C = 0$ $I_E = 10\ \mu A$

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

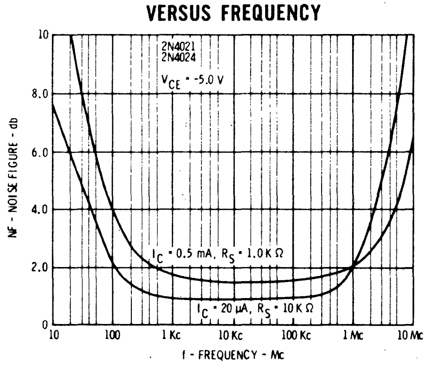
*NOTE: **FACT** Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

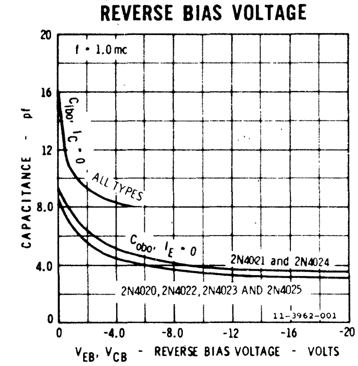
NOISE FIGURE VERSUS FREQUENCY



NOISE FIGURE VERSUS FREQUENCY

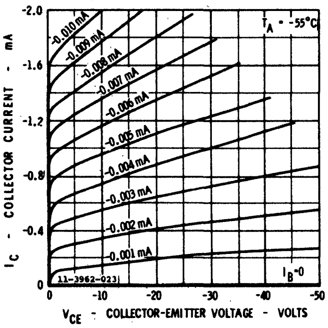


INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE

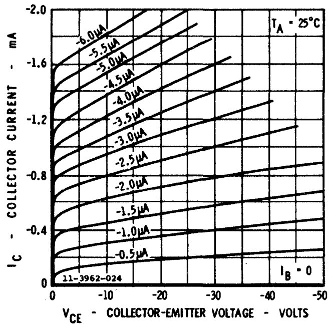


TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4021 AND 2N4024

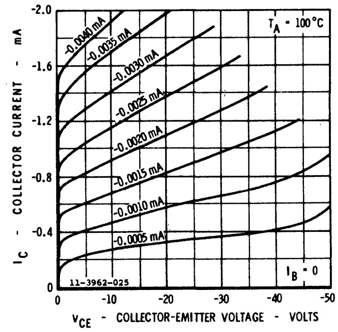
COLLECTOR CHARACTERISTICS*



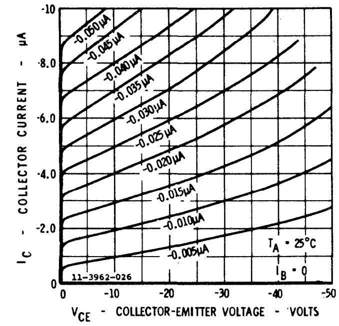
COLLECTOR CHARACTERISTICS



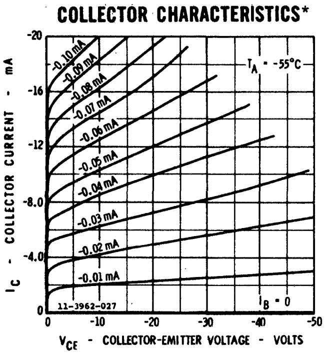
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS*



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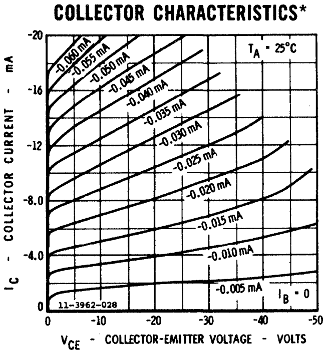
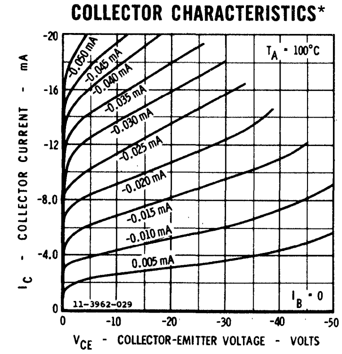
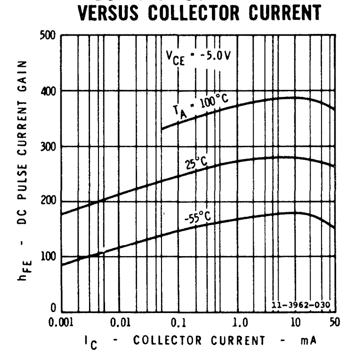


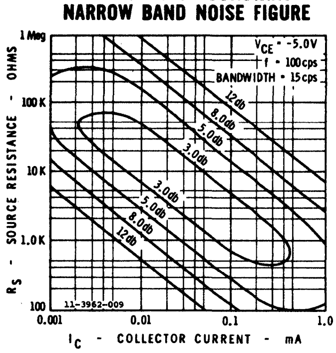
COLLECTOR CHARACTERISTICS*



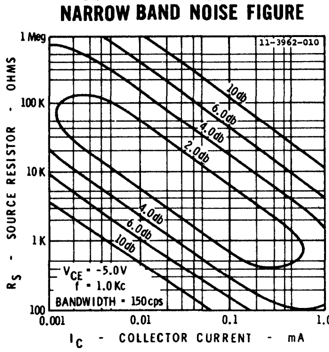
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



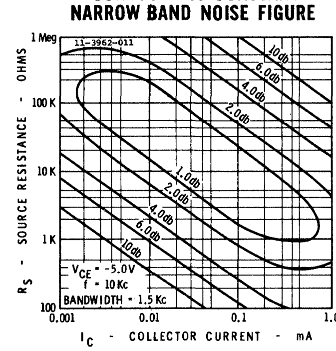
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



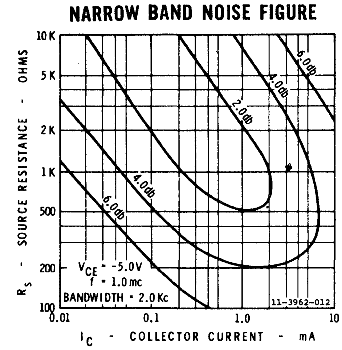
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



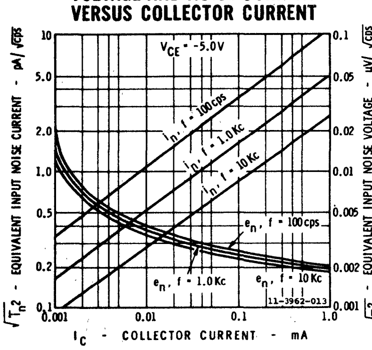
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



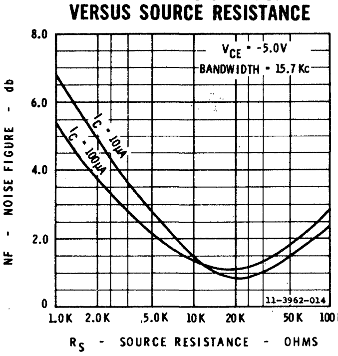
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



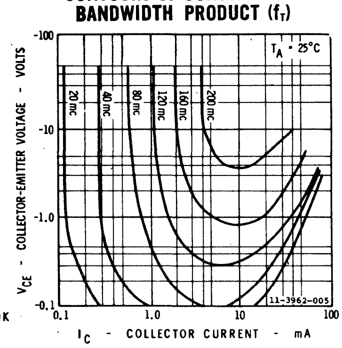
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



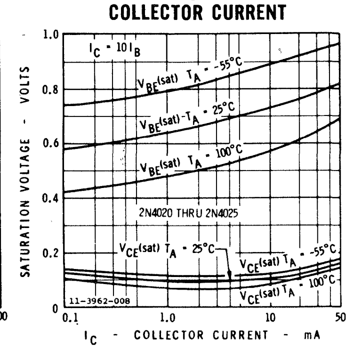
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



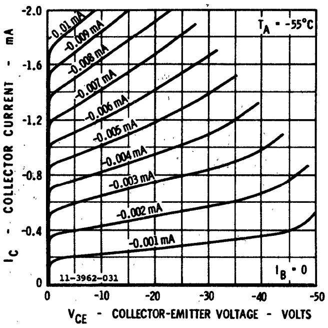
COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



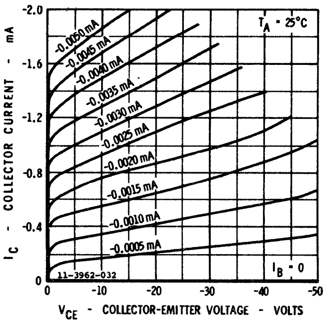
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS FOR 2N4020, 2N4022, 2N4023 AND 2N4025

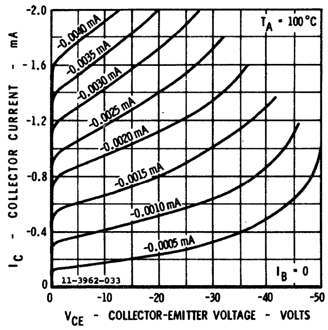
COLLECTOR CHARACTERISTICS*



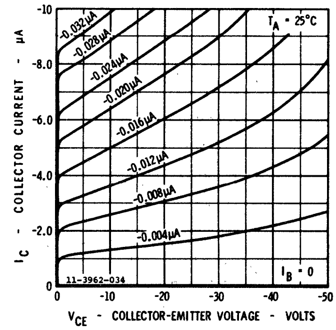
COLLECTOR CHARACTERISTICS



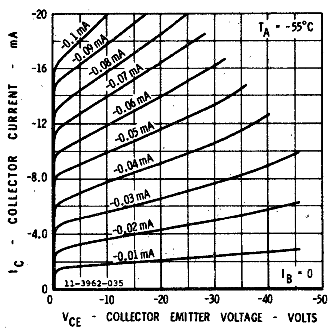
COLLECTOR CHARACTERISTICS



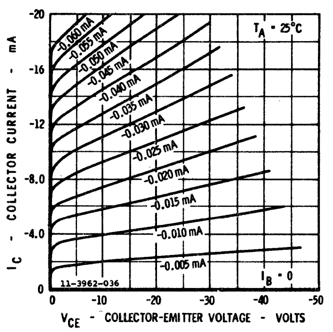
COLLECTOR CHARACTERISTICS



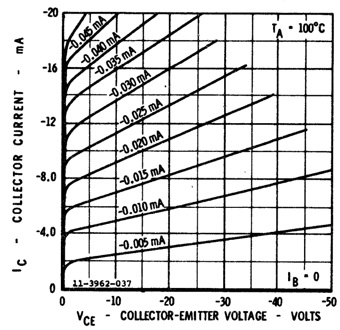
COLLECTOR CHARACTERISTICS*



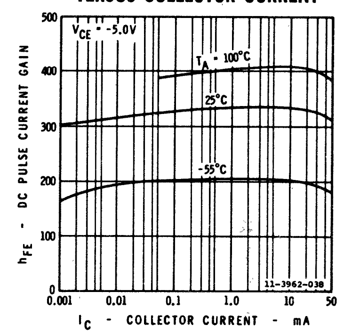
COLLECTOR CHARACTERISTICS*



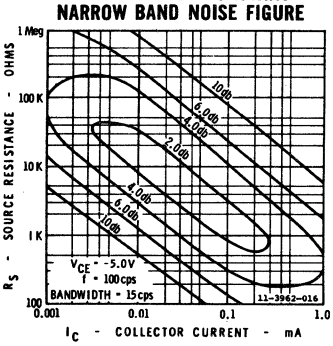
COLLECTOR CHARACTERISTICS*



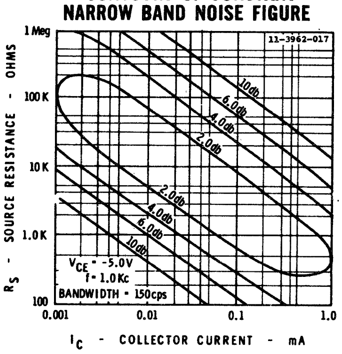
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



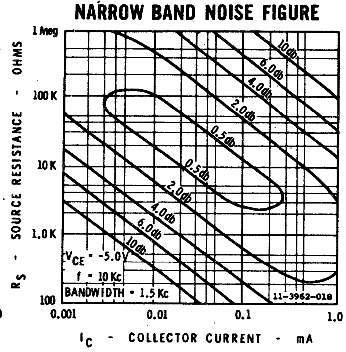
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



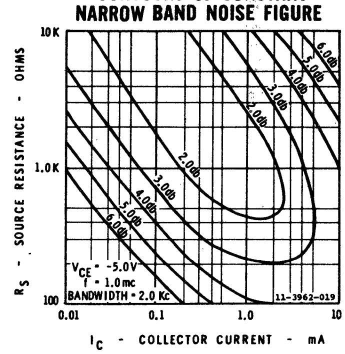
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



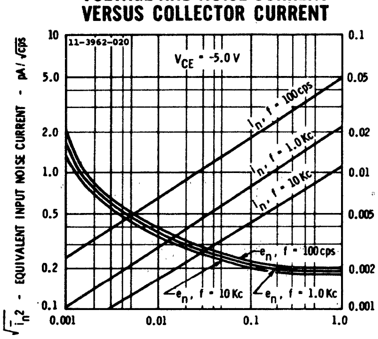
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



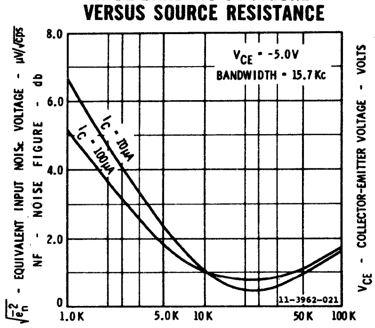
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



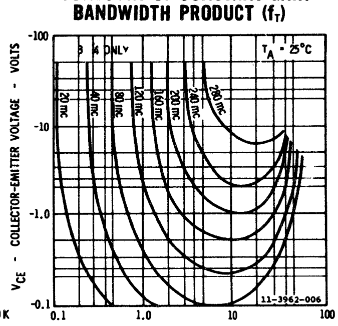
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



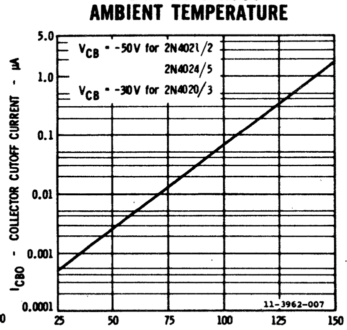
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



* Single family characteristics on Transistor Curve Tracer.

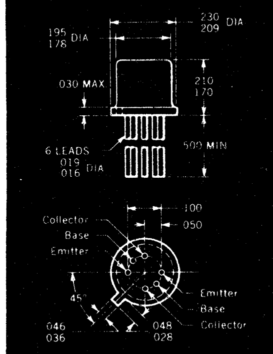
FT4020 THROUGH FT4025

PNP HIGH-GAIN, LOW-NOISE DIFFERENTIAL AMPLIFIERS

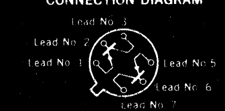
DIFFUSED SILICON PLANAR II EPITAXIAL TRANSISTORS

- **HIGH BREAKDOWN -- 45 AND 60 VOLT LV_{CEO}**
- **HIGH CURRENT GAIN AT LOW COLLECTOR CURRENT -- 250 Min. @ 10 uA**
- **GUARANTEED BETA AT-55 AND +100°C**
- **10% BETA MATCH FROM 100μA TO 1.0 mA**
- **LOW NOISE -- 4.0 db Max. @ 100 cps; 8.0 db Max. @ 10 cps**
- **FLAT BETA FROM 1.0 uA TO 50 mA**

PHYSICAL DIMENSIONS



CONNECTION DIAGRAM



BOTTOM VIEW

NOTES: All dimensions in inches
Leads are gold plated kovar
Package weight is [illegible] 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

		One Side	Both Sides
Total Dissipation at 25°C Case Temperature	(Notes 2 and 3)	0.70 Watt	1.10 Watts
at 25°C Ambient Temperature	(Notes 2 and 3)	0.40 Watt	0.50 Watts

Maximum Voltages and Current for each Transistor

			FT4021 FT4022 FT4024 FT4025	FT4020 FT4023
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		-6.0 Volts	-6.0 Volts
I_C	Collector Current		200 mA	200 mA

MATCHING CHARACTERISTICS

(25°C Free Air Temperature unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic	FT4020 FT4021 FT4022 Min.	FT4020 FT4021 FT4022 Max.	FT4023 FT4024 FT4025 Min.	FT4023 FT4024 FT4025 Max.	Units	Test Conditions	
* $\frac{h_{FE1}}{h_{FE2}}$	1a	**DC Current Gain Ratio** (Note 5)	0.8	1.0	**0.9**	**1.0**		I_C = **100 μA to 1.0 mA**	V_{CE} = -5.0 V
* $\lvert V_{BE1} - V_{BE2} \rvert$	1a	**Base-Emitter Voltage Differential**		5.0		**3.0**	**mV**	I_C = **100 μA**	V_{CE} = -5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	4	**Base-Emitter Voltage Differential**		10		**5.0**	**mV**	I_C = **100 μA to 1.0 mA**	V_{CE} = -5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	4	Base-Emitter Voltage Differential Change (T_A = -55°C to +25°C)		1.6		0.8	mV	I_C = 100 μA	V_{CE} = -5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	4	Base-Emitter Voltage Differential Change (T_A = 25°C to +125°C)		2.0		1.0	mV	I_C = 100 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 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 437°C/Watt (derating factor of 2.3 mW/°C) for one side; 350°C/Watt (derating factor of 2.8 mW/°C) for both sides. Junction-to-case thermal resistance of 250°C/Watt (derating factor of 4.0 mW/°C) for one side; 159°C/Watt (derating factor of 6.2 mW/°C) for both sides.

(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.

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

FAIRCHILD
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FAIRCHILD TRANSISTORS FT4020 THROUGH FT4025

ELECTRICAL CHARACTERISTICS

(25°C Free Air Temperature unless otherwise noted)

Symbol	† FACT Subgroup	Characteristic	FT4021 FT4024 Min.	FT4021 FT4024 Max.	FT4020 FT4022 FT4023 FT4025 Min.	FT4020 FT4022 FT4023 FT4025 Max.	Units	Test Conditions
h_{FE}	4	**DC Current Gain**	**60**		**180**			**$I_C = 1.0\ \mu A$** $V_{CE} = -5.0$ V
h_{FE}	4	**DC Current Gain**	**100**	**350**	**250**	**500**		**$I_C = 10\ \mu A$** $V_{CE} = -5.0$ V
h_{FE}(-55°C)	4	DC Current Gain	40		100			I_C = 10 μA $V_{CE} = -5.0$ V
*h_{FE}	1a	**DC Current Gain**	100	400	250	550		I_C = 100 μA $V_{CE} = -5.0$ V
h_{FE}	4	DC Current Gain	100	500	250	600		I_C = 1.0 mA $V_{CE} = -5.0$ V
h_{FE}(100°C)	4	DC Current Gain		**600**		**800**		**$I_C = 1.0$ mA** $V_{CE} = -5.0$ V
h_{FE}	4	DC Pulse Current Gain (Note 6)	100		200			I_C = 10 mA $V_{CE} = -5.0$ V
h_{FE}	4	DC Pulse Current Gain (Note 6)	90		180			I_C = 50 mA $V_{CE} = -5.0$ V
h_{FE}(-55°C)	4	DC Pulse Current Gain (Note 6)	40		80			I_C = 50 mA $V_{CE} = -5.0$ V
NF	4	Noise Figure		3.0		2.0	db	I_C = 20 μA, $V_{CE} = -5.0$ V, f = 1.0 Kc, BW = 150 cps, R_S = 10 KΩ
NF	4	**Noise Figure**				**8.0**	**db**	I_C = 20 μA, $V_{CE} = -5.0$ V, **f = 10 cps, BW = 2.0 cps, R_S = 10 Kohm**
NF	4	**Noise Figure**		10		**4.0**	**db**	I_C = 20 μA, $V_{CE} = -5.0$ V, **f = 100 cps, BW = 15 cps, R_S = 10 Kohm**
*V_{CE}(sat)	1b	Collector Saturation Voltage		-0.25		-0.25	Volts	I_C = 10 mA I_B = 0.5 mA
V_{CE}(sat)	4	Collector Saturation Voltage (Note 6)		-0.4		-0.4	Volts	I_C = 50 mA (pulsed) I_B = 5.0 mA
*V_{BE}(sat)	1b	Base Saturation Voltage		-0.9		-0.9	Volts	I_C = 10 mA I_B = 0.5 mA
V_{BE}(sat)	4	Base Saturation Voltage (Note 6)		-0.95		-0.95	Volts	I_C = 50 mA (pulsed) I_B = 5.0 mA
C_{obo}	4	Common-Base, Open-Circuit Output Capacitance		6.0		6.0	pf	I_E = 0 $V_{CB} = -5.0$ V
C_{ibo}	4	Common-Base, Open-Circuit Input Capacitance		15		15	pf	I_C = 0 $V_{EB} = -0.5$ V
h_{fe}	4	High Frequency Current Gain (f = 20 Mc)	2.0	8.0	2.5	8.0		I_C = 0.5 mA $V_{CE} = -5.0$ V
h_{ie}	4	Input Resistance (f = 1.0 Kc)	2.5	17	6.0	20	KOhm	I_C = 1.0 mA $V_{CE} = -5.0$ V
h_{oe}	4	Output Conductance (f = 1.0 Kc)	5.0	40	5.0	50	μmho	I_C = 1.0 mA $V_{CE} = -5.0$ V
h_{re}	4	Reverse Voltage Feedback Ratio (f = 1.0 Kc)		10		10	$x10^{-4}$	I_C = 1.0 mA $V_{CE} = -5.0$ V
h_{fe}	4	Small Signal Current Gain (f = 1.0 Kc)	100	550	250	700		I_C = 1.0 mA $V_{CE} = -5.0$ V

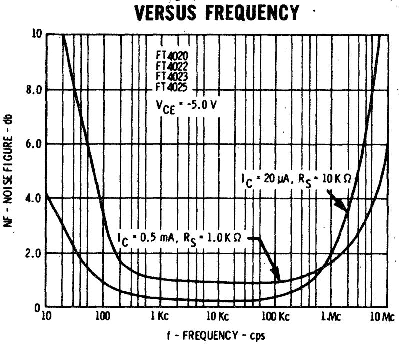
Symbol	† FACT Subgroup	Characteristic	FT4020 FT4023 Min.	FT4020 FT4023 Max.	FT4021 FT4022 FT4024 FT4025 Min.	FT4021 FT4022 FT4024 FT4025 Max.	Units	Test Conditions
*I_{CBO}	1b	Collector Cutoff Current		10			nA	I_E = 0 $V_{CB} = -30$ V
*I_{CBO}	1b	Collector Cutoff Current				10	nA	I_E = 0 $V_{CB} = -50$ V
*I_{CBO}(125°C)	1b	Collector Cutoff Current		10			μA	I_E = 0 $V_{CB} = -30$ V
*I_{CBO}(125°C)	1b	Collector Cutoff Current				10	μA	I_E = 0 $V_{CB} = -50$ V
*I_{EBO}	1b	Emitter Cutoff Current		10		10	nA	I_C = 0 $V_{EB} = -4.0$ V
BV_{CBO}	1a	Collector to Base Breakdown Voltage	-45		-60		Volts	I_E = 0 I_C = 10 μA
V_{CEO}(sust)	1a	**Collector to Emitter Sustaining Voltage** Voltage (Notes 4 and 5)	**—45**		**—60**		**Volts**	**$I_C = 5.0$ 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

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

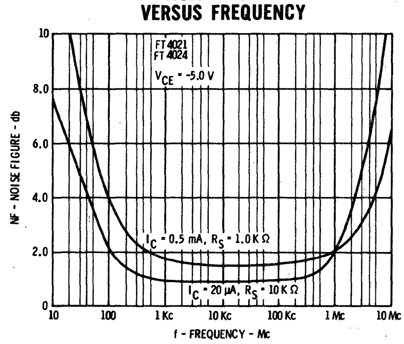
*NOTE: **FACT** Program End-Point Measurement Parameter.

TYPICAL ELECTRICAL CHARACTERISTICS

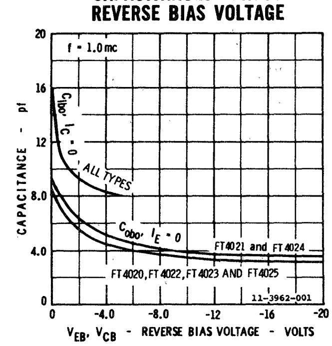
NOISE FIGURE VERSUS FREQUENCY



NOISE FIGURE VERSUS FREQUENCY

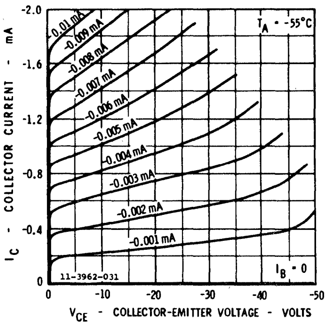


INPUT AND OUTPUT CAPACITANCES VERSUS REVERSE BIAS VOLTAGE

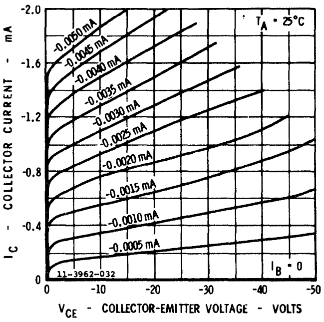


TYPICAL ELECTRICAL CHARACTERISTICS FOR FT4020, FT4022, FT4023 AND FT4025

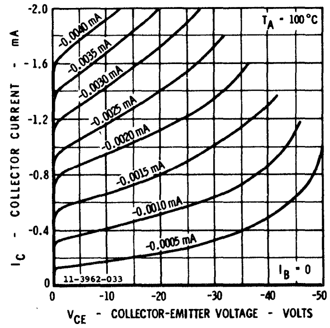
COLLECTOR CHARACTERISTICS*



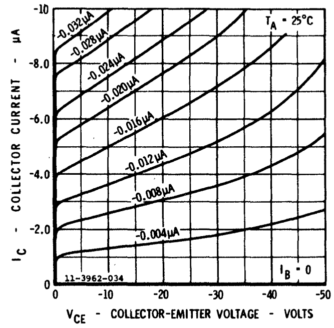
COLLECTOR CHARACTERISTICS



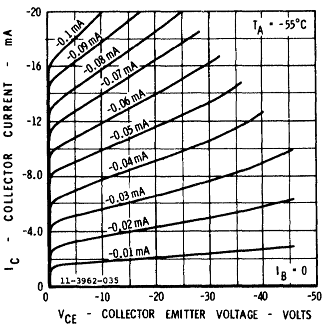
COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS



COLLECTOR CHARACTERISTICS*



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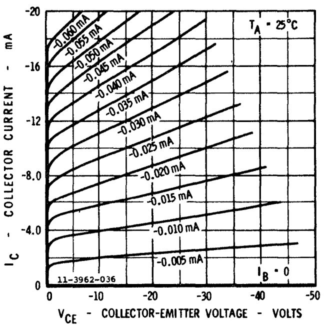

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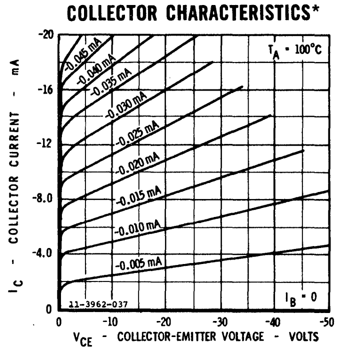
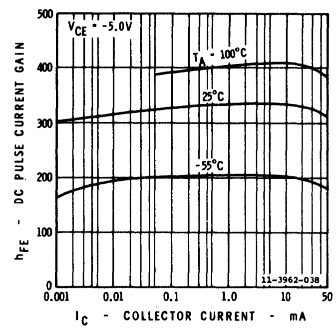
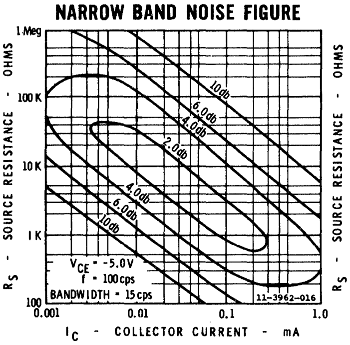


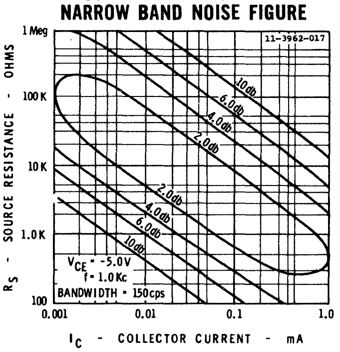
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



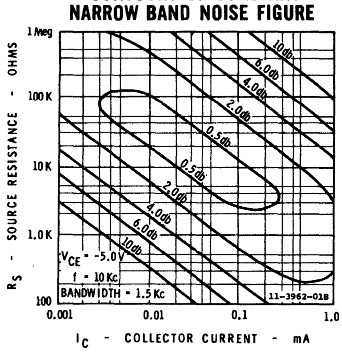
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



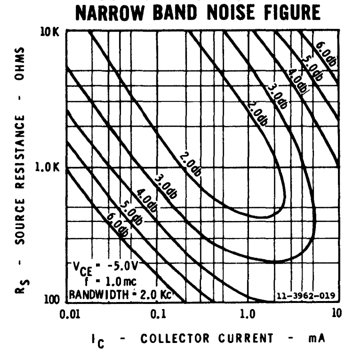
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



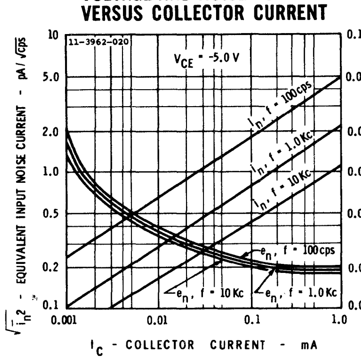
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



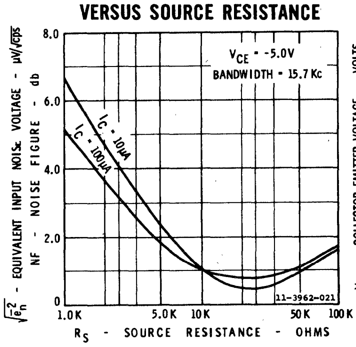
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



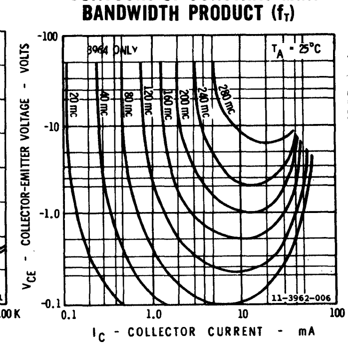
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



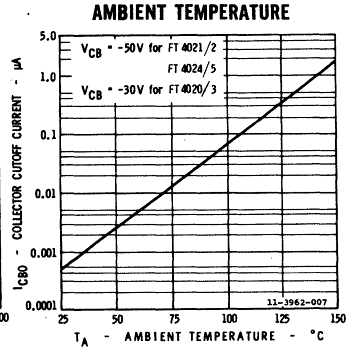
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



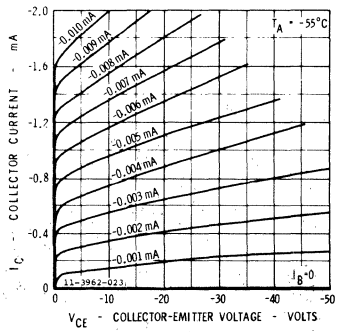
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



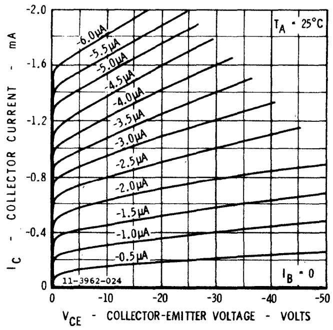
* Single family characteristics on Transistor Curve Tracer.

TYPICAL ELECTRICAL CHARACTERISTICS FOR FT4021 AND FT4024

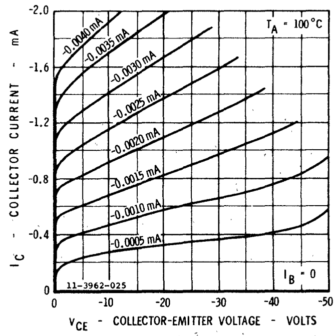
COLLECTOR CHARACTERISTICS*



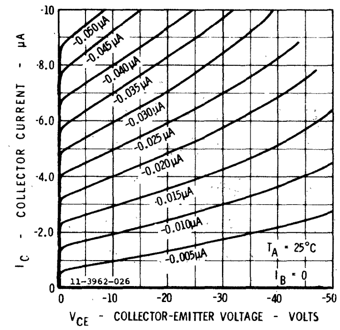
COLLECTOR CHARACTERISTICS



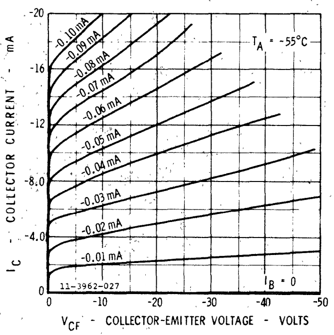
COLLECTOR CHARACTERISTICS



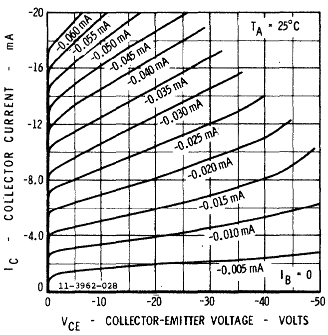
COLLECTOR CHARACTERISTICS



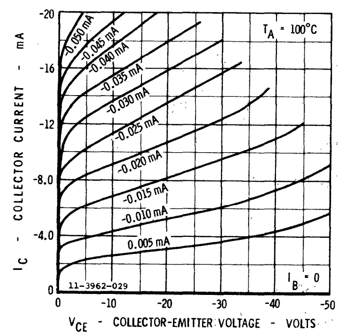
COLLECTOR CHARACTERISTICS*



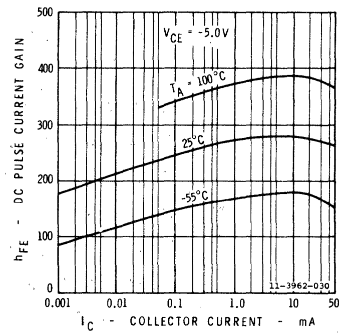
COLLECTOR CHARACTERISTICS*



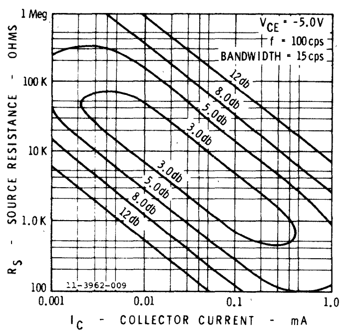
COLLECTOR CHARACTERISTICS*



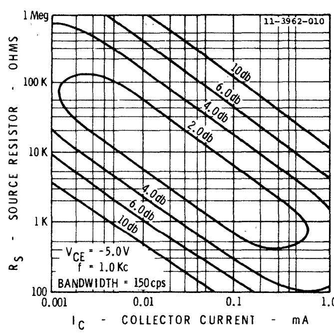
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



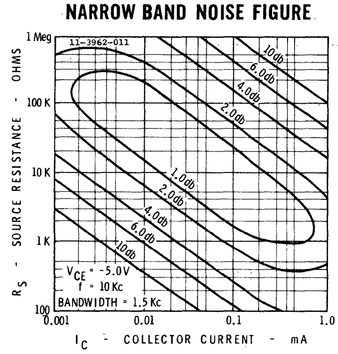
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



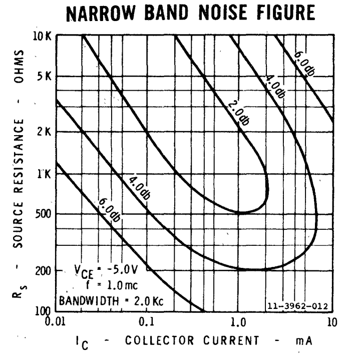
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



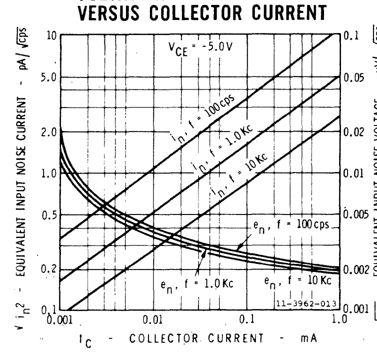
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



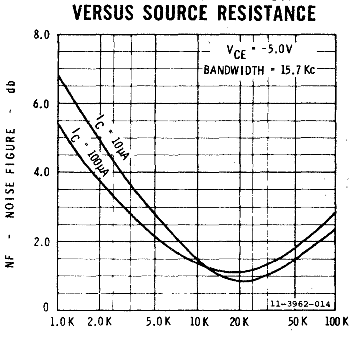
CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



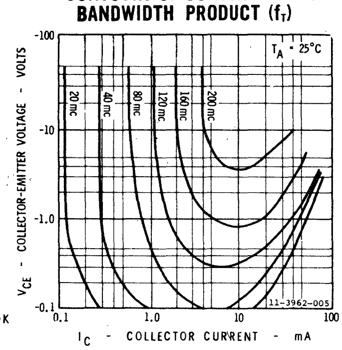
EQUIVALENT INPUT NOISE VOLTAGE AND NOISE CURRENT VERSUS COLLECTOR CURRENT



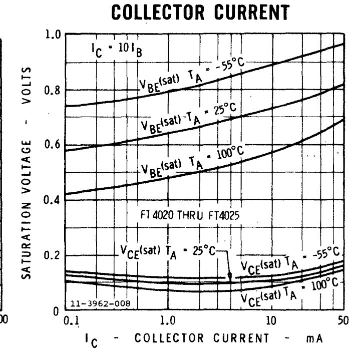
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



COLLECTOR AND BASE SATURATION VOLTAGES VERSUS COLLECTOR CURRENT



* Single family characteristics on Transistor Curve Tracer.

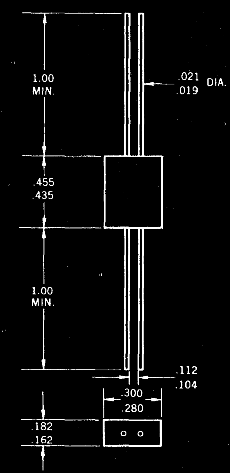
USN1N4306 • 1N4306

MATCHED PAIR, HIGH CONDUCTANCE ULTRA FAST PLANAR EPITAXIAL DIODES

GENERAL DESCRIPTION - The USN 1N4306 (1N4306) consists of two High-Conductance Ultra-Fast Planar Epitaxial Diodes with the forward voltage closely matched. The close forward voltage matching and low reverse current characteristics provide ideal performance in critical chopper applications. The stability and proven reliability of Fairchild Planar epitaxial devices guarantee continued high performance, low leakage current, and close V_F matching during operation.

The USN 1N4306 is supplied in accordance with MIL-S-19500/278.

PHYSICAL DIMENSIONS



NOTES:
1. All dimensions in inches
2. Leads shall be gold plated

ABSOLUTE MAXIMUM RATINGS OF INDIVIDUAL DIODES (25°C) (Note 1)

WIV	Working Inverse Voltage	50 Volts
I_o	Average Rectified Current	200 mA
i_f	Recurrent Peak Forward Current	600 mA
i_f(surge)	Peak Forward Surge Current Pulse Width of 1 sec	1.0 Amp
i_f(surge)	Peak Forward Surge Current Pulse Width of 1 μsec	4.0 Amp
P	Power Dissipation	500 mW
P	Power Dissipation	100 mW at 125°C
T_A	Operating Temperature	-65°C to +150°C
T_{stg}	Storage Temperature, Ambient	-65°C to +175°C

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
V_{F1}	Forward Voltage	0.440	0.550	Volts	I_F = 100 μA
V_{F2}	Forward Voltage	0.560	0.670	Volts	I_F = 1.0 mA
V_{F3}	Forward Voltage	0.670	0.810	Volts	I_F = 10 mA
V_{F4}	Forward Voltage	0.750	1.000	Volts	I_F = 50 mA
I_{R1}	Reverse Current		50.0	nA	V_R = -50 V
I_{R2}	Reverse Current		5.0	μA	V_R = -75 V
I_{R3}	Reverse Current (150°C)		50.0	μA	V_R = -50 V
C	Capacitance		2.0	pf	V_R = 0, f = 1 Mc
t_{rr} (Note 2)	Reverse Recovery Time		4.0	nsec	I_F = I_R = 10 to 200 mA, R_L = 100 Ω
ΔV_{F1}	Forward Voltage Match		10	mV	I_F = 0.1 to 10 mA, T_A = -55°C to +125°C
ΔV_{F2}	Forward Voltage Match		20	mV	I_F = 10 to 50 mA, T_A = -55°C to +125°C

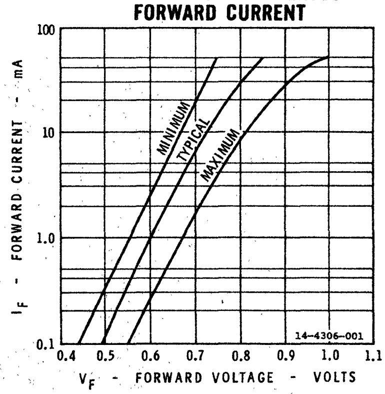
NOTES:
(1) The maximum ratings are limiting values above which life or satisfactory performance may be impaired.
(2) Recovery to 10% of I_F.

FAIRCHILD
SEMICONDUCTOR
A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

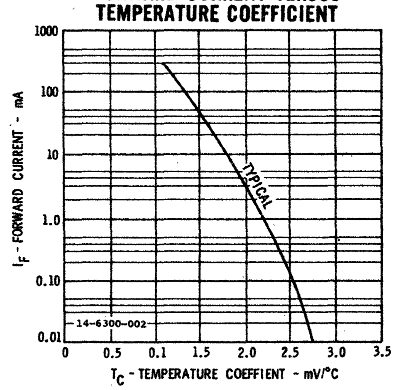
313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA, (415) 962-5011, TWX: 910-379-6435

TYPICAL ELECTRICAL CHARACTERISTICS

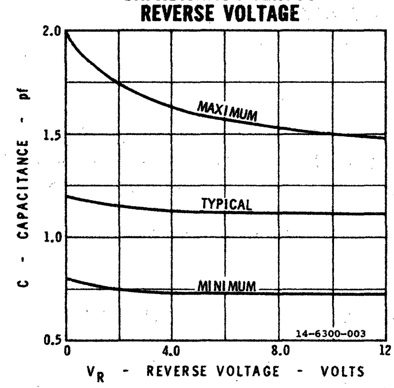
FORWARD VOLTAGE VERSUS FORWARD CURRENT



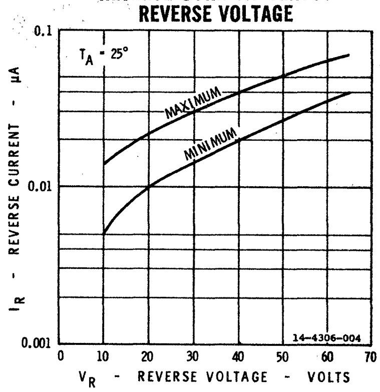
FORWARD CURRENT VERSUS TEMPERATURE COEFFICIENT



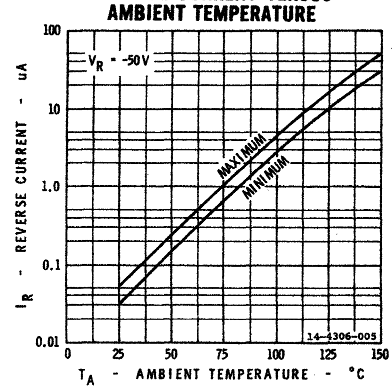
CAPACITANCE VERSUS REVERSE VOLTAGE



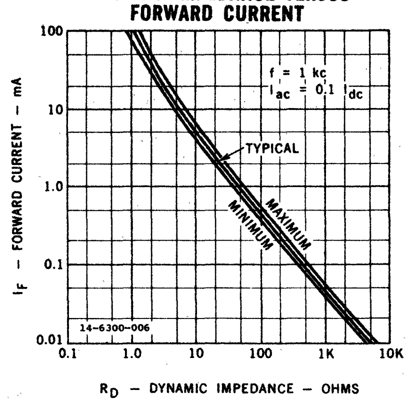
REVERSE CURRENT VERSUS REVERSE VOLTAGE



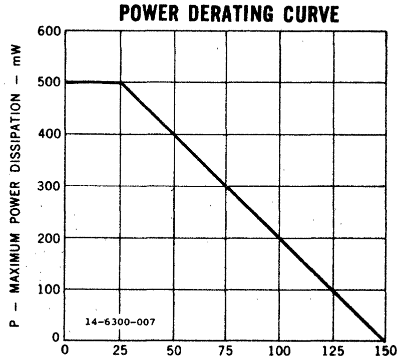
REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



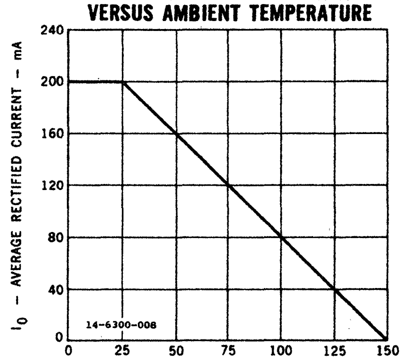
DYNAMIC IMPEDANCE VERSUS FORWARD CURRENT



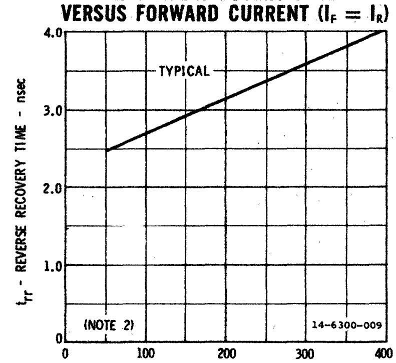
POWER DERATING CURVE



AVERAGE RECTIFIED CURRENT VERSUS AMBIENT TEMPERATURE



REVERSE RECOVERY TIME VERSUS FORWARD CURRENT ($I_F = I_R$)

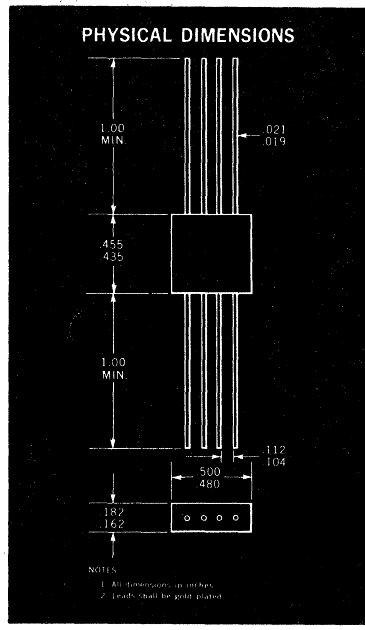


USN1N4307 • 1N4307

MATCHED QUAD, HIGH CONDUCTANCE ULTRA FAST PLANAR EPITAXIAL DIODES

GENERAL DESCRIPTION - The USN 1N4307 (1N4307) consists of four High-Conductance Ultra-Fast Planar Epitaxial Diodes with the forward voltages closely matched. The close forward voltage matching and low reverse current characteristics provide ideal performance in bridge modulators, ring modulators, and transmission gate applications. The stability and proven reliability of Fairchild Planar epitaxial devices guarantee continued high-performance, low-leakage current, and close V_F matching during operation.

The USN 1N4307 is supplied in accordance with MIL-S-19500/284.



ABSOLUTE MAXIMUM RATINGS OF INDIVIDUAL DIODES (25°C) (Note 1)

WIV	Working Inverse Voltage	50 Volts
I_o	Average Rectified Current	200 mA
i_f	Recurrent Peak Forward Current	600 mA
i_f(surge)	Peak Forward Surge Current Pulse Width of 1 sec	1.0 Amp
i_f(surge)	Peak Forward Surge Current Pulse Width of 1 μsec	4.0 Amp
P	Power Dissipation	500 mW
P	Power Dissipation	170 mW at 125°C
T_A	Operating Temperature	-65°C to +150°C
T_{stg}	Storage Temperature, Ambient	-65°C to +175°C

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
V_{F1}	Forward Voltage	0.440	0.550	V	I_F = 100 μA
V_{F2}	Forward Voltage	0.560	0.670	V	I_F = 1.0 mA
V_{F3}	Forward Voltage	0.670	0.810	V	I_F = 10 mA
V_{F4}	Forward Voltage	0.750	1.000	V	I_F = 50 mA
I_{R1}	Reverse Current		50.0	nA	V_R = -50 V
I_{R2}	Reverse Current		5.0	μA	V_R = -75 V
I_{R3}	Reverse Current (150°C)		50.0	μA	V_R = -50 V
C	Capacitance		2.0	pf	V_R = 0 , f = 1 Mc
t_{rr} (Note 2)	Reverse Recovery Time		4.0	nsec	I_F = I_R = 10 mA to 200 mA R_L = 100 Ω
ΔV_{F1}	Forward Voltage Match		10	mV	I_F = 0.1 to 10 mA T_A = -55°C to 125°C
ΔV_{F2}	Forward Voltage Match		20	mV	I_F = 10 to 50 mA T_A = -55°C to 125°C

NOTES:

(1) The maximum ratings are limiting values above which life or satisfactory performance may be impaired.

(2) Recovery to 10% of I_F.

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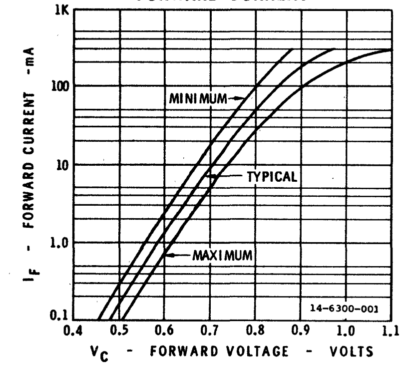
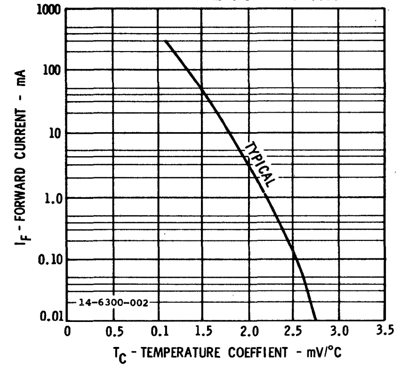
TYPICAL ELECTRICAL CHARACTERISTICS

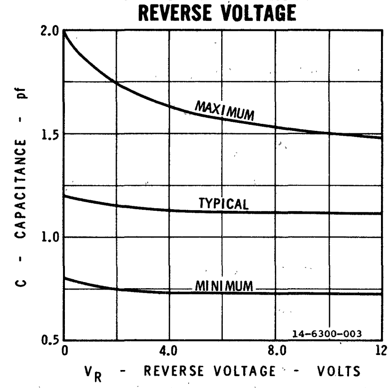
FORWARD VOLTAGE VERSUS FORWARD CURRENT



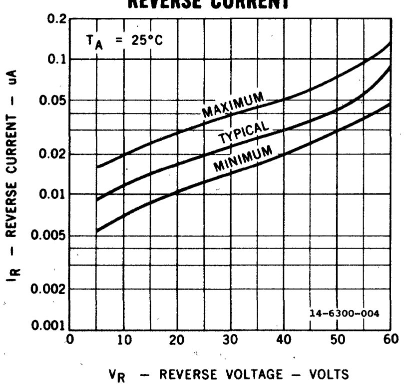
FORWARD CURRENT VERSUS TEMPERATURE COEFFICIENT



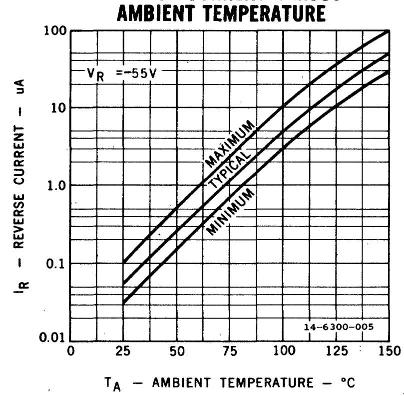
CAPACITANCE VERSUS REVERSE VOLTAGE



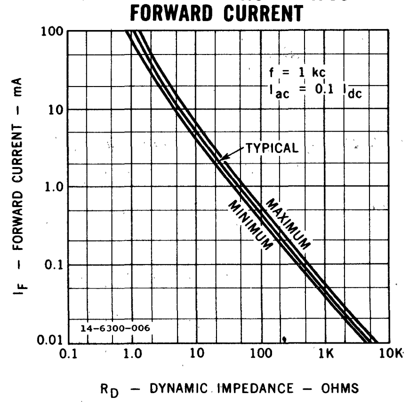
REVERSE VOLTAGE VERSUS REVERSE CURRENT



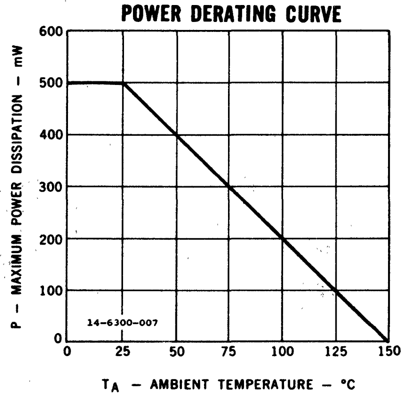
REVERSE CURRENT VERSUS AMBIENT TEMPERATURE



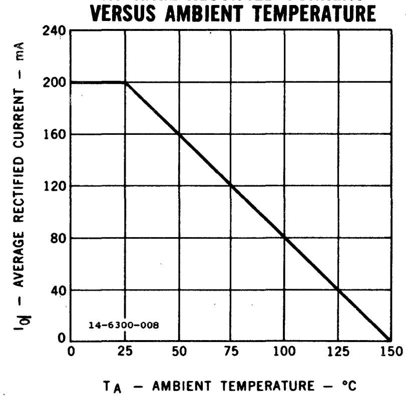
DYNAMIC IMPEDANCE VERSUS FORWARD CURRENT



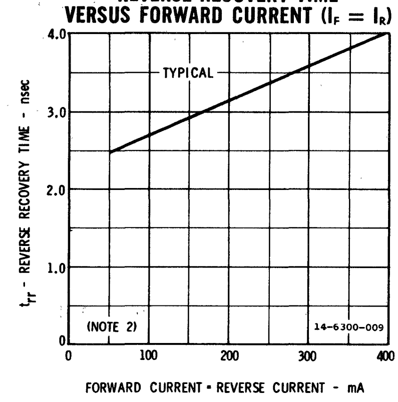
POWER DERATING CURVE



AVERAGE RECTIFIED CURRENT VERSUS AMBIENT TEMPERATURE



REVERSE RECOVERY TIME VERSUS FORWARD CURRENT ($I_F = I_R$)



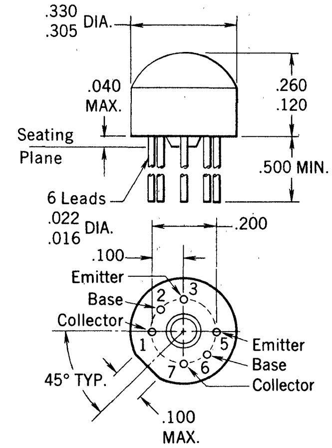
2N4955 • 2N4956

NPN LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* TRANSISTORS

- **BETA MATCH -- 20% MAX. AT 100 μA.**
- **V_{BE} TRACKING -- 20 μV/°C MAX. AT 100 μA FROM −40°C TO +85°C.**
- **V_{BE} MATCH -- 5.0 mV MAX. AT 100 μA.**
- **h_{FE} -- 100 MIN. AT 100 μA; 60 MIN. AT 10 μA.**
- **LOW NOISE FIGURE -- 4.5 dB MAX.**
- **SOLID PACKAGE TO GIVE MAXIMUM MECHANICAL SUPPORT TO THE CHIP.**

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Package weight is 0.77 gram
Package is electrically non-conductive material

ABSOLUTE MAXIMUM RATINGS [Note 1]

Maximum Temperatures

Storage Temperature	−55°C to +125°C
Operating Junction Temperature	+125°C
Lead Temperature (Soldering, 10 seconds Time Limit)	+260°C

Maximum Power Dissipation [Note 2 and 3]

	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	0.75 Watt	1.3 Watts
at 25°C Ambient Temperature	0.35 Watt	0.45 Watt

Maximum Voltages and Current for Each Transistor

V_{CBO}	Collector to Base Voltage	30 Volts
V_{CEO}	Collector to Emitter Voltage [Note 4]	25 Volts
V_{EBO}	Emitter to Base Voltage	5.0 Volts
I_C	Collector Current	30 mA

MATCHING AND ELECTRICAL CHARACTERISTICS FOR 2N4956 (25°C Free Air Temperature unless otherwise noted)

SYMBOL	CHARACTERISTICS	For 2N4956 only MIN.	MAX.	UNITS	TEST CONDITIONS	
$\frac{h_{FE1}}{h_{FE2}}$	**DC Current Gain Ratio** [Note 5]	**0.8**	**1.0**		**$I_C = 100\ \mu A$**	**$V_{CE} = 5.0$ V**
$\lvert(V_{BE1} - V_{BE2})\rvert$	Base-Emitter Voltage Differential [Note 6]		10	mV	$I_C = 10\ \mu A$ to 1.0 mA	$V_{CE} = 5.0$ V
$\lvert(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential** [Note 6]		**5.0**	**mV**	**$I_C = 100\ \mu A$**	**$V_{CE} = 5.0$ V**
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change ($T_A = -40°C$ to $+25°C$)** [Note 6]		**1.3 (20 μV/°C)**	**mV**	**$I_C = 100\ \mu A$**	**$V_{CE} = 5.0$ V**
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change ($T_A = +25°C$ to $+85°C$)** [Note 6]		**1.2 (20 μV/°C)**	**mV**	**$I_C = 100\ \mu A$**	**$V_{CE} = 5.0$ 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. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 125°C and junction to case thermal resistance of 133°C/Watt (derating factor of 7.5 mW/°C) for one side; and 77°C/Watt (derating factor of 13 mW/°C) for both sides. Junction to ambient thermal resistance of 286°C/Watt (derating factor of 3.5 mW/°C) for one side; and 222°C/Watt (derating factor of 4.5 mW/°C) for both sides.
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. Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
6. Absolute values.
7. Pulse Conditions: length = 300 μs; duty cycle = 1%.

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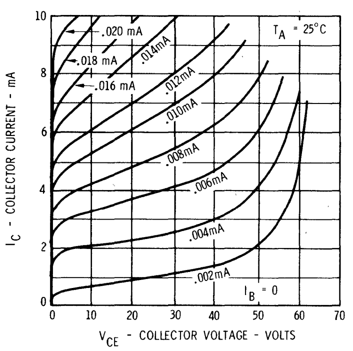
ELECTRICAL CHARACTERISTICS (25°C Free Air Temperature unless otherwise noted)

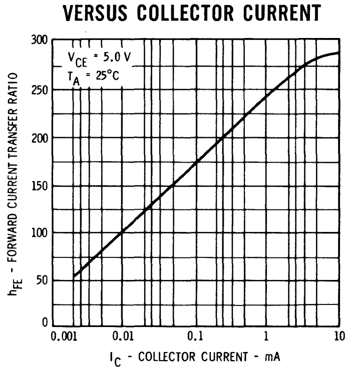
SYMBOL	CHARACTERISTIC	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	DC Current Gain	150			$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{FE}	**DC Current Gain**	**100**			**$I_C = 100\ \mu A$**	**$V_{CE} = 5.0$ V**
h_{FE}	**DC Current Gain**	**60**	**600**		**$I_C = 10\ \mu A$**	**$V_{CE} = 5.0$ V**
V_{CE} (sat)	Collector Saturation Voltage		0.35	Volts	$I_C = 1.0$ mA	$I_B = 0.1$ mA
V_{BE} (on)	Emitter-Base On Voltage		0.7	Volts	$I_C = 0.1$ mA	$V_{CE} = 5.0$ V
I_{CBO}	Collector Cutoff Current		10	nA	$I_E = 0$	$V_{CB} = 25$ V
I_{CBO} (85°C)	Collector Cutoff Current		1.0	μA	$I_E = 0$	$V_{CB} = 25$ V
I_{CEO}	Collector Cutoff Current		10	nA	$I_B = 0$	$V_{CE} = 5.0$ V
I_{EBO}	Emitter Cutoff Current		10	nA	$I_C = 0$	$V_{EB} = 5.0$ V
C_{cb}	Collector-Base Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 10$ V
h_{fe}	High Frequency Current Gain (f = 20 MHz)	3.0	15		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	150	1000		$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ie}	Input Impedance (f = 1.0 kHz)	3.5	30	kohms	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance (f = 1.0 kHz)		40	μmhos	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{re}	Voltage Feedback Ratio (f = 1.0 kHz)		800	$X10^{-6}$	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	30		Volts	$I_C = 10\ \mu A$	$I_E = 0$
V_{CEO} (sust)	Collector to Emitter Sustaining Voltage (pulsed, notes 4 and 7)	25		Volts	$I_C = 2.0$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	5.0		Volts	$I_E = 10\ \mu A$	$I_C = 0$
C_{eb}	Emitter-Base Capacitance		6.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
NF	Narrow Band Noise Figure (f = 1.0 kHz)		4.5	dB	$I_C = 10\ \mu A$ B.W. = 200 Hz	$V_{CE} = 5.0$ V $R_S = 10$ kΩ
NF	**Wide Band Noise Figure (3.0 dB points @ 10 Hz and 10 kHz)**		**4.5**	**dB**	**$I_C = 10\ \mu A$** **B.W. = 15.7 kHz**	**$V_{CE} = 5.0$ V** **$R_S = 10$ kΩ**

TYPICAL ELECTRICAL CHARACTERISTICS

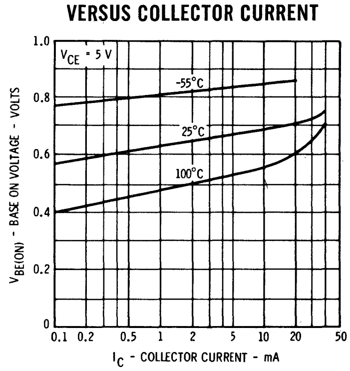
COLLECTOR CHARACTERISTICS*



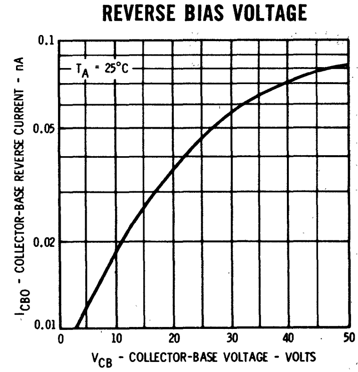
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



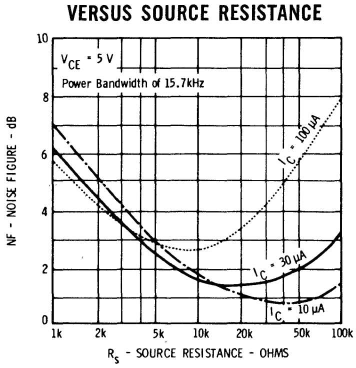
BASE-EMITTER ON VOLTAGE VERSUS COLLECTOR CURRENT



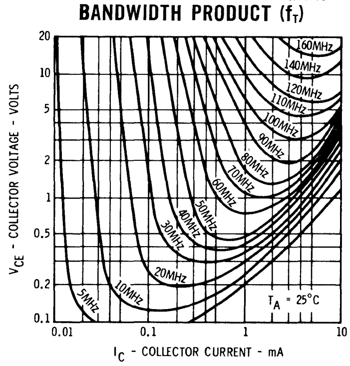
COLLECTOR-BASE DIODE REVERSE CURRENT VERSUS REVERSE BIAS VOLTAGE



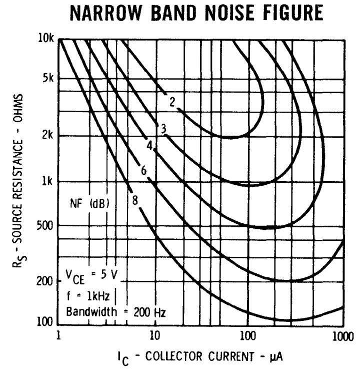
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



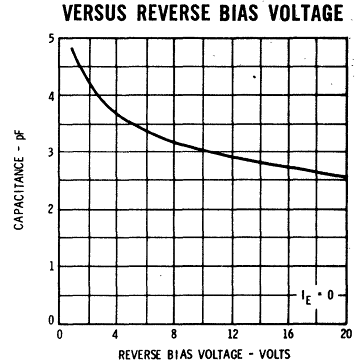
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



OUTPUT CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



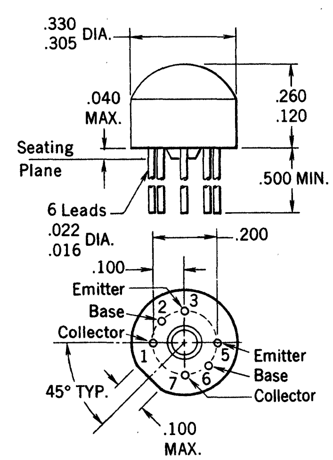
2N5254 • 2N5255 • 2N5256

PNP LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIERS

DIFFUSED SILICON PLANAR* EPITAXIAL TRANSISTORS

- **EXCELLENT V_{BE} MATCH . . . . . 3.0 mV (MAX.) AT 100 μA**
- **TIGHT BETA MATCH . . . . . . 10% (MAX.) AT 100 μA**
- **EXCELLENT V_{BE} TRACKING . . . 10 μV/°C (MAX.) AT 100 μA FROM −40°C TO +85°C**
- **HIGH BETA . . . . 175 (MIN.) AT 1.0 mA; 150 (MIN.) AT 100μA**
- **LOW NOISE FIGURE . . . . . . 2.5 dB (MAX.) AT 1.0 kHz**
- **LOW COST EPOXY PACKAGE**

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches
Package weight is 0.77 gram

ABSOLUTE MAXIMUM RATINGS (Note 1)

Maximum Temperatures

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

Maximum Power Dissipation (Notes 2 and 3)	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	0.8 Watt	1.4 Watts
at 25°C Ambient Temperature	0.35 Watt	0.43 Watt

Maximum Voltages and Current for Each Transistor

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	50 mA

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

		2N5255			2N5256					
SYMBOL	CHARACTERISTIC	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	UNITS	TEST CONDITIONS	
h_{FE1}/h_{FE2}	**DC Current Gain Ratio** (Note 5)	0.8		1.0	**0.9**		**1.0**		$I_C = 100\ \mu A$	$V_{CE} = -5.0$ V
$\lvert(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential** (Note 6)			5.0			**3.0**	mV	$I_C = 100\ \mu A$	$V_{CE} = -5.0$ V
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	**Base-Emitter Voltage Differential Change (T_A = −40°C to +25°C)** (Note 6)			1.3 (20 μV/°C)			**0.65 (10 μV/°C)**	mV	$I_C = 100\ \mu A$	$V_{CE} = -5.0$ V
$\lvert\Delta(V_{BE1} - V_{BE2})\rvert$	Base-Emitter Voltage Differential Change (T_A = +25°C to +85°C) (Note 6)			1.2 (20 μV/°C)			0.60 (10 μV/°C)	mV	$I_C = 100\ \mu A$	$V_{CE} = -5.0$ V
$I_{B1} - I_{B2}$	Base Current Differential		80			40		nA	$I_C = 100\ \mu A$	$V_{CE} = -5.0$ V
$\Delta(I_{B1} - I_{B2})$	Base Current Differential Change (T_A = −40°C to +85°C)		2.5			2.0		nA/°C	$I_C = 100\ \mu A$	$V_{CE} = -5.0$ 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 125°C and junction to case thermal resistance of 125°C/Watt (derating factor of 8.0 mW/°C) for one side, and 71°C/Watt (derating factor of 14 mW/°C) for both sides. Junction to ambient thermal resistance of 285°C/Watt (derating factor of 3.5 mW/°C) for one side; and 233°C/Watt (derating factor of 4.3 mW/°C) for both sides.
(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) Lowest of two h_{FE} readings is taken as h_{FE1} for purposes of this ratio.
(6) Absolute values.
(7) Pulse Conditions: length = 300 μs; duty cycle = 1%.

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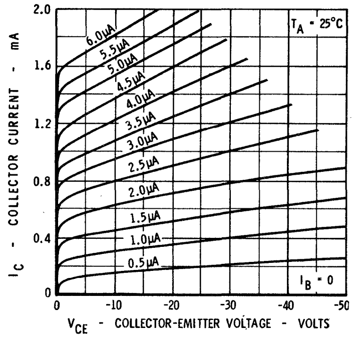
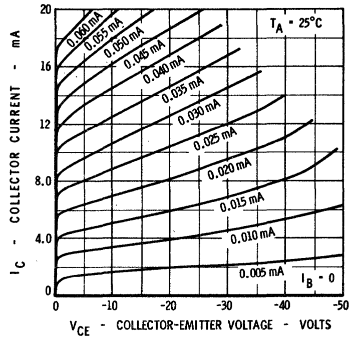
TYPICAL ELECTRICAL CHARACTERISTICS

2N5254 ONLY

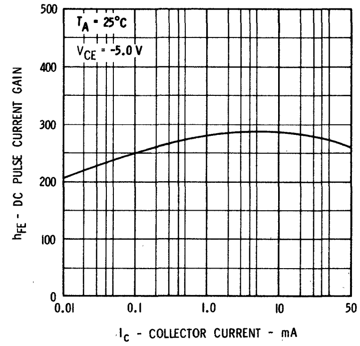
COLLECTOR CHARACTERISTICS*



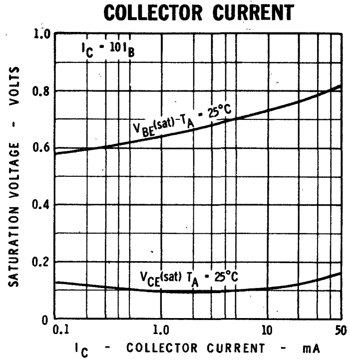
COLLECTOR CHARACTERISTICS*



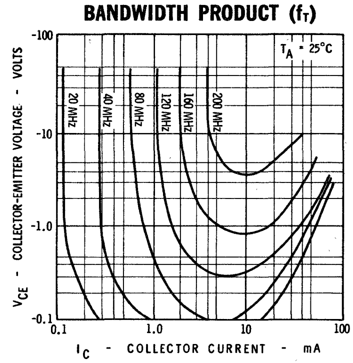
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



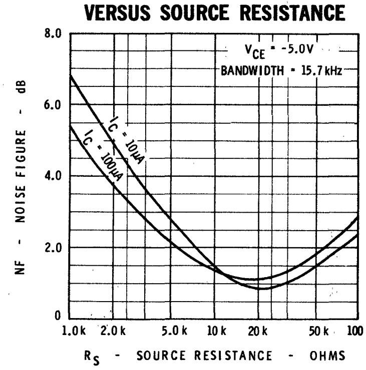
COLLECTOR AND BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



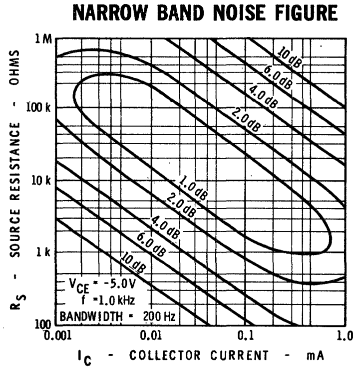
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



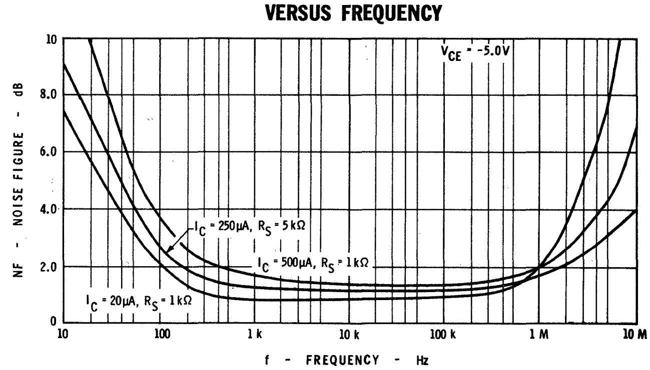
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



NOISE FIGURE VERSUS FREQUENCY



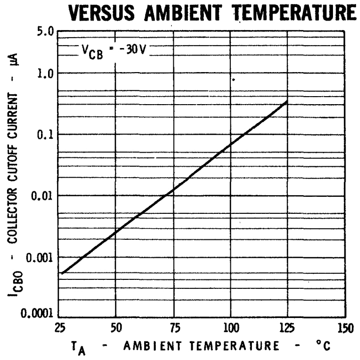
*Single family characteristics on Transistor Curve Tracer

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

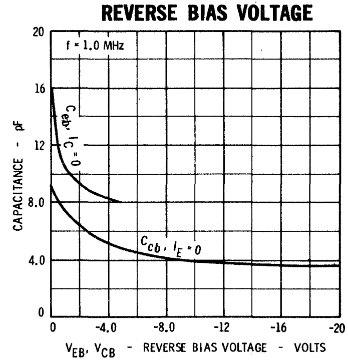
SYMBOL	CHARACTERISTIC	2N5254 MIN.	2N5254 MAX.	2N5255 2N5256 MIN.	2N5255 2N5256 MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**	70		**175**			**$I_C = 1.0$ mA**	**$V_{CE} = -5.0$ V**
h_{FE}	**DC Current Gain**	50	750	**150**	750		**$I_C = 100$ μA**	**$V_{CE} = -5.0$ V**
h_{FE}	DC Current Gain			90			$I_C = 20$ μA	$V_{CE} = -5.0$ V
$V_{CE(sat)}$	Pulsed Collector Saturation Voltage (Note 7)		−0.25		−0.25	Volts	$I_C = 10$ mA	$I_B = 0.5$ mA
$V_{BE(on)}$	Emitter-Base On Voltage		−0.9		−0.9	Volts	$I_C = 0.1$ mA	$V_{CE} = -5.0$ V
I_{CBO}	Collector Cutoff Current		10		10	nA	$I_E = 0$	$V_{CB} = -30$ V
I_{CBO}(85°C)	Collector Cutoff Current		1.0		1.0	μA	$I_E = 0$	$V_{CB} = -30$ V
I_{CEO}	Collector Cutoff Current		10		10	nA	$I_B = 0$	$V_{CE} = -5.0$ V
I_{EBO}	Emitter Cutoff Current		10		10	nA	$I_C = 0$	$V_{EB} = -4.0$ V
$V_{BE(sat)}$	Pulsed Base Saturation Voltage (Note 7)		−0.9		−0.9	Volts	$I_C = 10$ mA	$I_B = 0.5$ mA
h_{fe}	High Frequency Current Gain (f = 20 MHz)	2.0	15	2.0	15		$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{fe}	Small Signal Current Gain (f = 1.0 kHz)	70	900	175	900		$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{ie}	Input Impedance (f = 1.0 kHz)	1.7	25	4.4	25	kΩ	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{oe}	Output Conductance (f = 1.0 kHz)	5.0	70	15	70	μmhos	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
h_{re}	Voltage Feedback Ratio (f = 1.0 kHz)		1200		1200	$X10^{-6}$	$I_C = 1.0$ mA	$V_{CE} = -5.0$ V
BV_{CBO}	Collector to Base Breakdown Voltage	−40		−40		Volts	$I_C = 10$ μA	$I_E = 0$
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (pulsed, Notes 4 and 7)	−40		−40		Volts	$I_C = 10$ mA	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0		−5.0		Volts	$I_E = 10$ μA	$I_C = 0$
C_{cb}	Collector to Base Capacitance		6.0		6.0	pF	$I_E = 0$	$V_{CB} = -10$ V
C_{eb}	Emitter to Base Capacitance		16		16	pF	$I_C = 0$	$V_{EB} = -0.5$ V
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		3.0		**2.5**	**dB**	**$I_C = 100$ μA B.W. = 200 Hz**	**$V_{CE} = -5.0$ V $R_S = 10$ kΩ**
NF	Wide Band Noise Figure (3.0 dB points at 10 Hz and 10 kHz)		3.0		2.5	dB	$I_C = 100$ μA B.W. = 15.7 kHz	$V_{CE} = -5.0$ V $R_S = 10$ kΩ

THESE CURVES APPLY TO ALL TYPES

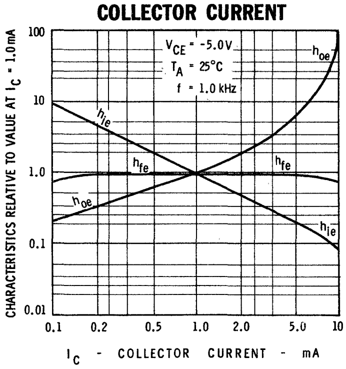
COLLECTOR CUTOFF CURRENT VERSUS AMBIENT TEMPERATURE



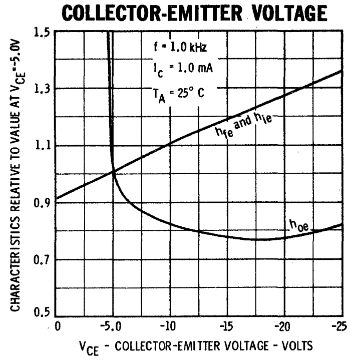
CAPACITANCE VERSUS REVERSE BIAS VOLTAGE



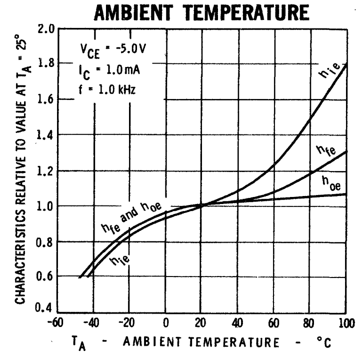
COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR CURRENT



COMMON EMITTER CHARACTERISTICS VERSUS COLLECTOR-EMITTER VOLTAGE



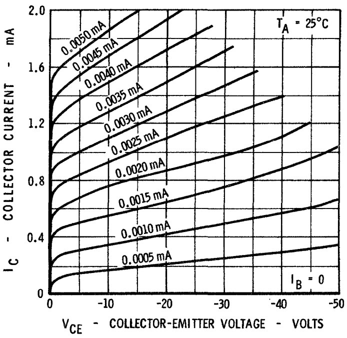
COMMON EMITTER CHARACTERISTICS VERSUS AMBIENT TEMPERATURE



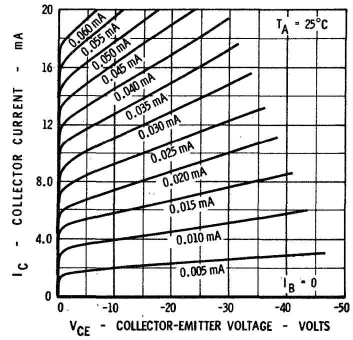
TYPICAL ELECTRICAL CHARACTERISTICS

2N5255 • 2N5256

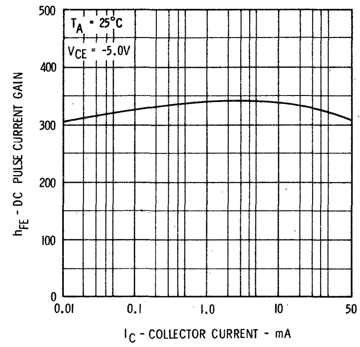
COLLECTOR CHARACTERISTICS*



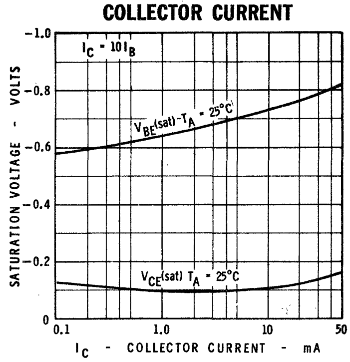
COLLECTOR CHARACTERISTICS*



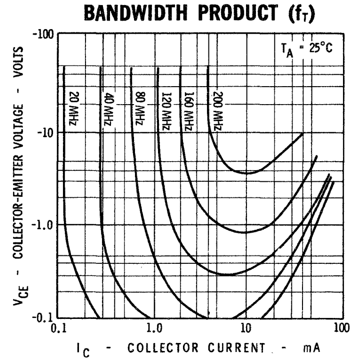
DC PULSE CURRENT GAIN VERSUS COLLECTOR CURRENT



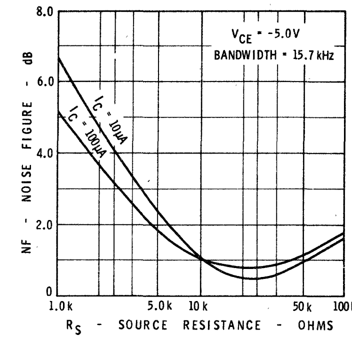
COLLECTOR AND BASE SATURATION VOLTAGE VERSUS COLLECTOR CURRENT



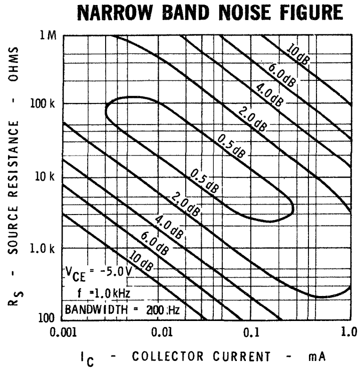
CONTOURS OF CONSTANT GAIN BANDWIDTH PRODUCT (f_T)



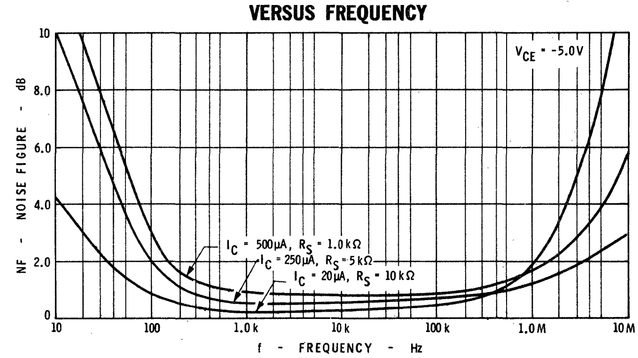
WIDE BAND NOISE FIGURE VERSUS SOURCE RESISTANCE



CONTOURS OF CONSTANT NARROW BAND NOISE FIGURE



NOISE FIGURE VERSUS FREQUENCY



*Single family characteristics on Transistor Curve Tracer

FAIRCHILD SEMICONDUCTOR

A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION

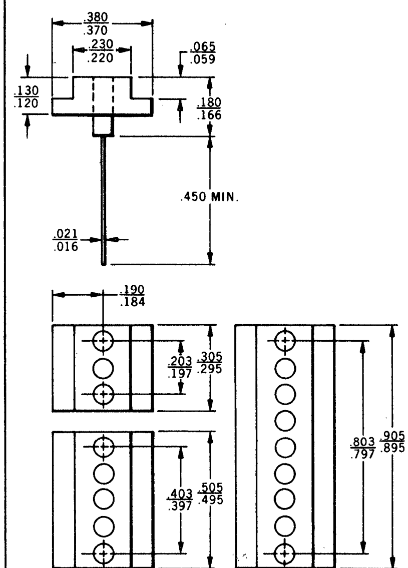
FPM 7011 • FPM 7012

NPN PHOTOTRANSISTOR TAPE READER ARRAYS

GENERAL DESCRIPTION - These Fairchild tape reader arrays consist of matched Fairchild FPM100 phototransistors flush mounted in permanent alignment. The flat windows allow the front surface to serve as wear-plate in direct contact with data tape thus minimizing cross-talk and the influence of stray light.

Dimensions are compatible with standard one inch data tape. The FPM7011 is in two sections to accommodate in-line mechanical sprockets. The FPM7012 is in one piece and includes a ninth phototransistor for sprocket hole detection.

PHYSICAL DIMENSIONS



NOTES: All dimensions in inches.
Brass plate is common to all emitters.
All holes on 0.100±.002 centers.
Windows are nominal .051 diameter.

ABSOLUTE MAXIMUM RATINGS (Each Phototransistor)

V_{CE}	Collector-Emitter Voltage		40 V
V_{EC}	Emitter-Collector Voltage		5 V
P	Power Dissipation (25°C Ambient)	(Note 1)	75 mW
T_A	Operating Temperature, Ambient		-65°C to +175°C
T_{stg}	Storage Temperature, Ambient		-65°C to +200°C

ELECTRICAL CHARACTERISTICS (25°C Each Phototransistor

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
V_{CEO}(sust)	Collector-Emitter Sustaining Voltage	40		Volts	I_C = 0.1 mA H ≤ 0.1 μW/cm²
V_{CE}(sat)	Collector Saturation Voltage (Note 2)		0.3	Volts	I_C = 0.4 mA H = 20 mW/cm²
I_{L-1}	Light Current (Note 2)	0.8		mA	V_{CE} = 5.0 V H = 20 mW/cm²
I_{L-2}	Light Current (Note 3)	1.0		mA	V_{CE} = 5.0 V H = 9.0 mW/cm²
$I_{L\,min}/I_{L\,max}$	Matching Factor (Note 2 & 4)	0.67	1.0		V_{CE} = 5.0 V H = 20 mW/cm²
I_D	Dark Current		0.1	μA	V_{CE} = 15 V H ≤ 0.1 μW/cm²
BV_{ECO}	Emitter-Collector Breakdown Voltage	5		Volts	I_C = 0.1 mA H ≤ 0.1 μW/cm²

NOTES:

(1) Derating factor is 0.5 mW/°C above 25°C.

(2) Irradiation source is an unfiltered tungsten lamp at 2870°K color temperature.

(3) Irradiation source is a filtered tungsten lamp with Corning CS7-69 filter, plus a 2 cm H_2O filter cell. This rejects wavelengths outside the 0.7 to 1.0 micron range of maximum response. This test method is included only for reference because of common usage. The unfiltered source is more typical of actual applications.

(4) Matching factor = ratio of minimum to maximum light current between any sensors in the array.

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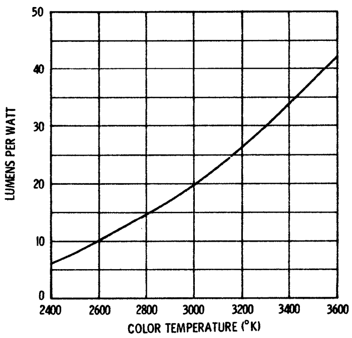
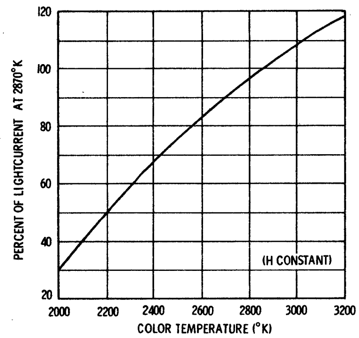
IRRADIATION AND ILLUMINATION

All light current ratings are given in radiometric dimensions (mW/cm^2). Conversion to illumination units requires knowledge of the luminous efficiency of the source in lumens per watt of radiated power. For incandescent sources graph A may be used. Graph B shows the effect of color temperature upon light current.

GRAPH A



GRAPH B

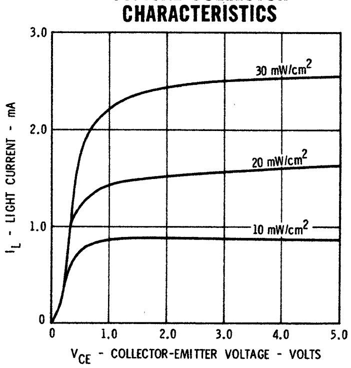


Ft. candles = candle power/distance in ft^2 = lumens/ft^2 = mW/cm^2 x 0.929 x lumens per watt

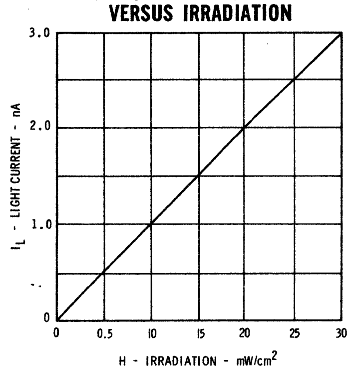
DEFINITIONS

IRRADIATION:	Total incident radiant energy. Measured in power per unit area. Symbol: H
ILLUMINATION:	Incident irradiation of wavelengths which are visible to the human eye. Measured in ft. candles.
LUMINOUS EFFICIENCY:	Ratio of illumination to irradiation.
LIGHT CURRENT:	The current resulting from the action of light upon a light sensitive device.
DARK CURRENT:	Current in a photosensitive device which is effectively shielded from wavelengths to which it responds.
COLOR TEMPERATURE:	The temperature of a perfect radiator (black body) when it is the same color as the incandescent source being described. Measured in degrees Kelvin.

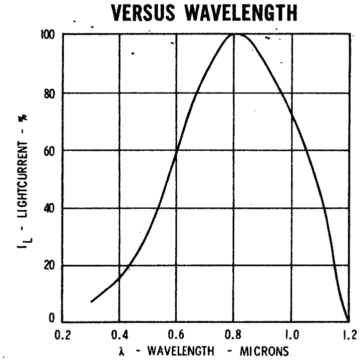
TYPICAL COLLECTOR CHARACTERISTICS



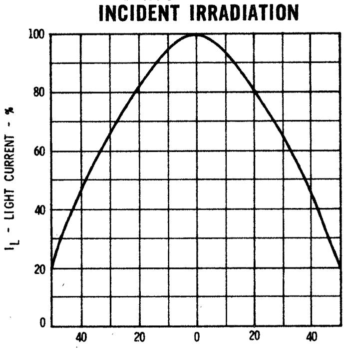
TYPICAL LIGHT CURRENT VERSUS IRRADIATION



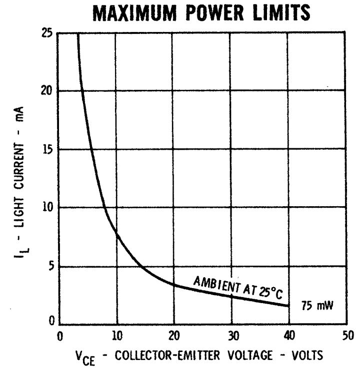
TYPICAL LIGHT CURRENT VERSUS WAVELENGTH



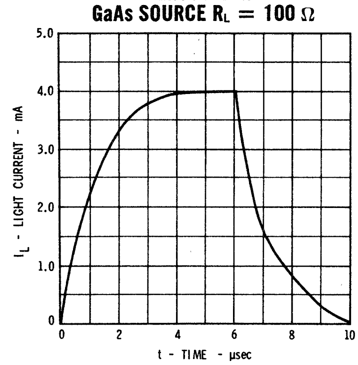
TYPICAL LIGHT CURRENT VERSUS ANGLE OF INCIDENT IRRADIATION



MAXIMUM POWER LIMITS



TYPICAL LIGHT CURRENT VERSUS TIME
GaAs SOURCE R_L = 100 Ω



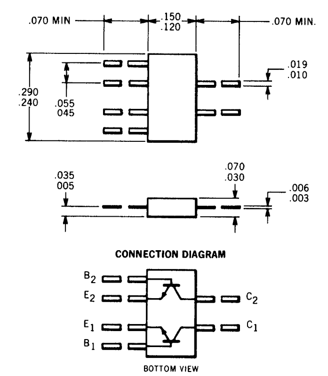
SP10800

NPN LOW-LEVEL, LOW-NOISE DUAL TRANSISTOR

DIFFUSED SILICON PLANAR* TRANSISTOR

- **TWO DEVICES IN 0.125 X 0.250 INCHES FOR HIGH DENSITY PACKAGING**
- **HIGH GAIN . . . . h_{FE} = 60-600 AT 10 μA**
  . . . . h_{FE} = 100 (MIN) AT 100 μA
- **BREAKDOWN VOLTAGE . . . LV_{CEO} = 45 V (MIN)**
- **LOW NOISE . . . . NF = 4.0 dB (MAX) - 1 kHz AND WIDE BAND**

PHYSICAL DIMENSIONS
in accordance with
JEDEC (TO-89) outline



NOTES: All dimensions in inches
Leads are gold-plated kovar
Package weight is .09 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)	**One Side**	**Both Sides**
Total Dissipation at 25°C Case Temperature	1.75 Watts	3.5 Watts
at 25°C Ambient Temperature	0.25 Watt	0.350 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	6.0 Volts

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

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
h_{FE}	**DC Current Gain**	**60**	**600**		**I_C = 10 μA**	**V_{CE} = 5.0 V**
h_{FE}	**DC Current Gain**	**100**			**I_C = 100 μA**	**V_{CE} = 5.0 V**
h_{FE}	**DC Current Gain**	**150**			**I_C = 1.0 mA**	**V_{CE} = 5.0 V**
h_{FE}(−55°C)	DC Current Gain	15			I_C = 10 μA	V_{CE} = 5.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.35	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{CE}(sat)	Collector Saturation Voltage		1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage		1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
h_{fe}	High Frequency Current Gain (f = 30 MHz)	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
I_{CEO}	Collector-Emitter Cutoff Current		10	nA	I_B = 0	V_{CE} = 5.0 V

Additional Electrical Characteristics on page 2
Notes on page 2

*Planar is a patented Fairchild process.

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FAIRCHILD TRANSISTOR SP10800

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

SYMBOL	CHARACTERISTICS	MIN.	MAX.	UNITS	TEST CONDITIONS	
C_{obo}	Output Capacitance		6.0	pF	$I_E = 0$	$V_{CB} = 5.0$ V
C_{ibo}	Input Capacitance		6.0	pF	$I_C = 0$	$V_{EB} = 0.5$ V
BV_{CBO}	Collector to Base Breakdown Voltage	45		Volts	$I_C = 10\ \mu A$	$I_E = 0$
V_{CEO}(sust)	**Collector to Emitter Sustaining Voltage** (Notes 4 and 5)	**45**		**Volts**	**$I_C = 10$ mA**	$I_B = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		Volts	$I_C = 0$	$I_E = 10\ \mu A$
NF	**Wide Band Noise Figure (f = 15.7 kHz)**		**4.0**	**dB**	**$I_C = 10\ \mu A$**	**$V_{CE} = 5.0$ V** **$R_S = 10k\Omega$**
NF	**Narrow Band Noise Figure (f = 1.0 kHz)**		**4.0**	**dB**	**$I_C = 10\ \mu A$** **PBW = 200 Hz**	**$V_{CE} = 5.0$ V** **$R_S = 10k\Omega$**
h_{ie}	Input Resistance (f = 1 kHz)	3.5		kΩ	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{oe}	Output Conductance (f = 1 kHz)	5.0	30	μmho	$I_C = 1.0$ mA	$V_{CE} = 5.0$ V
h_{ob}	Output Conductance (f = 1 kHz)		1.0	μmho	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V
h_{ib}	Input Resistance (f = 1 kHz)	25	32	Ω	$I_C = 1.0$ mA	$V_{CB} = 5.0$ V

NOTES:

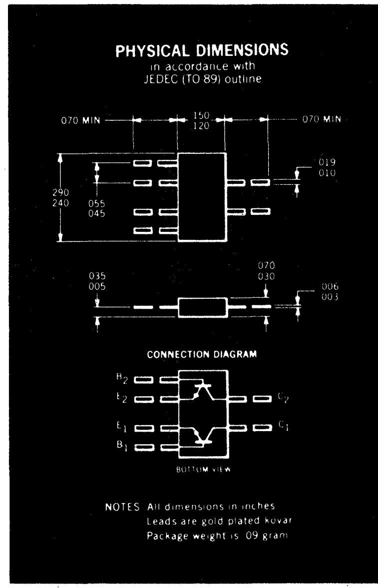
(1) These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
(2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
(3) These ratings give a maximum junction temperature of 200°C and junction to ambient thermal resistance of 700°C/Watt (derating factor of 1.42 mW/°C) for one side; 500°C/Watt (derating factor of 2.0 mW/°C) for both sides. Junction to case thermal resistance of 100°C/Watt (derating factor of 10 mW/°C) for one side; 50°C/Watt (derating factor of 20 mW/°C) for both sides.
(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%.

SP10801

NPN LOW-LEVEL, LOW-NOISE DIFFERENTIAL AMPLIFIER

DIFFUSED SILICON PLANAR TRANSISTOR

GENERAL DESCRIPTION - The six-terminal device contains two isolated High-Gain, Low-Noise NPN Double-Diffused Silicon Planar Transistors in one hermetically sealed enclosure. It is designed for use in high-performance amplifier and differential-amplifier circuits requiring high-gain and low-noise at low-current levels. The SP 10801 features very high beta at low-collector current.



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)	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	1.75 Watts	3.5 Watts
at 25°C Ambient Temperature	0.25 Watt	0.350 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	6.0 Volts

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio (Note 6)	0.8	1.0		I_C = 100 μA V_{CE} = 5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	Base-Emitter Voltage Differential		5.0	mV	I_C = 100 μA V_{CE} = 5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	Base-Emitter Voltage Differential		10	mV	I_C = 10 μA V_{CE} = 5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	Base-Emitter Voltage Differential		10	mV	I_C = 1.0 mA V_{CE} = 5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	Base-Emitter Voltage Differential Change (T_A = -55°C to +25°C)		1.6	mV	I_C = 100 μA V_{CE} = 5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	Base-Emitter Voltage Differential Change (T_A = +25°C to +125°C)		2.0	mV	I_C = 100 μA V_{CE} = 5.0 V
NF	Wide Band Noise Figure (Note 8)		4.0	db	I_C = 10 μA V_{CE} = 5.0 V
NF	Narrow Band Noise Figure (Note 7)		4.0	db	I_C = 10 μA V_{CE} = 5.0 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	
h_{FE}	DC Current Gain	60	600		I_C = 10 μA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	100			I_C = 100 μA	V_{CE} = 5.0 V
h_{FE}	DC Current Gain	150			I_C = 1.0 mA	V_{CE} = 5.0 V
h_{FE}(-55°C)	DC Current Gain	15			I_C = 10 μA	V_{CE} = 5.0 V
V_{CE}(sat)	Collector Saturation Voltage		0.35	Volts	I_C = 1.0 mA	I_B = 0.1 mA
V_{CE}(sat)	Collector Saturation Voltage		1.0	Volts	I_C = 10 mA	I_B = 1.0 mA
V_{BE}(sat)	Base Saturation Voltage		1.0	Volts	I_C = 10 mA	I_B = 1.0 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
I_{CEO}	Collector-Emitter Cutoff Current		10	nA	I_B = 0	V_{CE} = 5.0 V
C_{obo}	Output Capacitance		6.0	pf	I_E = 0	V_{CB} = 5.0 V
C_{ibo}	Input Capacitance		6.0	pf	I_C = 0	V_{EB} = 0.5 V
BV_{CBO}	Collector-to-Base Breakdown Voltage	45		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	I_B = 0
BV_{EBO}	Emitter-to-Base Breakdown Voltage	6.0		Volts	I_C = 0	I_E = 10 μA
h_{ie}	Input Resistance (f = 1 Kc)	3.5		KOhm	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{oe}	Output Conductance (f = 1 Kc)	5.0	30	μmho	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{ob}	Output Conductance (f = 1 Kc)		1.0	μmho	I_C = 1.0 mA	V_{CE} = 5.0 V
h_{ib}	Input Resistance (f = 1 Kc)	25	32	Ohm	I_C = 1.0 mA	V_{CE} = 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-ambient thermal resistance of 700°C/Watt (derating factor of 1.43 mW/°C) for one side; 500°C/Watt (derating factor of 2.0 mW/°C) for both sides. Junction-to-case thermal resistance of 100°C/Watt (derating factor of 10 mW/°C) for one side; 50°C/Watt (derating factor of 20 mW/°C) for both sides.

(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) Lowest of two h_{FE} readings is taken as $h_{FE\,1}$ for purposes of this ratio.

(7) f = 1 Kc; R_S = 10 KΩ; Power Bandwidth of 200 cps.

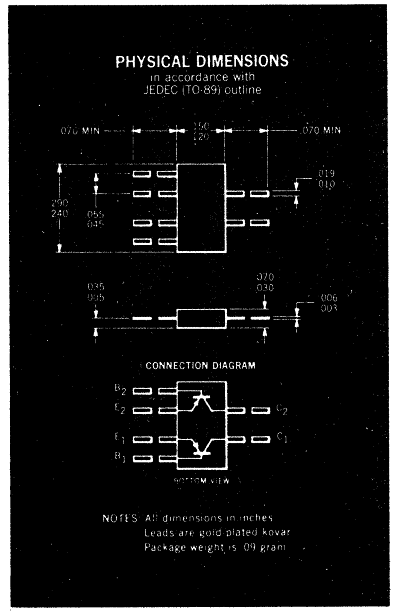
(8) f = 10 cps to 10 Kc; R_S = 10 KΩ; Power Bandwidth of 15.7 Kc.

SP10810

PNP DIFFERENTIAL AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The SP 10810 is a double diffused silicon PNP Planar epitaxial transistor in the JEDEC TO-89 outline. It is designed as a high-frequency, low noise, differential amplifier.



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 & 3)	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	1.5 Watts	3.0 Watts
at 25°C Ambient Temperature	0.25 Watt	0.35 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

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

Symbol	Characteristic	Min.	Max.	Units	Test Conditions
$\frac{h_{FE1}}{h_{FE2}}$	DC Current Gain Ratio (Note 6)	0.8	1.0		I_C = 1.0 mA V_{CE} = -5.0 V
$\lvert V_{BE1} - V_{BE2} \rvert$	Base Emitter Voltage Differential		5.0	mV	I_C = 1.0 mA V_{CE} = -5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	Base Emitter Voltage Differential Change (T_A = -55°C to +25°C)		4.0	mV	I_C = 1.0 mA V_{CE} = -5.0 V
$\lvert \Delta(V_{BE1} - V_{BE2}) \rvert$	Base Emitter Voltage Differential Change (T_A = +25°C to +125°C)		5.0	mV	I_C = 1.0 mA V_{CE} = -5.0 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 ambient thermal resistance of 700°C/Watt (derating factor of 1.42 mW/°C) for one side; 500°C/Watt (derating factor of 2.0 mW/°C) for both sides. Junction to case thermal resistance of 110°C/Watt (derating factor of 8.5 mW/°C) for one side; 58°C/Watt (derating factor of 17.2 mW/°C) for both sides.

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

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

(6) Lowest of two h_{FE} readings is taken as h_{FE1} for purpose of this ratio.

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

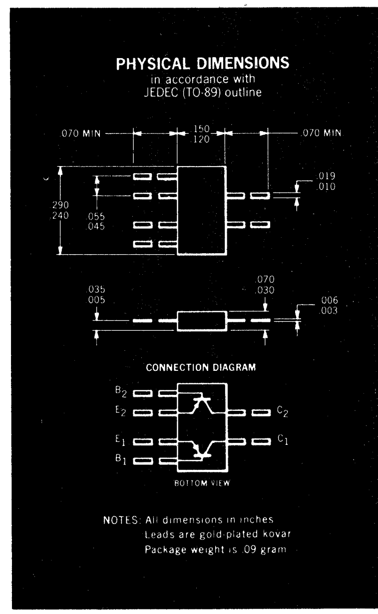
Symbol	Characteristic	Min.	Max.	Units	Test Conditions
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 & 5)	-15		Volts	I_C = 10 mA I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-20		Volts	I_C = 10 μA I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-4.0		Volts	I_C = 0 I_E = 10 μA
h_{FE}	DC Pulse Current Gain (Note 5)	35			I_C = 10 mA V_{CE} = -1.0 V
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0 V_{CB} = -15 V
V_{CE}(sat)	Collector Saturation Voltage		-0.25	Volt	I_C = 20 mA I_B = 2.0 mA
V_{BE}(sat)	Base Saturation Voltage		-1.0	Volt	I_C = 20 mA I_B = 2.0 mA
h_{fe}	High Frequency Current Gain (f = 100 Mc)	1.0			I_C = 10 mA V_{CE} = -10 V
C_{obo}	Output Capacitance		10	pf	I_E = 0 V_{CB} = -10 V
C_{ibo}	Input Capacitance		10	pf	I_C = 0 V_{BE} = 0.5 V
I_{CBO}(150°C)	Collector Cutoff Current		25	μA	I_E = 0 V_{CB} = -15 V

SP10811

DUAL PNP HIGH-SPEED SWITCH AND RF AMPLIFIER

DIFFUSED SILICON PLANAR EPITAXIAL TRANSISTOR

GENERAL DESCRIPTION - The SP 10811 is a double diffused silicon PNP Planar epitaxial dual transistor packaged in the JEDEC TO-89 outline. It is designed as a high-frequency, low noise, general-purpose 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 sec time limit)	+300°C Maximum

Maximum Power Dissipation (Notes 2 & 3)	One Side	Both Sides
Total Dissipation at 25°C Case Temperature	1.5 Watts	3.0 Watts
at 25°C Ambient Temperature	0.25 Watt	0.35 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 Free Air Temperature unless otherwise noted)

Symbol	Characteristic	Min.	Max.	Units	Test Conditions	
V_{CEO}(sust)	Collector to Emitter Sustaining Voltage (Notes 4 & 5)	-15		Volts	I_C = 10 mA	I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	-20		Volts	I_C = 10 μA	I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	-4.0		Volts	I_C = 0	I_E = 10 μA
h_{FE}	DC Pulse Current Gain (Note 5)	35			I_C = 10 mA	V_{CE} = -1.0 V
I_{CBO}	Collector Cutoff Current		10	nA	I_E = 0	V_{CB} = -15 V
V_{CE}(sat)	Collector Saturation Voltage		-0.25	Volt	I_C = 20 mA	I_B = 2.0 mA
V_{BE}(sat)	Base Saturation Voltage		-1.0	Volt	I_C = 20 mA	I_B = 2.0 mA
h_{fe}	High Frequency Current Gain (f = 100 Mc)	1.0			I_C = 10 mA	V_{CE} = -10 V
C_{obo}	Output Capacitance		10	pf	I_E = 0	V_{CB} = -10 V
C_{ibo}	Input Capacitance		10	pf	I_C = 0	V_{BE} = 0.5 V
I_{CBO}(150°C)	Collector Cutoff Current		25	μA	I_E = 0	V_{CB} = -15 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 ambient thermal resistance of 700°C/Watt (derating factor of 1.42 mW/°C) for one side; 500°C/Watt (derating factor of 2.0 mW/°C) for both sides. Junction to case thermal resistance of 110°C/Watt (derating factor of 8.5 mW/°C) for one side; 58°C/Watt (derating factor of 17.2 mW/°C) for both sides.

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

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

(6) Lowest of two h_{FE} readings is taken as $h_{FE\,1}$ for purposes of this ratio.

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