MOTOROLA SMALL-SIGNAL TRANSISTORS, FETs AND DIODES

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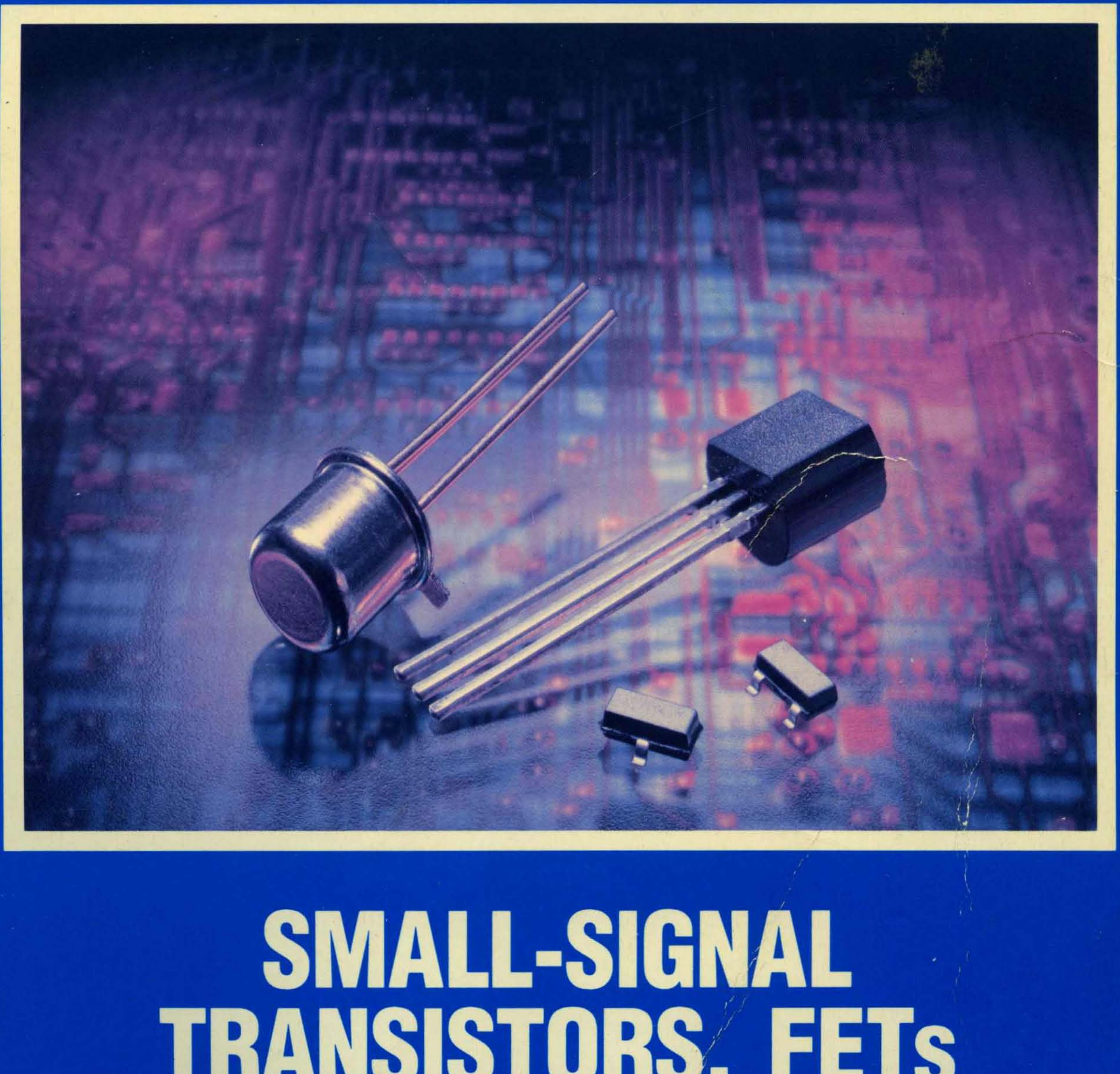
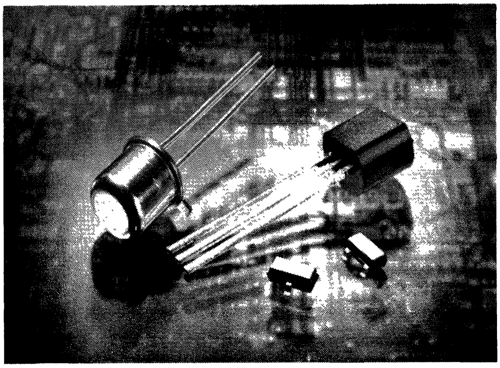


SMALL-SIGNAL TRANSISTORS, FETs AND DIODES



MOTOROLA

SMALL-SIGNAL TRANSISTORS, FETs AND DIODES

Prepared by
Technical Information Center

This publication presents technical information for the several product families that comprise the Motorola small-signal semiconductor line. The families includes bipolar, field-effect transistors, and diodes. These are available in a variety of packages; metal can, plastic, and surface mount. Complete device specifications and typical performance curves are given on individual data sheets, which are grouped by the various families.

A quick comparison of performance characteristics is presented in the easy-to-use selector guides in the first section. The tables will assist in the selection of the proper transistor for a specific application.

Separate sections are included to describe package outline drawings, and to clarify the high reliability processing and testing procedure.

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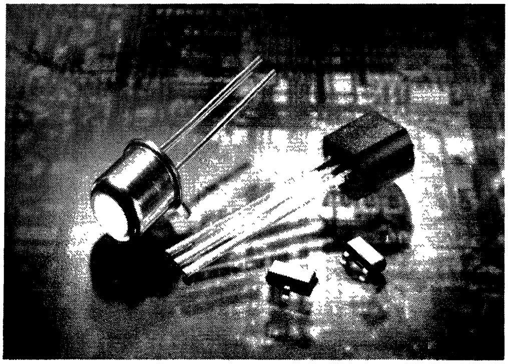
Selector Guides



The following selector guides highlight semiconductors that are the most popular and have a history of high usage for the most applications.

These selector guides cover a wide range of small signal plastic and metal can semiconductors.

A large selection of encapsulated plastic transistors, FETs and diodes are available for surface mount and insertion assembly technology. Plastic packages include TO-226AA, TO-226AE 1 Watt and SOT-23. Plastic multiples are available in 14-pin and 16-pin dual-in-line packages for insertion applications: SO-8, SO-14 and SO-16 for surface mount applications.

Metal can and ceramic packages are available for applications requiring higher power dissipation or having hermetic requirements. TO-18, TO-205AD, TO-46, TO-52 and TO-72 packages contain discrete devices. There is a variety of ceramic dip and flatpacks available for multiple transistors, FETs and diodes.

Devices which are JAN, JANTX, JTXV or CECC qualified are noted in the individual selector guides or in the Hi-Rel and Military Section of this selector guide.

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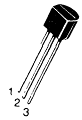
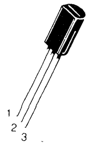
Small-Signal Bipolar Transistors



CASE 29-04
TO-226AA
(TO-92)



CASE 29-03
TO-226AE
(1 WATT TO-92)

Plastic-Encapsulated

Motorola's small-signal TO-226 plastic transistors encompass hundreds of devices with a wide variety of characteristics for general purpose, amplifier and switching applications. The popular high-volume package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems. All devices are laser marked for ease of identification and shipped in antistatic containers, as part of Motorola's ongoing practice of maintaining the highest standards of quality and reliability.

Table 1. General-Purpose Transistors

The general-purpose transistors are designed for small-signal amplification from dc to low radio frequencies. They are also useful as oscillators and general purpose switches.

			$V_{(BR)CEO}$	f_T @ I_C		I_C	h_{FE} @ I_C			NF
NPN	PNP	Pin Out	Volts Min	MHz Min	mA	mA Max	Min	Max	mA	Max dB
TO-226AA (TO-92)										
BC546	BC556	CBE	65	150	10	100	120	450	2.0	10
BC546A	BC556A	CBE	65	150	10	100	120	220	2.0	10
BC546B	BC556B	CBE	65	150	10	100	180	450	2.0	10
MPS8098	MPS8598	EBC	60	150	10	200	100	300	1.0	—
MPSA05	MPSA55	EBC	60	100	10	500	50	—	100	—
MPS651	MPS751	EBC	60	75	50	2000	40	—	2000	—
BC182	BC212	CBE	50	200	10	100	120	460	2.0	10
MPS5209		EBC	50	30	0.5	50	100	300	0.1	3.0
MPS5210		EBC	50	30	0.5	50	200	600	0.1	2.0
BC237	BC307	CBE	45	150	10	100	120	460	2.0	10
BC547	BC557	CBE	45	150	10	100	120	450	2.0	10
BC547A	BC557A	CBE	45	150	10	100	120	220	2.0	10
BC547B	BC557B	CBE	45	150	10	100	180	450	2.0	10
BC547C	BC557C	CBE	45	150	10	100	380	800	2.0	10
BC317	BC320	CBE	45	250	10	150	110	450	2.0	10
MPSA20	MPSA70	EBC	40	125	5.0	100	40	400	5.0	—
MPS6531	MPS6534	EBC	40	390*	50	600	10	120	100	—
MPS2222	MPS2907	EBC	30	250	20	600	100	300	150	—
MPS3703	MPS3705	EBC	30	100	50	600	30	150	50	—
MPS3704	MPS3702	EBC	30	100	50	600	100	300	50	—
MPS6513	MPS6517	EBC	30	330*	10	100	90	180	2.0	—
BC548	BC558	CBE	30	300*	10	100	120	300	2.0	10
BC548A	BC558A	CBE	30	300*	10	100	120	220	2.0	10
BC548B	BC558B	CBE	30	300*	10	100	180	450	2.0	10
BC548C	BC558C	CBE	30	300	10	100	380	800	2.0	10
	2N5227	EBC	30	100	10	50	50	700	2.0	—
	2N5226	EBC	25	50	20	500	30	600	50	—
MPS6514	MPS6518	EBC	25	480*	10	100	150	300	2.0	—
MPS6515	MPS6519	EBC	25	480	10	100	250	500	2.0	—
MPS5172		EBC	25	120*	5.0	100	100	500	10	—
MPS6560	MPS6562	EBC	25	60	10	500	50	200	600	—
MPS6601	MPS6651	EBC	25	100	50	1000	30	150	1000	—
BC238	BC308	CBE	25	150	10	100	120	800	2.0	10
MPS5222		EBC	15	450	4.0	50	20	150	4.0	—
MPS5223		EBC	20	150	10	100	50	800	2.0	—

Table 2. Low-Noise and Good h_{FE} Linearity

These devices are designed to use on applications where good h_{FE} linearity and low noise characteristics are required: Instrumentation, Hi-Fi Preamplifier.

NPN	PNP	Pin Out	$V_{(BR)CEO}$ Volts	h_{FE} Min	h_{FE} Max	@ I_C mA	V_T[1] mV Typ	NF[2] dB Max	f_T Typ MHz
TO-226AA (TO-92)									
—	MPS4249	EBC	60	100	—	10	—	3.0	100
—	2N5087	EBC	60	250	—	10	—	2.0	40
—	MPS4250A	EBC	60	250	—	10	—	2.0	250
—	2N5086	EBC	50	150	—	10	—	3.0	40
2N6428	—	EBC	50	250	650	0.1	3.0**	3.5***	100†
2N6428A	—	EBC	50	250	650	0.1	2.0**	3.0***	100†
BC239	BC309	CBE	45	120	800	2.0	9.5	2.0	240
BC414	BC416	CBE	45	180	800	2.0	8.0	2.5	250
BC550	BC560	CBE	45	180	800	2.0	8.0	2.5	250
BC550B	BC560B	CBE	45	180	460	2.0	8.0	2.5	250
BC550C	BC560C	CBE	45	380	800	2.0	8.0	2.5	250
BC651	—	EBC	45	380	1400	2.0	—	—	300
MPSA18	—	EBC	45	500	—	2.0	7.0	—	160
MPS3904	MPS3906	EBC	40	100	300	10	—	5.0	200
—	MPS4250	EBC	40	250	—	10	—	2.0	250
BC413	BC415	CBE	30	180	800	2.0	8.0	2.5	250
BC549	BC559	CBE	30	180	800	2.0	8.0	2.5	250
BC549B	BC559B	CBE	30	180	800	2.0	8.0	2.5	250
BC459C	BC459C	CBE	30	380	800	2.0	8.0	2.5	250
BC650	—	EBC	30	380	1400	2.0	—	—	300
2N4123	2N4125	EBC	30	50	150	2.0	—	6.0	300
2N5088	—	EBC	30	350	—	2.0	—	3.0	150
2N4124	2N4126	EBC	25	120	360	2.0	—	5.0	350
2N5089	—	EBC	25	450	—	2.0	—	2.0	150
—	MPS6523	EBC	25	300	—	2.0	—	3.0	340*

[1] V_T· Total Input Noise Voltage (see BC413/BC414 and BC415/BC416 Data Sheets) at $R_S = 2.0\ k\Omega$, $I_C = 200\ \mu A$, $V_{CE} = 5.0$ Volts

[2] N_F Noise Figure at $R_S = 2.0$ k, $I_C = 200\ \mu A$, $V_{CE} = 5\ 0$ Volts. f = 30 Hz to 15 kHz

* "S" version.

** $R_S = 10\ k\Omega$, BW = 1.0 Hz, f = 100 MHz

*** $R_S = 500\ \Omega$, BW = 1 0 Hz, f = 10 MHz

† Min

Table 3. Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high gain and input impedance. These devices have monolithic construction.

NPN	PNP	Pin Out	$V_{(BR)CEO}$ Volts	I_C Max	h_{FE} Min	h_{FE} Max	I_C mA	$V_{CE(sat)}$ Volts Max	I_C mA	I_B mA	f_T Min	I_C
TO-226AA (TO-92)												
MPSA29	—	EBC	100	500	10K	—	100	1.4	100	0.1	125	10
BC372	—	EBC	100	1000	25K	160K	100	1 0	250	0.25	100	100
MPSA28	—	EBC	80	500	10K	—	100	1.4	100	0.1	125	10
BC373	—	EBC	80	1000	25K	160K	100	1 0	250	0.25	100	100
MPSA27	MPSA77	EBC	60	500	10K	—	100	1.5	100	0.1	125	10
BC618	—	CBE	55	1000	10K	50K	200	1 1	200	0.2	150	500
MPSA26	—	EBC	50	500	10K	—	100	1.5	100	0.1	125	10
MPSA25	MPSA75	EBC	40	500	10K	—	100	1.5	100	0.1	125	10
BC617	—	CBE	40	1000	20K	70K	200	1.1	200	0.2	150	500
2N6427	—	EBC	40	500	20K	200K	100	1.5	500	0.5	125	10
2N6426	—	EBC	40	500	30K	300K	100	1.5	500	0.5	125	10
MPSA14	MPSA64	EBC	30	500	20K	—	100	1.5	100	0.1	125	10
MPSA13	MPSA63	EBC	30	500	10K	—	100	1.5	100	0.1	125	10
BC517	—	CBE	30	400	30K	—	20	1.0	100	0.1	125	10
MPSA12	MPSA62	EBC	20	500	20K	—	10	1.0	10	0.01	125	10
TO-226AE (1 WATT TO-92)												
MPSW45	—	EBC	40	1000	25K	—	200	1.5	1000	2.0	100	200
MPSW14	MPSW64	EBC	30	1000	20K	—	100	1.5	100	0.1	125	10
MPSW13	MPSW63	EBC	30	1000	10K	—	100	1.5	100	0.1	125	10

SMALL-SIGNAL BIPOLAR DEVICES — PLASTIC-ENCAPSULATED (continued)

Table 4. High-Current Transistors

TO-226AA (TO-92) — P_D = 625 mW

NPN	PNP	Pin Out	$V_{(BR)CEO}$ Volts	P_D mW 25°C Amb	I_C (mA) Cont	h_{FE} Min	h_{FE} Max	@ I_C mA	V_{CE} (Volts)	f_T Typical (MHz)
BC337	BC327	CBE	45	625	800	100	600	100	1.0	210
BC338	BC328	CBE	25	625	800	100	600	100	1.0	210
BC445	BC446	CBE	60	625	300	70	—	10	5.0	250/200[1]
BC447	BC448	CBE	80	625	300	70	—	10	5.0	250/200[1]
BC449	BC450	CBE	100	625	300	70	—	10	5.0	250/200[1]
BC485	BC486	CBE	45	625	1000	60	400	100	2.0	200/150[1]
BC487	BC488	CBE	60	625	1000	60	400	100	2.0	200/150[1]
BC489	BC490	CBE	80	625	1000	60	400	100	2.0	200/150[1]
MPSA05	MPSA55	EBC	60	625	500	50	—	100	1.0	150/175[1]
MPSA06	MPSA56	EBC	80	625	500	50	—	100	1.0	150/175[1]
MPS8099	MPS8599	EBC	80	625	500	75	—	100	5.0	200[1]
2N4409	—	EBC	50	625	250	60	400	10	1.0	200
2N4410	—	EBC	80	625	250	60	400	10	1.0	200
MPS650	MPS750	EBC	40	625	2000	75	—	1000	2.0	100
MPS651	MPS751	EBC	60	625	2000	75	—	1000	2.0	100
MPS8098	MPS8508	EBC	60	625	500	75	—	100	5.0	150

[1] Relevant to PNP.

TO-226AA (TO-92) — P_D = 800 mW

NPN	PNP	Pin Out	$V_{(BR)CEO}$ Volts Min	I_C Amp Cont	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	@ I_B mA	f_T MHz Min	@ I_C mA
BF420	BF421	ECB	300	0.1	40	25	2.0	20	2.0	60	10
BF422	BF423	ECB	250	0.1	50	25	2.0	20	2.0	60	10
BC639	BC640	ECB	80	1.0	40	150	0.5	500	50	60	10
BC637	BC639	ECB	60	1.0	40	150	0.5	500	50	60	10
BC635	BC636	ECB	45	1.0	40	150	0.5	500	50	60	10
BC368	BC369	ECB	20	1.0	60	1000	0.5	1000	100	65	10

TO-226AE (TO-92) — P_D = 1 W

NPN	PNP	Pin Out	$V_{(BR)CEO}$ Volts Min	MHz f_T Min	@ I_C mA	I_C Max A	h_{FE} Min	h_{FE} Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	@ I_B mA
BDB01D	BDB02D	EBC	100	50	200	1.5	40	400	100	0.7	1000	100
BDC01D	BDC02D	ECB	100	50	200	1.5	40	400	100	0.7	1000	100
BDB01C	BDB02C	EBC	80	50	200	1.5	40	400	100	0.7	1000	100
BDC01C	BDC02C	ECB	80	50	200	1.5	40	400	100	0.7	1000	100
MPS6717	MPS6729	EBC	80	50	200	0.5	80	—	50	0.5	250	10
MPSW06	MPSW56	EBC	80	50	200	0.5	50	—	50	0.4	250	10
BDB01B	BDB02B	EBC	60	50	200	1.5	40	400	100	0.7	1000	100
BDC01B	BDC02B	ECB	60	50	200	1.5	40	400	100	0.7	1000	100
MPSW05	MPS6728	EBC	60	50	200	0.5	80	—	50	0.4	250	10
MPS6716	MPSW55	EBC	60	50	200	0.5	80	—	50	0.5	250	10
BDB01A	BDB02A	EBC	45	50	200	1.5	40	400	100	0.7	1000	100
BDC01A	BDC02A	ECB	45	50	200	1.5	40	400	100	0.7	1000	100
MPS6715	MPS6727	EBC	40	50	50	1.0	50	—	1000	0.5	1000	100
MPSW01A	MPSW51A	EBC	40	50	50	1.0	50	—	1000	0.5	1000	100
MPS6714	MPS6726	EBC	30	50	50	1.0	50	—	1000	0.5	1000	100
MPSW01	MPSW51	EBC	30	50	50	1.0	50	—	1000	0.5	1000	100

Table 5. High-Voltage Amplifier Transistors

These high-voltage transistors are designed for driving neon bulbs and Nixie® indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage ($V_{(BR)CEO}$).

NPN Transistors

Device Type	Pin Out	$V_{(BR)CEO}$ Volts Min	I_C Amp Max	h_{FE} Min	@ I_C mA	V_F Volts Max	@ I_C mA	& I_B mA	f_T MHz Min	@ I_C mA
TO-226AA (TO-92)										
BF844	EBC	400	0.5	40	30	0.5	10	1.0	50	10
MPSA44	EBC	400	0.3	40	100	0.75	50	5.0	20	10
BF845	EBC	350	0.5	40	30	0.5	10	1.0	50	10
MPSA45	EBC	350	0.3	50	100	0.75	50	5.0	20	10
2N6516	EBC	350	0.5	30	30	0.2	10	1.0	40	10
BF393	EBC	300	0.5	40	10	0.2	20	2.0	50	10
MPSA42	EBC	300	0.5	40	30	0.5	20	2.0	50	10
2N6517	EBC	300	0.5	45	30	0.3	10	1.0	40	10
BF392	EBC	250	0.5	40	10	0.2	20	2.0	50	10
2N6515	EBC	250	0.5	50	30	0.3	10	1.0	40	10
BF391	EBC	200	0.5	40	10	0.2	20	2.0	50	10
MPSA43	EBC	200	0.5	40	10	0.4	20	2.0	50	10
2N5551	EBC	160	0.6	80	10	0.15	10	1.0	100	10
2N5550	EBC	140	0.6	60	10	0.15	10	1.0	100	10
MPSL01	EBC	100	0.15	20	30	0.2	10	1.0	40	10
TO-226AE (1 WATT TO-92)										
BDC05	ECB	300	0.5	40	25	2.0	20	2.0	60	10
MPS6735	EBC	300	0.3	40	10	2.0	20	2.0	50	10
MPSW10	EBC	300	0.3	40	30	0.75	30	3.0	45	10
MPSW42	EBC	300	0.3	40	30	0.5	20	2.0	50	10
BDC07	ECB	250	0.5	200	50	2.0	20	2.0	60	10
MPS6734	EBC	250	0.3	40	10	2.0	20	2.0	50	10
MPSW43	EBC	200	0.3	50	30	0.4	20	2.0	50	10
MPS6733	EBC	200	0.3	40	10	2.0	20	2.0	50	10
PNP Transistors										
TO-226AA (TO-92)										
BF493S	EBC	350	0.5	40	10	20	20	2.0	50	10
2N6520	EBC	350	0.5	30	30	3.0	10	1.0	40	10
BF493	EBC	350	0.5	40	10	0.2	20	2.0	50	10
MPSA92	EBC	300	0.5	40	10	0.5	20	2.0	50	10
2N6519	EBC	300	0.5	45	30	0.3	10	1.0	40	10
BF492	EBC	250	0.5	40	10	0.2	20	2.0	50	10
BF491	EBC	200	0.5	40	10	0.2	20	2.0	50	10
MPSA93	EBC	200	0.5	40	10	0.4	20	2.0	50	10
2N5401	EBC	150	0.6	60	10	0.2	10	1.0	100	10
2N5400	EBC	120	0.6	40	10	0.2	10	1.0	100	10
MPSL51	EBC	100	0.5	40	50	0.25	10	1.0	50	10
TO-226AE (1 WATT TO-92)										
BDC06	ECB	300	0.5	40	25	2.0	20	2.0	60	10
MPSW92	EBC	300	0.3	25	30	0.5	20	2.0	50	10
BDC08	ECB	250	0.5	40	25	2.0	20	2.0	60	10
MPSW93	EBC	200	0.3	25	30	0.5	20	2.0	50	10

SMALL-SIGNAL BIPOLAR DEVICES — PLASTIC-ENCAPSULATED (continued)

Table 6. RF Transistors

The RF transistors are designed for Small Signal amplification from RF to VHF/UHF frequencies. They are also used as mixers and oscillators in the same frequency ranges. Several types are AGC characterized.

Device Type	Pin Out	$V_{(BR)CEO}$ Volts Min	I_C Max mA	h_{FE} Min	I_C mA	V_{CE} V	f_T Typ MHz	CRE/CRB pF Max	NF Typ dB	f MHz
NPN — TO-226AA (TO-92)										
BF373	BEC	45	100	38	7.0	10	720	0.32	—	—
BF241	CEB	40	25	35	1.0	10	470	0.34	2.5	100
BF240	CEB	40	25	65	1.0	10	600	0.34	2.5	100
BF224	CEB	30	50	30	7.0	10	600	0.28	2.5	100
MPSH32	BEC	30	30	27	4.0	5.0	300*	—	3.3*	45
MPSH24	BEC	30	100	30	8.0	10	400*	0.36	—	—
MPSH20	BEC	30	100	25	4.0	10	400*	—	—	—
MPSH07	EBC	30	25	20	3.0	10	400*	0.3	—	—
MPS3866	EBC	30	400	10	50	5.0	500*	—	—	—
BF371	BEC	30	100	38	7.0	10	720	0.23	—	—
MPSH11	BEC	25	25	60	4.0	10	660*	—	—	—
MPSH10	BEC	25	100	60	4.0	10	1500	0.7	—	—
BF375	BEC	25	100	35	1.0	10	800	0.6	4.0	100
BF374	BEC	25	100	70	1.0	10	800	0.6	4.0	100
BF199	CEB	25	100	40	7.0	10	750	0.35	2.5	35
MPSH30	BEC	20	50	20	4.0	5.0	300*	—	6.0*	100
BF959	CEB	20	100	40	20	10	800	0.65	3.0	200
BF254	CEB	20	100	65	1.0	10	260	0.9	1.7	1.0
MPSH17	BEC	15	100	25	5.0	10	1600	0.9	6.0*	200
MPS918	EBC	15	50	20	8.0	10	800	1.7	6.0*	60
MPS5179	EBC	12	50	25	3.0	1.0	2000	—	4.5*	200
MPS3563	EBC	12	50	20	8.0	10	800	1.7	6.0*	60
MPSH04	EBC	10	30	30	1.5	10	80*	—	2.0*	1.0
PNP — TO-226AA (TO-92)										
MPSH55	BEC	80	100	30	1.5	10	80	—	—	—
BF506	CBE	35	50	20	3.0	10	600	0.25	4.0	200
2N5208	BEC	25	50	20	2.0	10	300*	—	3.0*	100
MPSH81	BEC	20	50	60	5.0	10	700	0.85	—	—

*Max

Table 7. High-Speed Saturated Switching Transistors

The transistors listed in this table are specially optimized for high-speed saturated switches. They are heavily gold doped and processed to provide very short switching times and low output capacitance (below 6 pF). The transistors are listed in order of decreasing turn-on time (t_{on}).

Device Type	t_{on} ns Max	& t_{off} ns Max	@ I_C mA	$V_{(BR)CEO}$ Volts Min	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA	f_T MHz Min	@ I_C mA
NPN — TO-226AA (TO-92)											
2N3904	70	250	10	40	100	10	0.2	10	1.0	300	10
2N3903	70	225	10	40	50	10	0.2	10	1.0	250	10
2N4401	35	225	10	40	40	10	0.4	10	1.0	250	20
2N4400	35	255	150	40	50	150	0.4	150	15	200	20
2N4264	25	35	10	15	40	10	0.22	10	1.0	300	10
2N4265	25	35	10	12	100	10	0.22	10	1.0	300	10
MPS3646	18	28	300	15	30	30	0.2	30	3.0	350	30
MPS2369	12	18	10	15	40	10	0.25	10	1.0	500	10
PNP — TO-226AA (TO-92)											
2N3638	75	170	300	25	20	300	0.25	50	2.5	100	50
2N3638A	75	170	300	25	20	300	0.25	50	2.5	150	50
2N3906	70	250	10	40	100	10	0.25	10	1.0	250	10
2N3905	70	225	10	40	100	10	0.25	10	1.0	200	10
2N4402	35	255	150	40	50	150	0.4	150	15	150	20
2N4403	35	225	150	40	100	150	0.4	150	15	200	20
MPS3640	25	35	50	12	30	10	0.2	10	1.0	500	10
MPS4258	15	20	10	12	30	50	0.15	10	1.0	700	10
2N5771	15	20	10	15	50	10	0.18	10	1.0	850	10

[1] $V_{(BR)EBO}$

*Typ

Table 8. Choppers

Devices are listed in decreasing ($V_{(BR)EBO}$)

Device Type	Pin Out	$V_{(BR)EBO}$ Volts Min	I_C Amp* Max	@ h_{FE} Min	I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA	f_T MHz Min	@ I_C mA
NPN — TO-226AA (TO-92)										
MPSA17	EBC	15	100	200	5.0	0.25	10	1.0	100	5.0
MPSA16	EBC	12	100	200	5.0	0.25	10	1.0	80	5.0

Table 9. Industrial Transistors

These devices are special products ranges intended for use in applications which require well specified high performing devices like high quality amplifier differential input, driver stage.

NPN	PNP	Pin Out	$V_{(BR)CEO}$ (Volts)	I_C (mA) Cont	h_{FE} Min	h_{FE} Max	@ I_C (mA)	& V_{CE} (Volts)	f_T Typ (MHz)	Typ (dB)	t_{on} ns Typ	t_{off} ns Typ
TO-226AA (TO-92)												
—	MPS2907A	EBC	60	600	100	—	10	10	200*	—	45	100
BCX59	BCX79	CBE	45	200	120	630	2.0	5.0	250	2.0	75	600/350
MPS2222A	—	EBC	40	600	75	—	10	10	300*	—	30	270
BCX58	BCX78	CBE	32	200	120	630	2.0	5.0	250	2.0	75	600/350

*f_T Min

Table 10. Telecom Transistors

These devices are special product ranges intended for use in Telecom application which require an excellent long term reliability.

Device Type	Pin Out	$V_{(BR)CEO}$ Volts	P_D mW 25°C Amb	I_C (mA) Cont	h_{FE}				f_T Min MHz
					Min	Max	I_C (mA)	V_{CE} (V)	
NPN — TO-226AA (TO-92)									
P2N2222	CBE	30	625	600	75	—	10	10	250
P2N2222A	CBE	40	625	600	75	—	10	10	300
(1)PBF259,S	EBC	300	625	500	25	—	1.0	10	40
(1)PBF259R,RS	CBE	300	625	500	25	—	1.0	10	40
PNP — TO-226AA (TO-92)									
P2N2907	CBE	40	625	600	75	—	10	10	200
P2N2907A	CBE	60	625	600	100	—	10	10	200
(2)PBF493,S	EBC	300	625	500	40	—	1.0	10	40
(2)PBF493R,RS	CBE	300	625	500	40	—	1.0	10	40

(1) "S" version, h_{FE} Min 60 @ I_C = 20 mA, V_{CE} = 10 V.
(2) "S" version, h_{FE} Min 40 @ I_C = 0.1 mA, V_{CE} = 1.0 V.

Small-Signal Metal Packaged Transistors

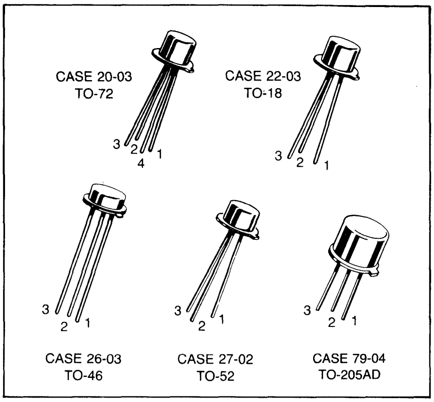


Table 11. General-Purpose Transistors

These transistors are designed for dc to VHF amplifier applications, general-purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package group.

Device Type	$V_{(BR)CEO}$ Volts Min	f_T MHz Min	@ I_C mA	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C mA
NPN — TO-206AA (TO-18)							
2N2896	90	120	50	1000	60	200	150
2N720A	80	50	50	150	40	120	150
2N3700#	80	80	1.0	1000	50	—	500
2N2895	65	120	50	1000	40	120	150
2N910	60	60	50	1000	75	—	10
2N956	50	70	50	—	40	120	150
2N2897	45	100	50	1000	50	200	150
2N915	50	250	10	30	50	200	10
BC107	45	150	10	200	110	450	2.0
BC107A	45	150	10	200	110	220	2.0
BC107B	45	150	10	200	200	450	2.0
BC107C	45	150	10	200	420	800	2.0
BCY59	45	125	10	200	120	630	2.0
BCY59-IX	45	125	10	200	250	460	2.0
BCY59-VII	45	125	10	200	120	220	2.0
BCY59-VIII	45	125	10	200	180	310	2.0
BCY59-X	45	125	10	200	380	630	2.0
2N2218#	40	250	20	800	40	120	150
2N2221A#	40	250	20	800	40	120	150
2N2222A#	40	300	20	800	100	300	150
2N3946	40	300	10	200	50	150	10
2N3947	40	300	10	300	100	300	10
2N718	40	50	50	—	40	120	150
BCY58	32	125	10	200	120	630	2.0
BCY58-IX	32	125	10	200	250	460	2.0
BCY58-VII	32	125	10	200	120	220	2.0
BCY58-VIII	32	125	10	200	180	310	2.0
BCY58-X	32	125	10	200	380	630	2.0
2N2221	30	250	20	800	40	120	150
2N2222#	30	250	20	800	100	300	150
2N3302	30	250	50	500	100	300	150
2N916*	25	300	10	—	50	200	10
BC108	25	150	10	100	110	800	2.0
BC108A	25	150	10	100	110	220	2.0
BC108B	25	150	10	100	200	450	2.0
BC108C	25	150	10	100	420	800	2.0
BC109	25	150	10	100	200	800	2.0
BC109A	25	150	10	100	110	220	2.0
BC109B	25	150	10	100	200	450	2.0
BC109C	25	150	10	100	420	800	2.0
2N706	15	200	10	50	20	—	10
2N706A	15	200	10	50	20	60	—
2N706B	15	200	10	50	20	60	—

#JAN/JANTX/JANTXV available

Table 11. General-Purpose Transistors (continued)

Device Type	$V_{(BR)CEO}$ Volts Min	f_T MHz Min	@ I_C mA	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C mA
NPN — TO-205AD (TO-39)							
2N1711	80	70	50	—	100	300	150
2N694	80	50	50	150	40	120	150
2N3019#	80	100	50	1000	100	300	150
2N3020	80	80	50	1000	40	120	150
BSX47-10	80	50	20	1000	63	160	100
BSX47-16	80	50	20	1000	100	250	100
BSX47-6	80	50	20	1000	40	100	100
2N1893	80	50	50	500	40	120	150
2N2102	65	60	50	1000	40	120	150
BC141	60	50	50	1000	40	400	100
BC141-10	60	50	50	1000	63	160	100
BC141-16	60	50	50	1000	100	250	100
2N697	60	—	—	150	40	120	150
BSX46-10	60	50	20	1000	63	160	100
BSX46-16	60	50	20	1000	100	250	100
BSX46-6	60	50	20	1000	40	100	100
2N3053A	60	100	50	700	50	250	150
2N3073	60	130	50	500	30	130	50
2N1613#	50	60	50	500	40	120	150
2N2270	45	100	50	1000	50	200	150
2N2219A#	40	300	20	800	100	300	150
2N3053	40	100	50	700	50	250	150
2N697	40	—	—	200	40	120	150
BC140	40	50	50	1000	40	400	100
BC140-10	40	50	50	1000	63	160	100
BC140-16	40	50	50	1000	100	250	100
BSX45-10	40	50	20	1000	63	160	100
BSX45-16	40	50	20	1000	100	250	100
BSX45-6	40	50	20	1000	40	100	100
BFY50	35	60	50	1000	30	—	150
2N2218#	30	250	20	800	40	120	150
2N2219#	30	250	20	800	100	300	150
2N3300	30	250	50	500	100	300	150
BFY51	30	50	50	1000	40	—	150
BFY52	20	50	50	1000	50	—	150
NPN — TO-205AD (TO-46)							
2N5581**	40	250	20	800	40	120	150
2N5582**	40	300	20	800	100	300	150
NPN — TO-205AD (TO-52)							
MM3903	40	250	10	200	50	150	10
MM3904	40	300	10	200	100	300	10
PNP — TO-206AA (TO-18)							
2N4026	80	100	50	1000	15	—	100
2N4027	80	100	50	1000	10	—	100
2N4028	80	150	50	1000	40	—	100
2N4029	80	150	50	1000	25	—	100
2N2906A#	60	200	50	600	40	120	150
2N2907A	60	200	50	600	100	300	150
2N3250A#	60	250	10	200	50	150	10
2N3251A#	60	300	10	200	100	300	10
2N718A	50	60	50	500	40	300	150
BC177	45	200	10	200	120	460	2.0
BC177A	45	200	10	200	120	220	2.0
BC177B	45	200	10	200	180	460	2.0
BC177C	45	200	10	200	380	800	2.0
BCY79	45	10	200	200	100	600	10
BCY79-IX	45	180	10	200	250	460	2.0
BCY79-VII	45	180	10	200	120	220	2.0
BCY79-VIII	45	180	10	200	180	310	2.0
BCY79-X	45	180	10	200	380	630	2.0
2N2906#	40	200	50	600	40	120	150
2N2907#	40	200	50	600	100	300	150
2N3250	40	250	10	200	50	150	10
2N3251	40	300	10	200	100	300	10
BCY70	40	250	10	200	50	—	10

**JAN/JANTX available #JAN/JANTX/JANTXV available

SMALL-SIGNAL BIPOLAR TRANSISTORS — METAL (continued)

Table 11. General-Purpose Transistors (continued)

Device Type	$V_{(BR)CEO}$ Volts Min	f_T MHz Min	@ I_C mA	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C mA
PNP — TO-206AA (TO-18) (continued)							
2N3135	35	200	50	500	40	125	50
BCY78-IX	32	180	10	200	250	460	2.0
BCY78-VII	32	180	10	200	120	220	2.0
BCY78-VIII	32	180	10	200	180	310	2.0
BCY78-X	32	180	10	200	380	630	2.0
BC178	25	200	10	200	120	800	2.0
BC178A	25	200	10	200	120	220	2.0
BC178B	25	200	10	200	180	460	2.0
BC178C	25	200	10	200	380	800	2.0
BCY72	25	250	10	200	50	—	10
BC179	20	200	10	200	180	800	2.0
BC179A	20	200	10	200	120	220	2.0
BC179B	20	200	10	200	180	460	2.0
BC179C	20	200	10	200	380	800	2.0
2N3249	12	300	20	200	35	—	100
PNP — TO-205AD (TO-39)							
MM5007	100	30	50	2000	50	250	250
2N4031	80	100	50	1000	10	—	100
2N4033#	80	150	50	1000	25	—	100
BSV17-10	80	50	50	1000	63	160	100
BSV17-16	80	50	50	1000	40	100	100
MM5006	80	30	50	2000	50	250	200
BFX40	75	100	50	1000	85	—	100
BFX41	75	100	50	1000	40	—	100
2N4036	65	60	50	1000	40	140	150
2N4037	65	60	50	1000	40	—	150
2N2904A#	60	200	50	600	40	120	150
2N2905A	60	200	50	600	100	300	150
2N3073	60	130	50	500	30	130	50
2N4030	60	100	50	1000	15	—	100
2N4032	60	150	50	1000	40	—	100
BC161	60	50	50	1000	40	400	100
BC161-10	60	50	50	1000	63	160	100
BC161-16	60	50	50	1000	100	250	100
BC161-6	60	50	50	1000	40	100	100
BSV16-10	60	50	50	1000	63	160	100
BSV16-16	60	50	50	1000	100	250	100
BSV16-6	60	50	50	1000	40	100	100
MM5005	60	30	50	2000	50	250	150
2N4890	40	100	50	1000	50	250	150
2N1132A	40	60	50	600	30	90	150
2N2904#	40	200	50	600	40	120	150
2N2905#	40	200	50	600	100	300	150
BC160	40	50	50	1000	40	400	100
BC160-10	40	50	50	1000	63	160	100
BC160-16	40	50	50	1000	100	250	100
BC160-6	40	50	50	1000	40	100	100
BSV15-10	40	50	50	1000	63	160	100
BSV15-16	40	50	50	1000	100	250	100
BSV15-6	40	50	50	1000	40	100	100
MM4037	40	60	50	1000	50	250	150
2N1132	35	60	50	600	30	90	150
PNP — TO-205AD (TO-46)							
2N3485A**	60	200	50	600	40	120	150
2N3486A**	60	200	50	600	100	300	150
2N3485	40	200	50	600	40	120	150
2N3486	40	200	50	600	100	300	150
PNP — TO-205AD (TO-52)							
MM3906	40	250	10	200	100	300	10
MM3905	40	200	10	200	50	150	10

*JAN available **JAN/JANTX available #JAN/JANTX/JANTXV available

Table 12. High-Gain/Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

Device Type	NF Wideband Typ* Max dB	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C µA mA*	f_T MHz Min	@ I_C mA
NPN — TO-206AA (TO-18)								
2N2484#	8.0*	60	50	100	500	10	15	0.05
2N930A	3.0	45	30	100	300	10	45	0.5
2N930**	3.0	45	30	100	300	10	30	0.5
PNP — TO-206AA (TO-18)								
2N3962	10	60	200	100	450	1.0*	40	0.5
2N3963	10	80	200	100	450	1.0*	40	0.5
2N3965	8.0	60	200	250	600	1.0*	50	0.5
2N3964	4.0	45	200	250	600	1.0*	50	0.5
2N3798	3.5	60	50	150	450	500	30	0.5
2N3799	2.5	60	50	300	900	500	30	0.5
PNP — TO-206AB (TO-46)								
2N2605#	4.0	45	30	100	300	10	30	0.5

Table 13. High-Voltage/High-Current Transistors

The following table lists Motorola standard devices that have high Collector-Emitter Breakdown Voltage. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package type.

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA	f_T MHz Min	@ I_C mA
NPN — TO-206AA (TO-18)									
2N6431	300	50	50	30	0.5	20	2.0	50	10
BSS73	300	500	40	30	0.5	50	5.0	100	20
BSS72	250	500	40	30	0.5	50	5.0	100	20
2N6430	200	50	50	30	0.5	20	2.0	50	10
BSS71	200	500	40	30	0.5	50	5.0	100	20
BC394	180	500	30	10	0.3	10	1.0	50	20
NPN — TO-205AD (TO-39)									
2N3439#	350	1000	40	20	0.5	50	4.0	15	10
2N5058	300	150	35	30	1.0	30	3.0	30	10
BF259	300	100	25	30	1.0	30	6.0	110	30
2N3440#	250	1000	40	20	0.5	50	4.0	15	10
2N4927	250	50	20	30	2.0	30	3.0	30	10
2N5059	250	150	30	30	1.0	30	3.0	30	10
MM3003	250	50	20	10	—	—	—	150	10
BF258	250	100	25	30	1.0	30	6.0	110	30
BSS78	250	500	40	30	0.4	30	3.0	70	20
2N4926	200	50	20	30	2.0	30	3.0	30	10
MM3002	200	50	20	10	—	—	—	150	10
MM3009	180	400	40	10	—	—	—	50	20
MM3001	150	200	20	10	—	—	—	150	10
2N3500#	150	300	40	150	0.4	150	15	150	20
2N3501#	150	300	100	150	0.4	150	15	150	20
3N3114	150	200	30	30	1.0	50	5.0	40	30
BSW68A	150	2000	30	500	1.0	500	150	—	—
2N5682	120	1000	40	250	0.6	250	25	30	100
BSW67A	120	2000	30	500	1.0	500	150	—	—
2N3498#	100	500	40	150	0.6	300	30	150	20
2N3499#	100	500	100	150	0.6	300	30	150	20
2N5681	100	1000	40	250	0.6	250	25	30	100
2N657	100	—	300	200	4.0	200	40	—	—
MM3007	100	2500	50	250	0.35	150	15	50	50
2N4239	80	3000	30	250	0.3	500	50	2.0	100
MM3006	80	2500	50	200	0.35	150	15	50	50

#JAN/JANTX/JANTXV available **JAN/JTX

Table 13. High-Voltage/High-Current Transistors (continued)

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA	f_T MHz Min	@ I_C mA
NPN — TO-205AD (TO-39) (continued)									
3N4238	60	3000	30	250	0.3	500	50	2.0	100
MM3005	60	2500	50	150	0.35	150	15	50	50
2N4237	40	3000	30	250	0.3	500	50	2.0	100
PNP — TO-206AA (TO-18)									
2N6433	300	500	30	30	0.5	20	20	50	10
BSS76	300	500	35	30	0.5	50	5.0	100	20
BSS75	250	500	35	30	0.5	50	5.0	100	20
2N6432	200	1000	30	30	0.5	20	2.0	50	10
BSS74	200	500	35	30	0.5	50	5.0	100	20
BC393	180	500	50	10	0.3	10	1.0	50	20
2N3497	120	100	40	10	0.35	10	1.0	150	20
2N3496	80	100	40	10	0.3	10	1.0	200	20
PNP — TO-205AD (TO-39)									
2N3494	80	100	40	10	0.3	10	1.0	200	20
2N3495	120	100	40	10	0.35	10	1.0	150	20
2N3635#	140	1000	100	50	0.5	50	5.0	200	30
2N3636#	175	1000	50	50	0.5	50	5.0	150	30
2N3637#	175	1000	100	50	0.5	50	5.0	200	30
2N3743#	300	50	25	30	8.0	30	3.0	30	10
2N4234	40	3000	30	250	0.6	1000	125	3.0	100
2N4235	60	3000	30	250	0.6	1000	125	3.0	100
2N4236	80	3000	30	250	0.6	1000	125	3.0	100
2N4928	100	100	25	10	0.5	10	1.0	100	20
2N4929	150	500	25	10	0.5	10	1.0	100	20
2N4930#	200	500	20	20	5.0	10	1.0	20	20
2N4931#	250	500	20	20	5.0	10	1.0	20	20
2N5415#	200	1000	30	50	2.5	50	5.0	15	10
2N5416#	300	1000	30	50	2.5	50	5.0	15	10
2N5679	100	1000	40	250	0.6	250	25	30	100
2N5680	120	1000	40	250	0.6	250	25	30	100
2N3634#	140	1000	50	50	0.5	50	5.0	150	30
MM4000	100	100	20	20	0.6	10	1.0	—	—
MM4001	150	500	20	10	0.6	10	1.0	—	—
MM4002	200	500	20	10	5.0	10	1.0	—	—
MM4003	250	500	20	10	5.0	10	1.0	—	—
MM5005	60	2000	50	150	0.5	150	15	30	50
MM5006	80	2000	50	200	0.5	150	15	30	50
MM5007	100	2000	50	250	0.5	150	15	30	50

#JAN/JANTX/JANTXV available

Table 14. High-Frequency Amplifiers/Oscillators

The transistors shown are designed for use as both oscillators and amplifiers at UHF and VHF frequencies. Devices are listed in decreasing order of $V_{(BR)CEO}$ with each line.

Device Type	$V_{(BR)CEO}$ Volts Min	h_{FE} Min	@ I_C mA	G_{pe} dB Min	NF dB Max	@ f MHz	f_T MHz Min	@ I_C mA	C_{obo} pF Max
NPN — TO-206AF (TO-72)									
2N918†	15	20	3.0	15	6.0	60	600	4.0	1.7
PNP — TO-206AF (TO-72)									
2N3307	35	40	2.0	17	4.5	200	300	2.0	1.3
2N3308	25	25	2.0	17	6.0	200	300	2.0	1.6
2N4261#	15	30	10	—	—	—	1600	10	2.5
2N4260	15	30	10	—	—	—	2000	10	2.5

†JAN/JANTX/JANTXV/JANS available #JAN/JANTX/JANTXV available

Table 15. Switching Transistors

The following devices are intended for use in general-purpose switching and amplifier applications. Within each package group shown, the devices are listed in order of decreasing turn-on time (t_{on}).

Device Type	t_{on} ns Max &	t_{off} ns Max	@ I_C mA	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	@ I_B mA	f_T MHz Min	I_C mA
NPN — TO-206AA (TO-18)												
2N3012	60	75	30	12	200	20	100	0.5	100	10	—	—
2N708	40	70	10	15	30	30	10	0.4	10	1.0	300	10
2N2540	40	40	150	30	—	100	150	0.45	150	15	250	20
2N914**	40	40	200	15	150	12	10	0.7	200	20	300	20
2N2481	40	55	100	15	150	40	10	0.4	100	10	—	—
2N4014	35	60	500	50	1000	35	500	0.52	500	50	300	50
2N4013	35	60	500	30	1000	35	500	0.42	500	50	300	50
2N834	35	40	10	40	200	25	10	0.4	50	5.0	350	10
2N835	35	40	10	40	200	—	—	0.4	50	5.0	350	10
2N2501	15	25	300	20	—	10	500	0.3	50	5.0	350	10
2N2369	12	18	100	15	500	20	100	0.25	10	1.0	500	10
2N3011	15	20	30	12	500	12	100	0.5	100	10	400	20
2N3013	15	25	300	15	500	15	300	0.5	300	30	350	30
2N3014	16	25	30	20	500	25	100	0.35	100	10	350	30
2N2369A†	12	18	10	15	200	40	10	0.2	10	1.0	500	10
2N2368	12	—	10	15	200	20	10	0.25	10	1.0	400	10
2N3227	12	18	100	20	50	30	100	0.25	10	1.0	500	10
BSX20	7.0	18	100	15	500	20	10	0.25	10	1.0	400	10
NPN — TO-205AD (TO-39)**												
2N5320	80	800	500	75	2000	30	500	0.5	500	50	—	—
2N5321	80	800	500	50	2000	40	500	0.8	500	50	—	—
2N3444**	50	70	500	50	—	20	500	0.6	500	50	175	50
2N3253**	50	70	500	40	—	25	500	0.6	500	50	175	50
2N3735#	48	60	1000	50	1500	20	1000	0.5	500	50	250	50
2N3734	48	60	1000	50	1500	30	1000	0.5	500	50	250	50
2N3252	45	70	500	30	—	30	500	0.5	500	50	200	50
2N3506#	45	90	1500	40	3000	40	1500	1.0	1500	150	60	100
2N3507#	45	90	1500	50	3000	30	1500	1.0	1500	150	60	100
BSX60	40	70	500	30	1000	30	500	0.5	500	50	—	—
2N5859	36	70	100	40	2000	15	1000	0.7	1000	100	25	50
2N3725	35	60	500	50	2000	35	500	0.52	500	50	300	50
2N3724	35	60	500	30	2000	35	500	0.42	500	50	300	50
BSX59	35	60	500	45	1000	25	500	0.5	500	50	—	—
MM5262	30	60	1000	40	2000	25	1000	0.8	1000	100	350(typ)	50
2N5861	25	60	500	50	2000	25	500	0.5	500	50	200	50
NPN — TO-205AD (TO-46)												
2N3737#	48	60	1000	50	1500	20	1000	0.5	500	50	250	50
2N3648	16	18	150	15	500	30	150	0.4	150	15	450	15
NPN — TO-205AD (TO-52)												
MM1748A	10	15	10	—	150	20	10	—	—	—	600	5.0
PNP — TO-206AA (TO-18)												
2N2894	60	90	30	12	200	40	30	0.2	30	3.0	400	30
2N869A**	50	80	30	18	200	40	30	0.2	30	3.0	400	10
2N3546	40	30	50	12	—	25	50	0.25	50	5.0	700	10
2N4208	15	20	10	12	200	30	10	0.15	10	1.0	700	10
MM4258	15	20	10	12	200	30	10	0.15	10	1.0	700	10
2N4209	15	20	10	15	200	50	10	0.6	50	5.0	850	10

SMALL-SIGNAL BIPOLAR TRANSISTORS — METAL (continued)

Table 15. Switching Transistors (continued)

PNP — TO-205AD (TO-39)

Device Type	t_{on} ns Max	& t_{off} ns Max	@ I_C mA	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	@ I_B mA	f_T MHz Min	I_C mA
2N4036	110	700	150	65	1000	40	150	0.65	150	15	60	50
2N5322	100	1000	500	75	2000	30	500	0.7	500	50	—	—
2N5323	100	1000	500	50	2000	40	500	1.2	500	50	—	—
2N4406	75	225	1000	80	1500	20	1000	0.7	1000	100	150	50
2N4407	75	225	1000	80	1500	30	1000	0.7	1000	100	150	50
2N3245	55	165	500	50	1000	30	500	0.6	500	50	150	50
2N3244	50	185	500	40	1000	50	500	0.5	500	50	175	50
2N4453**	50	80	30	18	200	25	100	0.5	100	10	400	10
2N3467#	40	90	500	40	100	40	500	0.5	500	50	175	50
2N3468#	40	90	500	50	1000	25	500	0.6	500	50	150	50
2N4404	40	210	500	80	1000	30	500	0.5	500	50	200	50
2N4405**	40	210	500	80	1000	50	500	0.5	500	50	200	50
2N5022	40	90	500	—	500	25	1000	0.8	1000	100	170	50
2N5023	40	90	500	—	500	40	1000	0.7	1000	100	200	50
2N2800	34	270	150	35	800	25	500	1.2	500	50	120	50
2N3764	11.5	65	100	40	1500	30	1000	0.9	1000	100	180	50
2N3765	11.5	65	100	60	1500	20	1000	0.9	1000	100	150	50
2N3762#	11.5	65	100	40	1500	30	1000	0.9	1000	100	180	50
2N3763#	11.5	65	100	60	1500	20	1000	0.9	1000	100	150	50

**JAN/JANTX available   #JAN/JANTX/JANTXV available   †JAN/JANTX/JANTXV/JANS available

Table 16. Choppers

Devices are listed in decreasing $V_{(BR)EBO}$.

PNP — TO-206AB (TO-46)

Device	$V_{(BR)EBO}$ Min	$V_{(BR)ECO}$	$h_{FE(inv)}$ Min	Offset Voltage $V_{EC(ofs)}$ Max (mV)	On-State Resistance $r_{ec(on)}$ Max (Ω)
2N2946A	40	35	20	0.5	8.0
2N2946	40	35	3.0	0.8	8.0
2N5230	30	20	15	0.5	8.0
2N2945A	25	20	30	1.0	6.0
2N2945	25	20	4.0	1.0	35

Table 17. High-Gain Darlington Transistors

NPN — TO-206AF (TO-72)

Device	$V_{(BR)CB10}$	$V_{(BR)CE20}$	$V_{(BR)E2B10}$	h_{FE} Min	h_{FE} Max	I_C
2N2723	80	60	12	2000	10000	10
2N2785	60	40	15	2000	20000	100

NPN — TO-206AA (TO-18)

Device	$V_{(BR)CB10}$	$V_{(BR)CE20}$	$V_{(BR)E2B10}$	h_{FE} Min	h_{FE} Max	I_C
MM6427	40	50	12	10000	—	100

Small-Signal Field-Effect Transistors

JFETs

JFETs operate in the depletion mode. They are available in both P- and N-channel are are offered in both metal and plastic packages. Applications include general-purpose amplifiers, switches and choppers, and RF amplifiers and mixers. These devices are economical and very rugged. The drain and source are interchangeable on many typical FETs.

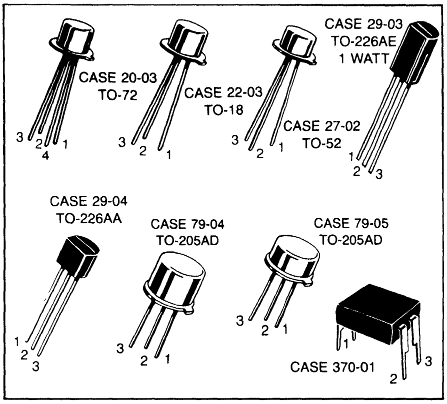


Table 1. Low-Frequency/Low-Noise

P-Channel JFETs

Package TO-	Device	$\mathrm{Re}\,\lvert Y_{fs}\rvert$ (mmho) Min	$\mathrm{Re}\,\lvert Y_{os}\rvert$ (μmho) Max	C_{iss} (pF) Max	C_{rss} (pF) Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max
72	2N3909	1.0	100	32	16	20	0.3	7.9	0.3	15
92	MPF2608	1.0	—	17	—	30	1.0	4.0	0.9	4.5
92	2N5460	1.0	50	7.0	2.0	40	0.75	6.0	1.0	5.0
92	2N5463	1.0	75	7.0	2.0	60	0.5	4.0	1.0	5.0
72	2N3330	1.5	40	20	—	20	—	6.0	2.0	6.0
92	MPF3330	1.5	40	20	—	20	—	6.0	2.0	6.0
92	2N5461	1.5	50	7.0	2.0	40	1.0	7.5	2.0	9.0
92	2N5464	1.5	75	7.0	2.0	60	0.8	4.5	2.0	9.0
92	2N5462	2.0	50	7.0	2.0	40	1.8	9.0	4.0	16
92	2N5465	2.0	75	7.0	2.0	60	1.5	6.0	4.0	16
72	2N3331	2.0	100	20	—	20	—	8.0	5.0	15
72	2N3909A	2.2	100	9.0	3.0	20	0.3	7.9	1.0	15
92	J271	6.0	200	32	8.0	30	0.5	2.0	2.0	15

N-Channel JFETs

Package TO-	Device	$\mathrm{Re}\,\lvert Y_{fs}\rvert$ (mmho) Min	$\mathrm{Re}\,\lvert Y_{fs}\rvert$ @ f (MHz)	$\mathrm{Re}\,\lvert Y_{os}\rvert$ (μmho) Max	$\mathrm{Re}\,\lvert Y_{os}\rvert$ @ f (MHz)	C_{iss} (pF) Max	C_{rss} (pF) Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max
18	2N3370	0.3	30	15	30	20	3.0	40	—	3.2	0.1	0.6
92	J201	0.5	20	1.0[t]	20	5.0[t]	2.0[t]	40	0.3	1.5	0.2	1.0
18	2N4339	0.8	15	15	15	7.0	3.0	50	0.6	1.8	0.5	1.5
92	MPF4339	0.8	15	15	15	7.0	3.0	50	0.6	1.8	0.5	1.5
18	2N3460	0.8	20	5.0	30	18	6.0	50	—	1.8	0.2	1.0
18	2N3438	0.8	20	5.0	30	18	6.0	50	—	2.3	0.2	1.0
72	2N4220	1.0	15	10	15	6.0	2.0	30	—	4.0	0.5	3.0
72	2N4220A	1.0	15	10	15	6.0	2.0	30	—	4.0	0.5	3.0

t = typical

SMALL-SIGNAL FIELD-EFFECT TRANSISTORS (continued)

Table 1. Low-Frequency/Low-Noise (continued)

N-Channel JFETs (continued)

		R_e $\|Y_{fs}\|$		R_e $\|Y_{os}\|$		C_{iss}	C_{rss}	$V_{(BR)GSS}$ $V_{(BR)GDO}$	$V_{GS(off)}$ (V)		I_{DSS} (mA)	
Package TO-	Device	(mmho) Min	@ f (MHz)	(µmho) Max	@ f (MHz)	(pF) Max	(pF) Max	(V) Min	Min	Max	Min	Max
18	2N4348	0.6	0.001	5.0	0.001	6.0	2.0	50	0.3	1.0	0.2	0.6
92	J202	1.0	20	3.5^t	20	5.0^t	2.0^t	40	0.8	4.0	0.9	4.5
72	2N5359	1.2	15	10	15	6.0	2.0	40	0.8	4.0	0.6	1.6
18	2N4340	1.3	15	30	15	7.0	3.0	50	1.0	3.0	1.2	3.6
72	2N5360	1.4	15	20	15	6.0	2.0	40	0.8	4.0	0.5	2.5
92	2N5458	1.5	15	50	15	7.0	3.0	25	1.0	7.0	2.0	9.0
72	2N5361	1.5	15	20	15	6.0	2.0	40	1.0	6.0	2.5	5.0
92	J203	1.5	20	10^t	20	5.0^t	2.0^t	40	2.0	10	4.0	20
18	2N3459	1.5	20	20	30	18	6.0	50	—	3.4	0.8	4.0
72	2N3821	1.5	15	10	15	6.0	3.0	50	—	4.0	0.5	2.5
92	MPF3821	1.5	15	10	15	6.0	3.0	50	—	4.0	0.5	2.5
18	2N3437	1.5	20	20	30	18	6.0	50	—	4.8	0.8	4.0
92	2N5457	2.0	15	50	15	7.0	3.0	25	0.5	6.0	1.0	5.0
92	2N5459	2.0	15	50	15	7.0	3.0	25	2.0	8.0	4.0	16
72	2N4221	2.0	15	20	15	6.0	2.0	30	—	6.0	2.0	6.0
92	MPF4221	2.0	15	20	15	6.0	2.0	30	—	6.0	2.0	6.0
72	2N4221A	2.0	15	20	15	6.0	2.0	30	—	6.0	2.0	6.0
72	2N3822	2.0	15	20	15	6.0	3.0	50	—	6.0	2.0	10
92	MPF3822	2.0	15	20	15	6.0	3.0	50	—	6.0	2.0	10
18	2N4341	2.0	15	60	15	7.0	3.0	50	2.0	6.0	3.0	9.0
72	2N4222	2.5	15	40	15	6.0	2.0	30	—	8.0	5.0	15
72	2N4222A	2.5	15	40	15	6.0	2.0	30	—	8.0	5.0	15
92	MPF4222A	2.5	15	40	15	6.0	2.0	30	—	8.0	5.0	15
18	2N4398	12^t	0.001	—	—	14	3.5	40	0.5	3.0	5.0	30
72	2N4118	80	0.001	5.0	10	3.0	1.5	40	1.0	3.0	80	240
92	MPF4118	80	0.001	5.0	10	3.0	1.5	40	1.0	3.0	80	240
72	2N4118A	80	0.001	5.0	10	3.0	1.5	40	1.0	3.0	80	240
92	MPF4118A	80	0.001	5.0	10	3.0	1.5	40	1.0	3.0	80	240

t = typical

Table 2. High-Frequency Amplifiers

N-Channel JFETs

		R_e $\|Y_{fs}\|$		R_e $\|Y_{os}\|$		C_{iss}	C_{rss}	NF		$V_{(BR)GSS}$ $V_{(BR)GDO}$	$V_{GS(off)}$ (V)		I_{DSS} (mA)	
Package TO-	Device	(mmho) Min	@ f (MHz)	(µmho) Max	@ f (MHz)	(pF) Max	(pF) Max	(dB) Max	@ RG = 1K f (MHz)	(V) Min	Min	Max	Min	Max
92	2N5669	1.6	100	100	100	7.0	3.0	2.5	100	25	1.0	6.0	4.0	10
92	MPF102	1.6	100	200	100	7.0	3.0	—	—	25	—	8.0	2.0	20
92	2N3819	1.6	100	—	—	8.0	4.0	—	—	25	—	8.0	2.0	20
92	2N5668	1.0	100	50	100	7.0	3.0	2.5	100	25	0.2	4.0	1.0	5.0
92	MPF4224	1.7	200	200	200	6.0	2.0	—	—	30	0.1	8.0	2.0	20
92	2N5484	2.5	100	75	100	5.0	1.0	3.0	100	25	0.3	3.0	1.0	5.0
92	2N5670	2.5	100	150	100	7.0	3.0	2.5	100	25	2.0	8.0	8.0	20

Table 2. High-Frequency Amplifiers (continued)

N-Channel JFETs (continued)

Package TO-	Device	$\text{Re}\,\lvert Y_{fs}\rvert$ (mmho) Min	@ f (MHz)	$\text{Re}\,\lvert Y_{os}\rvert$ (μmho) Max	@ f (MHz)	C_{iss} (pF) Max	C_{rss} (pF) Max	NF (dB) Max	@ RG = 1K f (MHz)	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max
92	2N5246	2.5	400	100	400	4.5	1.0	—	—	30	0.5	4.0	1.5	7.0
92	MPF4223	2.7	200	200	200	6.0	2.0	5.0	200	30	0.1	8.0	3.0	18
92	2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	1.0	4.0	4.0	10
92	J305	3.0^t	400	80^t	100	3.0^t	0.8^t	4.0^t	400	30	0.5	3.0	1.0	8.0
72	2N3823	3.2	200	200	200	6.0	2.0	2.5	100	30	—	8.0	4.0	20
92	2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20
72	2N4416	4.0	400	100	400	4.0	0.8	4.0	400	30	2.0	6.0	5.0	15
92	J300	4.5	0.001	200	0.001	5.5	1.1	—	—	25	—	1.0*	6.0	30
92	JF1033B	4.5	0.001	—	—	—	—	2.5	100	20	1.0	8.0	2.5	6.0
92	JF1033S	4.5	0.001	—	—	—	—	2.5	100	20	1.0	8.0	5.0	12
92	JF1033Y	4.5	0.001	—	—	—	—	2.5	100	20	1.0	8.0	10	20
72	2N4416A	4.0	400	100	400	4.0	0.8	4.0	400	30	2.0	6.0	5.0	15
92	2N5245	4.0	400	100	400	4.5	1.0	4.0	400	30	1.0	6.0	5.0	15
92	2N5247	4.0	400	150	400	4.5	1.0	4.0	400	30	1.5	8.0	8.0	24
92	J304	4.2^t	400	80^t	100	3.0^t	0.8^t	4.0^t	400	30	2.0	6.0	5.0	15
52	U308	10	0.001	150	100	5..0	2.5	3.0^t	450	25	1.0	6.0	12	60
52	U309	10	0.001	150	100	5.0	2.5	3.0^t	450	25	1.0	4.0	12	30
52	U310	10	0.001	150	100	5.0	2.5	3.0^t	450	25	2.5	6.0	24	60
92	J308	12^t	100	250^t	100	7.5	2.5	1.5^t	100	25	1.0	6.5	12	60
92	J309	12^t	100	250^t	100	7.5	2.5	1.5^t	100	25	1.0	4.0	12	30
92	J310	12^t	100	250^t	100	7.5	2.5	1.5^t	100	25	2.0	6.5	24	60

t = typical

*$V_{GS(f)}$

Table 3. Switches and Choppers

P-Channel JFETs

Package TO-	Device	$r_{ds(on)}$ (Ω) Max	@ I_D (μA)	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	C_{iss} (pF) Max	C_{rss} (pF) Max	t_{on} (ns) Max	t_{off} (ns) Max
92	MPF970	100	1.0	5.0	12	15	100	30	12	5.0	8.0	25
92	MPF971	250	1.0	1.0	7.0	2.0	80	30	12	5.0	10	120
72	2N3993	150	—	4.0	9.5	10	—	25	16	4.5	—	—
72	2N3994	300	—	1.0	5.5	2.0	—	25	16	4.5	—	—
92	J174	85	—	5.0	10	2.0	100	30	—	—	—	—
92	J175	125	—	3.0	6.0	7.0	60	30	—	—	—	—
92	J176	250	—	1.0	4.0	2.0	25	30	—	—	—	—
92	J177	300	—	0.8	2.5	1.5	20	30	—	—	—	—

N-Channel JFETs

Package TO-	Device	$r_{ds(on)}$ (Ω) Max	@ I_D (μA)	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	C_{iss} (pF) Max	C_{rss} (pF) Max	t_{on} (ns) Max	t_{off} (ns) Max
18	MFE2012	10	—	3.0	10	100	—	25	50	20	16	37
18	MFE2011	15	1.0	1.0	10	40	—	25	50	20	10	20
18	2N4859A	25	—	2.0	6.0	50	—	30	10	4.0	8.0	20
92	MPF4859A	25	—	2.0	6.0	50	—	30	10	4.0	8.0	20
18	2N4856A	25	—	4.0	10	50	—	40	10	4.0	8.0	20

SMALL-SIGNAL FIELD-EFFECT TRANSISTORS (continued)

Table 3. Switches and Choppers (continued)

N-Channel JFETs (continued)

Package TO-	Device	$r_{ds(on)}$ (Ω) Max	@ I_D (μA)	$V_{GS(off)}$ (V) Min	Max	I_{DSS} (mA) Min	Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ (V) Min	C_{iss} (pF) Max	C_{rss} (pF) Max	t_{on} (ns) Max	t_{off} (ns) Max
92	MPF4856A	25	—	4.0	10	50	—	40	10	4.0	8.0	20
18	2N4856	26	—	4.0	10	50	—	40	10	8.0	9.0	25
92	MPF4856	25	—	4.0	10	50	—	40	10	8.0	9.0	25
18	2N4859	25	—	4.0	10	50	—	30	18	8.0	9.0	25
92	MPF4859	25	—	4.0	10	50	—	30	18	8.0	9.0	25
18	MFE2010	25	1.0	0.5	10	15	—	25	50	20	10	35
18	2N4391	30	1.0	4.0	10	50	150	40	14	3.5	15	20
92	MPF4391	30	1.0	4.0	10	60	130	20	10	3.5	15	20
92	2N5638	30	1.0	—	(12)	50	—	30	10	4.0	9.0	15
18	2N4091	30	1.0	5.0	10	30	—	40	16	5.0	25	40
92	MPF4091	30	1.0	5.0	10	30	—	40	16	5.0	25	40
92	J111	30	1.0	3.0	10	20	—	35	10^{t}	5.0^{t}	13	35
18	MFE2006	30	1.0	−5.0	−10	30	—	−30	16	5.0	20	40
18	2N3970	30	1.0	4.0	10	50	150	40	25	6.0	20	30
92	MPF3970	30	1.0	4.0	10	50	150	40	25	6.0	20	30
92	MPF4857A	40	—	2.0	6.0	20	100	40	10	3.5	10	40
18	2N4860A	40	—	2.0	6.0	20	100	30	10	3.5	10	40
92	MPF4860A	40	—	2.0	6.0	20	100	30	10	3.5	10	40
18	2N4857	40	—	2.0	6.0	20	100	40	18	8.0	10	50
18	2N4857A	40	—	2.0	6.0	20	100	40	18	8.0	10	50
92	MPF4857	40	—	2.0	6.0	20	100	40	18	8.0	10	50
18	2N4860	40	—	2.0	6.0	20	100	30	18	8.0	10	50
92	MPF4860	40	—	2.0	6.0	20	100	30	18	8.0	10	50
18	2N4092	50	1.0	2.0	7.0	15	—	40	16	5.0	35	60
92	J112	50	1.0	1.0	5.0	5.0	—	35	10^{t}	5.0^{t}	13^{t}	35^{t}
18	MFE2005	50	1.0	−2.0	−8.0	15	—	−30	16	5.0	35	60
18	2N4392	60	1.0	2.0	5.0	25	75	40	14	3.5	15	35
92	MPF4392	60	1.0	2.0	5.0	25	75	20	10	3.5	15	35
18	2N4858A	60	1.0	0.8	4.0	8.0	80	40	10	3.5	16	80
92	MPF4858A	60	1.0	0.8	4.0	8.0	80	40	10	3.5	16	80
18	2N4861A	60	—	0.8	4.0	8.0	80	30	10	3.5	16	80
92	MPF4861A	60	—	0.8	4.0	8.0	80	30	10	3.5	16	80
92	2N5639	60	1.0	—	$(8.0)^{t}$	25	—	30	10	4.0	14	30
18	2N3971	60	1.0	2.0	5.0	25	75	40	25	6.0	30	60
18	2N4858	60	—	0.8	4.0	8.0	80	40	18	8.0	20	100
92	MPF4858	60	—	0.8	4.0	8.0	80	40	18	8.0	20	100
18	2N4861	60	—	0.8	4.0	8.0	80	30	18	8.0	20	100
92	MPF4861	60	—	0.8	4.0	8.0	80	30	18	8.0	20	100
18	2N4093	80	1.0	1.0	5.0	80	—	40	16	5.0	60	80
18	MFE2004	80	1.0	−1.0	−6.0	8.0	—	−30	16	5.0	60	80
18	2N4393	100	1.0	0.5	3.0	5.0	30	40	14	3.5	15	50
92	MPF4393	100	1.0	0.5	3.0	5.0	30	20	10	3.5	15	55
92	2N5640	100	1.0	—	(6.0)	5.0	—	30	10	4.0	18	45
18	2N3972	100	1.0	0.5	3.0	5.0	30	40	25	6.0	80	100
92	MPF3972	100	1.0	0.5	3.0	5.0	30	40	25	6.0	80	100
92	J113	100	1.0	0.5	3.0	2.0	—	35	10^{t}	5.0^{t}	13^{t}	35^{t}

SMALL-SIGNAL FIELD-EFFECT TRANSISTORS (continued)

Table 3. Switches and Choppers (continued)

N-Channel JFETs (continued)

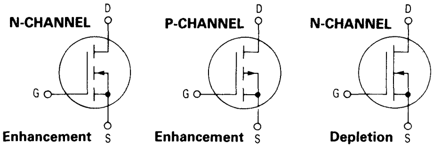
		$r_{ds(on)}$		$V_{GS(off)}$		I_{DSS}		$V_{(BR)GSS}$ $V_{(BR)GDO}$	C_{iss}	C_{rss}	t_{on}	t_{off}
Package TO-	**Device**	**(Ω) Max**	**@ I_D (µA)**	**(V) Min**	**Max**	**(mA) Min**	**Max**	**(V) Min**	**(pF) Max**	**(pF) Max**	**(ns) Max**	**(ns) Max**
92	2N555	150	—	—	1.0*	15	—	25	5.0	1.2	10	25
92	BF246	—	—	0.5	14	10	300	25	—	—	—	—
92	BF246A	35^t	1.0	1.5	4.0	30	80	25	—	—	—	—
92	BF246B	50^t	1.0	3.0	7.0	60	140	25	—	—	—	—
92	BF246C	65^t	1.0	5.5	12	110	250	25	—	—	—	—
92	J107	8.0	—	0.5	4.5	100	—	25	—	—	—	—
92	J108	8.0	—	3.0	10	80	—	25	—	—	—	—
92	J109	12	—	2.0	6.0	40	—	25	—	—	—	—
92	J110	18	—	0.5	4.0	10	—	25	—	—	—	—

t = typical *$V_{GS(f)}$

MOSFETs

MOSFETs are available in either depletion/enhancement or enhancement mode (in general, depletion/enhancement devices are operated in the depletion mode and are referred to as depletion devices). They are available in both N- and P-channel, and both single gate and dual gate construction. Some MOSFETs are also offered with input diode protection which reduces the chance of damage from static charge in handling.

Single Gate



Dual Gate

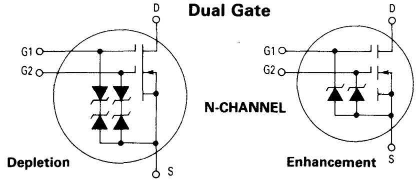


Table 4. Dual Gate

These devices are especially suited for RF amplifier and mixer applications in TV tuners, radio, etc. The Dual Gate construction also allows easy AGC control with very low power.

N-Channel MOSFETs

		Re $\|Y_{fs}\|$		Re $\|Y_{os}\|$		C_{iss}	C_{rss}	NF		$V_{(BR)GSS}$ $V_{(BR)GDO}$	$V_{GS(off)}$		I_{DSS}	
Package TO-	Device	(mmho) Min	@ f (MHz)	(μmho) Max	@ f (MHz)	(pF) Max	(pF) Max	(dB) Max	@ RG = 1K f (MHz)	(V) Min	(V) Min	Max	(mA) Min	Max
72	MFE521	10	0.001	—	—	4.0	0.02	3.5	200	10	0.5	2.0	5.0	20
72	MFE211	17	0.001	—	—	—	0.05	3.5	200	±6.0	−0.2	−5.5	6.0	40
72	MFE212	17	0.001	—	—	—	0.05	4.0	45	±6.0	−0.2	−5.5	6.0	40
72	MFE203	7.0	0.001	—	—	4.3^t	0.03	4.5	200	±6.0	−0.2	−5.0	3.0	11
72	MFE201	8.0	0.001	—	—	4.5^t	0.03	4.5	200	±6.0	−0.2	−5.0	6.0	30
72	MFE202	8.0	0.001	—	—	4.3^t	0.03	4.5	200	±6.0	−0.2	−5.0	6.0	30
72	MFE120	8.0	0.001	—	—	7.0	0.023	5.0	105	±7.0	—	−4.0	2.0	18
72	MFE121	10	0.001	—	—	6.0	0.023	5.0	60	±7.0	—	−4.0	5.0	30
72	MFE122	8.0	0.001	—	—	7.0	0.023	5.0	200	±7.0	—	−4.0	2.0	20
72	MFE131	8.0	0.001	—	—	7.0	0.05	5.0	200	±7.0	—	−4.0	3.0	30
72	MFE204	10	0.001	—	—	—	0.03	5.0	400	25	−0.2	−4.0	6.0	30
72	MFE130	8.0	0.001	—	—	7.0	0.05	5.0	105	±7.0	—	−4.0	3.0	30
72	MFE209	10	0.001	—	—	7.0	0.03	6.0	500	±7.0	−0.1	−4.0	5.0	30
72	MFE131	8.0	0.001	—	—	7.0	0.05	5.0	100	±7.0	—	−4.0	3.0	30

t = typical

Table 5. Single Gate Low-Frequency/Low-Noise

P-Channel MOSFETs

		Re $\|Y_{fs}\|$		C_{iss}	C_{rss}	$V_{(BR)DSS}$	$V_{GS(th)}$		I_{DSS}	
Package TO-	Device	(mmho) Min	(μmho) Max	(pF) Max	(pF) Max	(V) Min	(V) Min	Max	(mA) Min	Max
72	3N155	1.0	60	5.0	1.3	−35	−1.5	−3.2	—	−1.0
72	3N156	1.0	60	5.0	1.3	−35	−3.0	−5.0	—	−1.0
72	3N157	1.0	60	5.0	1.3	−35	−1.5	−3.2	—	−1.0
72	3N158A	1.0	60	5.0	1.3	−25	−2.0	−6.0	—	−20
18	MFE823	1.0	—	6.0	1.5	−50	−3.0	−5.0	—	−0.25
N-Channel MOSFETs										
18	2N3796	0.4	1.8	7.0	0.8	25	—	−7.0	2.0	6.0
18	MFE825	0.5	—	4.0	0.7	20	—	—	1.0	25
72	2N4351	1.0	—	5.0	1.3	25	1.0	5.0	—	10
72	3N169	1.0	—	5.0	1.3	25	0.5	1.5	—	10
72	3N170	1.0	—	5.0	1.3	25	1.0	2.0	—	10
72	3N171	1.0	—	5.0	1.3	25	1.5	3.0	—	10
18	2N3797	1.5	—	8.0	0.8	25	—	−7.0	2.0	6.0

SMALL-SIGNAL FIELD-EFFECT TRANSISTORS (continued)

Table 6. Switches and Choppers

TO-226AA (TO-92)
N-CHANNEL

Device	$r_{DS(on)}$ Ω Max	@ I_D A	$V_{GS(th)}$ V Min	Max	$V_{(BR)DSS}$ V Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max
VN0300L	1.2	1.0	0.8	2.5	30	100	25	30	30
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10
BS170	5.0	0.2	0.8	3.0	60	25 Typ	3.0 Typ	10	10
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10
VN1706L	6.0	0.5	0.8	2.0	170	125	20	16	30
VN2406L	6.0	0.5	0.8	2.0	240	125	20	16	30
BSS89	6.4	0.25	1.0	2.7	200	90	3.5	15	15
BS107A	6.4	0.25	1.0	3.0	200	70 Typ	6.0 Typ	15	15
MPF9200	6.4	0.25	1.0	4.0	200	90	10	15	15
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10
BS108	8.5	0.1	0.3	2.0	200	90	8.0	8.0 Typ	10 Typ
VN1710L	10	0.5	0.8	2.0	170	125	20	16	50
VN2410L	10	0.5	0.8	2.0	240	125	20	16	50
MPF4150†	12	0.1	1.0	6.0	150	125	15	—	—
BS107	14	0.2	1.0	3.0	200	70 Typ	6.0 Typ	15	15
2N4351*	300	—	1.0	5.0	25	5.0	1.3	110	160
MPF480	80	0.01	0.5	3.0	80	8.0	7.0	20	20
MPF481	140	0.01	0.5	3.0	180	8.0	7.0	20	20
P-CHANNEL									
2N4352*	600	—	−1.0	−5.0	−25	5.0	1.3	110	160
TO-226AE (1 WATT TO-92) **N-CHANNEL**									
MPF930	1.4	1.0	1.0	3.5	35	70	18	15	15
MPF960	1.7	1.0	1.0	3.5	60	70	18	15	15
MPF6659	1.8	1.0	0.8	2.0	35	50	10	5.0	5.0
MPF990	2.0	1.0	1.0	3.5	90	70	18	15	15
MPF6660	3.0	1.0	0.8	2.0	60	50	10	5.0	5.0
MPF6661	4.0	1.0	0.8	2.0	90	50	10	5.0	5.0
MPF910	5.0	0.5	0.8	2.5	60	50	10	10	10
MPF89	6.4	0.25	1.0	2.7	200	90	3.5	15	15

Table 6. Switches and Choppers (continued)

CASE 370-01 (FET DIP)
N-CHANNEL

	$r_{DS(on)}$	@	$V_{(BR)DSS}$ Volt	$I_{D(on)}$ V_{GS} = 10 V	G_{fs}	@	C_{iss} @ 25 V	C_{oss} @ 25 V	C_{rss} @ 25 V	$t_{d(on)}$	t_r	$t_{d(off)}$	t_f
Device	Ω Max	mA	Min	V_{DS} = 5.0 V Amp	mhos Min	5.0 V Amp	pF Max	pF Max	pF Max	ns Max	ns Max	ns Max	ns Max
IRFD120	0.3	600	100	1.3	0.9	0.6	600	400	100	40	70	100	70
IRFD123	0.4	600	60	1.1	0.9	0.6	600	400	100	40	70	100	70
IRFD110	0.6	800	100	1.0	0.8	0.8	200	100	25	20	25	25	20
IRFD113	0.8	800	60	0.8	0.8	0.8	200	100	25	20	25	25	20
IRFD220	0.8	400	200	0.8	0.5	0.4	600	300	80	40	60	100	60
IRFD223	1.2	400	150	0.7	0.5	0.4	600	300	80	40	60	100	60
IRFD213	2.4	300	150	0.45	0.3	0.5	150	80	25	15	25	15	15
IRFD210	1.5	600	200	0.6	0.3	0.5	150	80	25	15	25	15	15
IRFD1Z0	2.4	250	100	0.5	0.25	0.25	70	30	10	20	25	25	20
IRFD1Z3	3.2	250	60	0.4	0.25	0.25	70	30	10	20	25	25	20

P-CHANNEL

IRFD9120	0.6	800	100	1.0	0.8	0.8	450	350	100	50	100	100	100
IRFD9123	0.8	800	60	0.8	0.8	0.8	450	350	100	50	100	100	100
IRFD9110	1.2	300	100	0.7	0.6	0.3	250	100	35	30	60	40	40
IRFD9112	1.2	300	100	0.6	0.6	0.3	250	100	35	30	60	40	40

TO-205AD (TO-39)
N-CHANNEL

	$r_{DS(on)}$	@	$V_{GS(th)}$ V		$V_{(BR)DSS}$	C_{iss}	C_{rss}	t_{on}	t_{off}
Device	Ω Max	I_D A	Min	Max	V Min	pF Max	pF Max	ns Max	ns Max
VN0300B	1.2	1.0	0.8	2.5	30	100	25	30	30
MFE930	1.4	1.0	1.0	3.5	35	70	18	15	15
MFE960	1.7	1.0	1.0	3.5	60	70	18	15	15
2N6659	1.8	1.0	0.8	2.0	35	50	10	5.0	5.0
MFE990	2.0	1.0	1.0	3.5	90	70	18	15	15
2N6660	3.0	1.0	0.8	2.0	60	50	10	5.0	5.0
2N6661	4.0	1.0	0.8	2.0	90	50	10	5.0	5.0
MFE910	5.0	0.5	0.8	2.5	60	50	10	10	10
VN1706B	6.0	0.5	0.8	2.0	170	125	20	16	30
VN2406B	6.0	0.5	0.8	2.0	240	125	20	16	30
MFE9200††	6.4	0.25	1.0	4.0	200	90	10	15	15
VN1710B	10	0.5	0.8	2.0	170	125	20	16	57
VN2410B	10	0.5	0.8	2.0	240	125	20	16	57

††TO-18 — Case Style 12

Table 6. Switches and Choppers (continued)

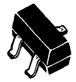
TO-205AF (TO-72)
N-CHANNEL

	$r_{DS(on)}$	@	$V_{GS(th)}$ V		$V_{(BR)DSS}$	C_{iss}	C_{rss}	t_{on}	t_{off}
Device	**Ω Max**	**I_D A**	**Min**	**Max**	**V Min**	**pF Max**	**pF Max**	**ns Max**	**ns Max**
2N6796	0.18	8.0	2.0	4.0	100	900	150	105	85
IRFF130	0.18	8.0	2.0	4.0	100	800	150	200	250
IRFF133	0.25	7.0	2.0	4.0	60	800	150	200	250
2N6788	0.3	3.5	2.0	4.0	100	600	100	110	110
IRFF120	0.3	6.0	2.0	4.0	100	600	100	110	170
2N6798	0.4	5.5	2.0	4.0	200	900	150	80	90
IRFF123	0.4	5.0	2.0	4.0	60	600	100	110	170
IRFF230	0.4	5.5	2.0	4.0	200	150	150	80	90
2N6782	0.6	3.5	2.0	4.0	100	200	25	40	45
IRFF110	0.6	3.5	2.0	4.0	100	200	25	45	45
IRFF233	0.6	4.5	2.0	4.0	150	800	150	80	90
2N6790	0.8	3.5	2.0	4.0	200	600	80	90	100
IRFF113	0.8	3.0	2.0	4.0	60	200	25	45	45
IRFF220	0.8	3.5	2.0	4.0	200	600	80	100	160
2N6800	1.0	3.0	2.0	4.0	400	900	80	65	90
IRFF330	1.0	3.5	2.0	4.0	400	900	80	65	90
IRFF223	1.2	3.0	2.0	4.0	150	600	80	100	160
2N6784	1.5	2.25	2.0	4.0	200	200	25	35	50
2N6802	1.5	3.5	2.0	4.0	500	900	60	60	85
IRFF210	1.5	2.2	2.0	4.0	200	150	25	40	30
IRFF333	1.5	3.0	2.0	4.0	350	900	80	65	90
IRFF430	1.5	2.75	2.0	4.0	500	800	60	60	85
IRFF313	1.5	1.15	2.0	4.0	350	150	15	30	25
IRFF433	2.0	2.25	2.0	4.0	450	800	60	60	85
IRFF213	2.4	1.8	2.0	4.0	150	150	25	40	30
IRFF310	3.6	1.35	2.0	4.0	400	150	15	30	25

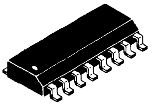
P-CHANNEL

IRFF9123	0.8	−3.5	2.0	4.0	−60	450	100	151	200

Small-Signal Surface Mount Devices



CASE 318-03
TO-236AB
SOT-23



CASE 751B-03
SO-16

Bipolar Transistors — SOT-23

Table 1. General-Purpose

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	h_{FE}			f_T
			Min	Max	@ I_C (mA)	Min (MHz)
BC846AL	1A	65	110	220	2.0	100
BC846BL	1B	65	200	450	2.0	100
BSS82BL	CH	60	40	120	150	100
BC817-16L	6A	45	100	250	100	200
BC817-25L	6B	45	160	400	100	200
BC817-40L	6C	45	250	600	100	200
BC847AL	1E	45	110	220	2.0	100
BC847BL	1F	45	200	450	2.0	100
BC847CL	1G	45	420	800	2.0	100
BCX70KL	AK	45	100	—	50	125
BCX70JL	AJ	45	90	—	50	125
BCW72L	K2	45	200	450	2.0	—
BCX70HL	AH	45	70	—	50	125
BCX70GL	AG	45	60	220	50	125
MMBT930L	1X	45	150	—	0.5	30
BCW71L	K1	45	110	220	2.0	—
BCX19L	U1	45	40	—	500	200
MMBC1623L7L	L7	40	300	600	1.0	200
MMBC1623L6L	L6	40	200	400	1.0	200
MMBC1623L5L	L5	40	135	270	1.0	200
BSS79CL	CF	40	100	300	150	250
MMBT2222AL	1P	40	40	—	500	200
MMBC1623L4L	L4	40	90	180	1.0	200
MMBC1623L3L	L3	40	60	120	1.0	200
BSS79BL	CE	40	40	120	150	250
MMBTA20L	1C	40	40	400	5.0	125
MMBT4123L	5B	30	25	—	50	250
MMBC1622D7L	D7	35	300	600	0.5	100
MMBC1622D6L	D6	35	200	400	0.5	100
BCW60AL	AA	32	60	—	50	125
BCW60DL	AD	32	100	—	50	125
BCW65AL	EA	32	100	250	100	100
BCW60CL	AC	32	90	—	50	125
BCW60BL	AB	32	70	—	50	125
BC848AL	1J	30	110	220	2.0	100
BC848BL	1K	30	200	450	2.0	100
BC848CL	1L	30	420	800	2.0	100
MMBC1009F1L	F1	25	30	60	0.5	150
MMBC1009F3L	F3	25	60	120	0.5	150
BC818-16L	6E	25	100	250	100	200
BC818-25L	6F	25	160	400	100	200
BC818-40L	6G	25	250	600	100	200
BCX20L	U2	25	100	600	100	—
BCW33L	D3	20	420	—	2.0	—
BCW31L	D1	20	110	220	2.0	—

SURFACE MOUNT BIPOLAR DEVICES (continued)

Table 1. General-Purpose (continued)

			h_{FE}			f_T
Device	Marking	$V_{(BR)CEO}$	Min	Max	@ I_C (mA)	Min (MHz)
PNP						
MMBT8599L	2W	80	75	—	100	150
BC856AL	3A	65	125	250	2.0	100
BC856BL	3B	65	220	475	2.0	100
MMBT8598L	2K	60	75	—	100	150
BSS82CL	CM	60	100	300	150	100
MMBA811C8L	C8	45	450	900	5.0	50
BC807-16L	5A	45	100	250	100	200
BC807-25L	5B	45	160	400	100	200
BC807-40L	5C	45	250	600	100	200
BC857AL	3E	45	125	250	2.0	100
BC857BL	3F	45	220	475	2.0	100
BC857CL	3G	45	420	800	2.0	100
BCX71KL	BK	45	100	—	50	—
MMBA811C7L	C7	45	300	600	5.0	50
BCX71JL	BJ	45	100	—	50	—
BCW70L	H2	45	215	500	2.0	—
MMBA811C6L	C6	45	200	400	5.0	50
BCW68GL	DG	45	60	—	500	100
MMBA811C5L	C5	45	135	270	5.0	50
BCW69L	H1	45	120	260	2.0	—
BCX71GL	BG	45	60	—	50	—
BCW68FL	DF	45	35	—	500	100
BCX17L	T1	45	100	600	100	100
MMBA812M7L	M7	40	300	600	1.0	150
MMBA812M6L	M6	40	200	400	1.0	150
MMBA812M5L	M5	40	135	270	1.0	150
MMBA812M4L	M4	40	90	180	1.0	150
MMBA812M3L	M3	40	60	120	1.0	150
BSS80BL	CH	40	40	120	150	200
BSS80CL	CJ	40	100	30	150	200
MMBTA70L	2C	40	40	400	5.0	125
BCW61DL	BD	32	110	—	50	—
BCW61CL	BC	32	100	—	50	—
BCW67CL	EC	32	100	—	500	100
BCW61BL	BB	32	80	—	50	—
BCW67BL	DB	32	60	—	500	100
BCW61AL	BA	32	60	—	50	—
BCW67AL	DA	32	35	—	500	100
BC808-16L	5E	25	100	250	100	200
BC808-25L	5F	25	160	400	100	200
BC808-40L	5G	25	250	600	100	200
BC858AL	3J	30	125	250	2.0	100
BC858BL	3K	30	220	475	2.0	100
BC858CL	3L	30	420	800	2.0	100
MMBT4125L	ZD	30	25	—	50	200
BCX18L	T2	25	40	—	500	—
MMBTA55L	AL	25	30	—	500	100
BCW30L	C2	20	215	500	2.0	—
BCW29L	C1	20	120	260	2.0	—

Table 2. Switching Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	Switching Time (ns)		$V_{(BR)CEO}$	h_{FE}			f_T Min (MHz)
		t_{on}	t_{off}		Min	Max	@ I_C (mA)	
NPN								
MMBT2369L	1J	12	18	15	20	—	100	—
BSV52L	B2	12	18	12	40	120	10	400
MMBT2222L	1B	35	385	30	30	—	500	250
MMBT2222AL	1P	35	385	40	40	—	500	200
MMBT4401L	2X	35	255	40	40	—	500	250
MMBT3903L	1Y	70	225	40	15	—	100	250
MMBT3904L	1A	70	250	40	30	—	100	200
PNP								
MMBT3640L	2J	25	35	12	20	—	50	500
MMBT4403L	2T	35	225	40	90	180	1.0	150
MMBT2907L	2B	45	100	40	30	—	500	200
MMBT2907AL	2F	45	100	60	50	—	500	200
MMBT3906L	2A	70	300	40	100	300	10	250

Table 3. VHF/UHF Amplifiers, Mixers, Oscillators

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	C_{ob} Max (pF)	f_T	
				Min (GHz)	@ I_C (mA)
NPN					
MMBTH10L	3E	25	0.7	0.65	4.0
MMBC1321Q3L	Q3	25	1.8	0.6	2.0
MMBC1321Q4L	Q4	25	1.8	0.6	2.0
MMBC1321Q5L	Q5	25	1.8	0.6	2.0
MMBT918L	3B	15	1.7	0.6	4.0
MMBTH24L	3A	30	0.36	0.4	8.0
PNP					
MMBTH81L	3D	20	0.85	0.6	5.0

Table 4. Choppers

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)EBO}$	$V_{(BR)CEO}$	h_{FE}		
				Min	Max	@ I_C (mA)
PNP						
MMBT404L	2M	12	24	30	400	12
MMBT404AL	2N	25	35	30	400	12

SURFACE MOUNT BIPOLAR DEVICES (continued)

Table 5. Darlingtons

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending h_{FE}.

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$ Max (V)	h_{FE}		
				Min	Max	@ I_C (mA)
NPN						
MMBTA14L	1N	30	1.5	20K	—	100
MMBT6427L	1V	40	1.5	14K	140K	500
MMBTA13L	1M	30	1.5	10K	—	100
PNP						
MMBTA64L	2V	30	1.5	20K	—	100
MMBTA63L	2U	30	1.5	10K	—	100

Table 6. Low-Noise Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of ascending NF.

Device	Marking	NF Typ (dB)	$V_{(BR)CEO}$	h_{FE}			f_T Min (MHz)
				Min	Max	@ I_C (mA)	
NPN							
MMBT5088L	1Q	1.0	30	300	—	10	50
MMBT5089L	1R	1.0	30	400	—	10	50
MMBT2484L	1U	3.0	60	—	800	10	15
MMBT6428L	1K	3.0	50	250	—	10	100
MMBT6429L	1L	3.0	45	500	—	10	100
BC849BL	2B	4.0*	30	200	450	2.0	100
BC849CL	2C	4.0*	30	420	800	2.0	100
BC850BL	2F	4.0*	45	200	450	2.0	100
BC850CL	2G	4.0*	45	420	800	2.0	100
PNP							
MMBT5086L	2P	1.0	50	150	—	10	40
MMBT5087L	2Q	1.0	50	250	—	10	40
BC859AL	4A	4.0*	30	100	220	2.0	100
BC859BL	4B	4.0*	30	200	450	2.0	100
BC859CL	4C	4.0*	30	420	800	2.0	100
BC860AL	4E	4.0*	45	100	220	2.0	100
BC860BL	4F	4.0*	45	200	450	2.0	100
BC860CL	4G	4.0*	45	420	800	2.0	100

*Max

Table 7. High-Voltage Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	h_{FE}			f_T Min (MHz)
			Min	Max	@ I_C (mA)	
NPN						
MMBT6517L	1Z	350	15	—	100	40
MMBTA42L	1D	300	40	—	30	50
MMBTA43L	1E	200	40	—	30	50
MMBC1654N5L	N5	160	50	130	15	120
MMBC1654N6L	N6	160	100	220	15	120
MMBC1654N7L	N7	160	150	330	15	120
MMBT5550L	1F	160	30	—	50	100
MMBT5551L	G1	160	30	—	50	100
PNP						
MMBT6520L	2Z	350	15	—	100	40
MMBTA92L	2D	300	25	—	30	50
MMBTA93L	2E	200	25	—	30	50
MMBT5401L	2L	150	50	—	50	100

Table 8. Drivers

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	h_{FE} Min	h_{FE} Max	h_{FE} @ I_C (mA)	f_T Min (MHz)
NPN						
MMBTA06L	1G	80	50	—	100	100
BSS64L	AM	80	20	80	4	50
MMBTA05L	1H	60	50	—	100	100
PNP						
BSS63L	BM	100	30	—	25	50
MMBTA55L	2H	60	50	—	100	50
MMBTA56L	2G	80	50	—	100	50

Table 9. RF Transistors

Pinout: 1-Base, 2-Emitter, 3-Collector

		f_T			NF			MAG			f
Device	Marking	Typ (GHz)	I_C (mA)	V_{CE} (V)	Typ (dB)	@ I_C (mA)	V_{CE} (V)	Typ (dB)	@ I_C (mA)	V_{CE} (V)	(MHz)
NPN											
MMBR571L	7X	8.0	50	10	2.0	5.0	6.0	16.5*	5.0	6.0	500
MMBR911L	7P	6.0	30	10	2.0	10	10	17*	10	5.0	500
MMBR930L	7C	5.5	30	5.0	1.9	2.0	5.0	11	30	5.0	500
BFR92L	P1	3.0	14	10	3.0	3.0	1.5	—	—	—	500
BFR93L	R1	3.0	30	5.0	2.5	2.0	5.0	—	—	—	30
MMBR931L	7D	3.5	1.0	1.0	4.3	0.5	1.0	10	1.0	1.0	1000
MMBR2060L	7E	2.5	20	1.0	2.0	1.5	10	13	20	10	450
MMBR5179L	7H	1.5	5.0	6.0	4.0	1.5	6.0	11	5.0	6.0	450
MMBR920L	7B	4.5	14	10	2.4	2.0	10	15	2.0	10	500
MMBR901L	7A	4.0	15	10	1.9	5.0	6.0	16	5.0	6.0	1000
MMBR941L	7Y	8.0	15	6.0	1.7	5.0	6.0	12.5	5.0	6.0	2000
MMBR951L	7Z	7.5	30	6.0	1.7	5.0	6.0	12.5	5.0	6.0	2000
MMBR5031L	7G	2.0	5.0	6.0	1.9	1.0	6.0	17	1.0	6.0	450
MMBR2857L	7K	1.2	4.0	10	3.0	1.5	6.0	12.5	1.5	6.0	450
BFS17L	E1	1.0	2.0	5.0	5.0	2.0	5.0	—	—	—	30
PNP											
MMBR536L	7R	5.5	20	5.0	4.5	10	5.0	—	—	—	500
MMBR4957L	7F	2.0	2.0	10	3.0	2.0	10	17	2.0	10	450

*GNF

Table 10. Bipolar Quad Transistors — SO-16

Device	$V_{(BR)CEO}$	$V_{(BR)CBO}$	h_{FE} Min	h_{FE} @ I_C mA	f_T MHz Min	f_T @ I_C (mA)	Package
MMPQ2222	40	60	30	300	350*	20	SO-16
MMPQ2222A	40	75	40	500	350*	20	SO-16
MMPQ2369	15	40	20	100	450	10	SO-16
MMPQ2907	40	40	30	300	350*	50	SO-16
MMPQ2907A	50	60	50	500	350*	50	SO-16
MMPQ3467	40	40	20	500	125	50	SO-16
MMPQ3725	40	60	25	500	250	50	SO-16
MMPQ3725A	50	70	30	500	200	50	SO-16
MMPQ3762	40	40	20	1000	150	50	SO-16

*Typ

Field-Effect Transistors — SOT-23

Table 11. RF JFETs

Pinout: 1-Drain, 2-Source, 3-Gate

		NF		Y_{fs}			
Device	Marking	Typ (dB)	f (MHz)	Min (mmhos)	Max (mmhos)	V_{DS} (V)	$V_{(BR)GSS}$
N-CHANNEL							
MMBFU310L	6C	1.5	1.0	10	18	10	−25
MMBF112L	TV	3.0**	—	1.0	7.5	10	−25
MMBF5484L	6B	2.0	100	3.0	6.0	15	−25
MMBF5486L	6H	2.0	100	4.0	8.0	15	−25
MMBF4416L	6A	2.0	100	4.5	7.5	15	−30
MMBFJ310L	6T	4.0	450	8.0	18	10	−25

**Max

Table 12. General-Purpose JFETs

Pinout: 1-Drain, 2-Source, 3-Gate

			Y_{fs}			I_{DSS}	
Device	Marking	$V_{(BR)GSS}$	Min (mmhos)	Max (mmhos)	V_{DS} (V)	Min (mA)	Max (mA)
N-CHANNEL							
MMBF5457L	6D	25	1.0	5.0	15	1.0	5.0
MMBF5459L	6L	25	2.0	6.0	15	4.0	16
P-CHANNEL							
MMBF5460L	6E	−40	1.0	4.0	−15	1.0	5.0

Table 13. Choppers/Switches, JFETs

Pinout: 1-Drain, 2-Source, 3-Gate

					$V_{GS(off)}$		I_{DSS}	
Device	Marking	$r_{DS(on)}$ Max (Ohms)	t_{off} Max (ns)	$V_{(BR)GSS}$	Min (V)	Max (V)	Min (mA)	Max (mA)
N-CHANNEL								
MMBF4391L	6J	30	20	30	−4.0	−10	50	150
BSR56L	M4	25	25	40	−4.0	−10	50	—
MMBF4860L	6F	40	50	30	−2.0	−6.0	20	100
BSR57L	M5	40	50	40	−2.0	−6.0	20	100
MMBF4392L	6K	60	35	30	−2.0	−5.0	25	75
BSR58L	M6	60	100	40	−0.8	−4.0	8.0	80
MMBF4393L	6G	100	50	30	−0.5	−3.0	5.0	30
P-CHANNEL								
MMBFJ175L	6W	125	30(t)	−30	3.0	6.0	−7.0	−60
MMBFJ177L	6Y	300	45(t)	−30	0.8	2.5	−1.5	−20

Table 14. TMOS FETs

Pinout: 1-Gate, 2-Source, 3-Drain

		$r_{DS(on)}$			$V_{GS(th)}$		Switching Time	
Device	Marking	Ohm	mA	V_{DSS}	Min (V)	Max (V)	t_{on} ns	t_{off} ns
N-CHANNEL								
MMBF170L	6Z	5.0	200	60	0.8	3.0	10	10
BSS123L	SA	6.0	100	100	0.8	2.8	20	40
2N7002	702	7.5	500	60	1.0	2.5	20	20

Table 15. Zener Diodes

Zener Diodes are offered in two popular series. The MMBZ5226 has the same specifications as the standard axial leaded 1N5226 series. The BCX84 series is identical to popular European series SOT-23's.

Pinout: 1-Anode, 2-NC, 3-Cathode (V_F = 0.9 V Max @ I_F = 10 mA for all types.)

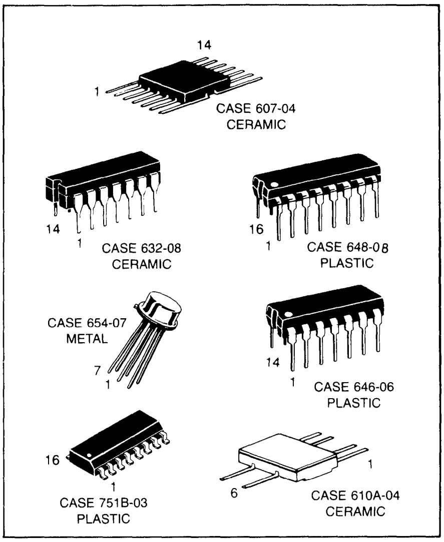
Device	Marking	Test Current I_{ZT} mA	Zener Voltage V_Z (±5%) Nominal	Z_{ZK} I_Z = 0.25 mA Ω Max	Z_{ZT} I_Z = I_{ZT} @ 10% Mod Ω Max	Max I_R μA	@ V_R V
MMBZ5226BL	8A	20	3.3	1600	28	25	1
MMBZ5227BL	8B	20	3.6	1700	24	15	1.0
MMBZ5228BL	8C	20	3.9	1900	23	10	1.0
MMBZ5229BL	8D	20	4.3	2000	22	5.0	1.0
MMBZ5230BL	8E	20	4.7	1900	19	5.0	2.0
MMBZ5231BL	8F	20	5.1	1600	17	5.0	2.0
MMBZ5232BL	8G	20	5.6	1600	11	5.0	3.0
MMBZ5233BL	8H	20	6.0	1600	7.0	5.0	3.5
MMBZ5234BL	8J	20	6.2	1000	7.0	5.0	4.0
MMBZ5235BL	8K	20	6.8	750	5.0	3.0	5.0
MMBZ5236BL	8L	20	7.5	500	6.0	3.0	6.0
MMBZ5237BL	8M	20	8.2	500	8.0	3.0	6.5
MMBZ5238BL	8N	20	8.7	600	8.0	3.0	6.5
MMBZ5239BL	8P	20	9.1	600	10	3.0	7.0
MMBZ5240BL	8Q	20	10	600	17	3.0	8.0
MMBZ5241BL	8R	20	11	600	22	2.0	8.4
MMBZ5242BL	8S	20	12	600	30	1.0	9.1
MMBZ5243BL	8T	9.5	13	600	13	0.5	9.9
MMBZ5244BL	8U	9	14	600	15	0.1	10
MMBZ5245BL	8V	8.5	15	600	16	0.1	11
MMBZ5246BL	8W	7.8	16	600	17	0.1	12
MMBZ5247BL	8X	7.4	17	600	19	0.1	13
MMBZ5248BL	8Y	7.0	18	600	21	0.1	14
MMBZ5249BL	8Z	6.6	19	600	23	0.1	14
MMBZ5250BL	81A	6.2	20	600	25	0.1	15
MMBZ5251BL	81B	5.6	22	600	29	0.1	17
MMBZ5252BL	81C	5.2	24	600	33	0.1	18
MMBZ5253BL	81D	5.0	25	600	35	0.1	19
MMBZ5254BL	81E	4.6	27	600	41	0.1	21
MMBZ5255BL	81F	4.5	28	600	44	0.1	21
MMBZ5256BL	81G	4.2	30	600	49	0.1	23
MMBZ5257BL	81H	3.8	33	700	58	0.1	25

Pinout: 1-Anode, 2-NC, 3-Cathode

Device	Marking	V_{Z1} Volts		V_{Z2} Volts		V_{Z3} Volts		@ I_Z mA			Max I_R		Z_{ZT} (ohms) (max)
		Min	Max	Min	Max	Min	Max	I_{Z1}	I_{Z2}	I_{Z3}	@ V_R (Volts)	I_R (μA)	@ I_Z = I_{Z1}
BZX84C3V3L	Z14	3.1	3.5	2.3	2.9	3.6	4.2	5.0	1.0	20	1.0	5.0	95
BZX84C4V3L	W9	4.0	4.6	3.3	4	4.4	5.1	5.0	1.0	20	1.0	3.0	90
BZX84C4V7L	Z1	4.4	5.0	3.7	4.7	4.5	5.4	5.0	1.0	20	2.0	3.0	80
BZX84C5V1L	Z2	4.8	5.4	4.2	5.3	5.0	5.9	5.0	1.0	20	2.0	2.0	60
BZX84C5V6L	Z3	5.2	6.0	4.8	6.0	5.2	6.3	5.0	1.0	20	2.0	1.0	40
BZX84C6V2L	Z4	5.8	6.6	5.6	6.6	5.8	6.8	5.0	1.0	20	4.0	3.0	10
BZX84C6V8L	Z5	6.4	7.2	6.3	7.2	6.4	7.4	5.0	1.0	20	4.0	2.0	15
BZX84C7V5L	Z6	7.0	7.9	6.9	7.9	7.0	8.0	5.0	1.0	20	5.0	1.0	15
BZX84C8V2L	Z7	7.7	8.7	7.6	8.7	7.7	8.0	5.0	1.0	20	5.0	0.7	15
BZX84C9V1L	Z8	8.5	9.6	8.4	9.6	8.5	9.7	5.0	1.0	20	6.0	0.5	15
BZX84C10L	Z9	9.4	10.6	9.3	10.6	9.4	10.7	5.0	1.0	20	7.0	0.2	20
BZX84C11L	Y1	10.4	11.6	10.2	11.6	10.4	11.8	5.0	1.0	20	8.0	0.1	20
BZX84C12L	Y2	11.4	12.7	11.2	12.7	11.4	12.9	5.0	1.0	20	8.0	0.1	25
BZX84C13L	Y3	12.4	14.1	12.3	14	12.5	14.2	5.0	1.0	20	8.0	0.1	30
BZX84C15L	Y4	13.8	15.6	13.7	15.5	13.9	15.7	5.0	1.0	20	10.5	0.05	30
BZX84C16L	Y5	15.3	17.1	15.2	17	15.4	17.2	5.0	1.0	20	11.2	0.05	40
BZX84C18L	Y6	16.8	19.1	15.7	19	16.9	19.2	5.0	1.0	20	12.6	0.05	45
BZX84C20L	Y7	18.8	21.2	18.7	21.1	18.9	21.4	5.0	1.0	20	14	0.05	55
BZX84C22L	Y8	20.8	23.3	20.7	23.2	20.9	23.4	5.0	1.0	20	15.4	0.05	55
BZX84C24L	Y9	22.8	25.6	22.7	25.5	22.9	25.7	5.0	1.0	20	16.8	0.05	70
BZX84C27L	Y10	25.1	28.9	25	28.9	25.2	29.3	2.0	0.5	10	18.9	0.05	80(1)
BZX84C30L	Y11	28	32	27.8	32	28.1	32.4	2.0	0.5	10	21	0.05	80(1)
BZX84C33L	Y12	31	35	30.8	35	31.1	35.4	2.0	0.5	10	23.1	0.05	80(1)

NOTE: (1) rdiff @ I_Z = 2.0 mA

Multiple Devices



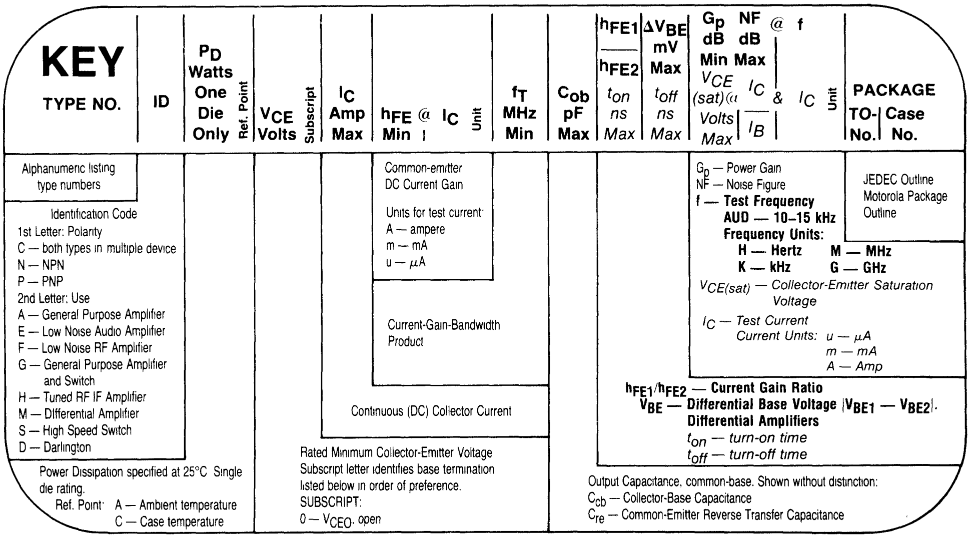
Bipolar Devices

The trend in electronic system design is toward the use of integrated circuits — to reduce component cost, assembly cost, and equipment cost. But ICs still aren't all things to all people, and for those circuit designs where ICs are not available, there is a noticeable swing towards the use of multiple devices.*

Motorola is reacting to this expanding market requirement by making available a large selection of quad, dual, Darlington transistors, and diode arrays for off-the-shelf delivery. The chips used in the Quad and Dual transistors are those that have emerged as the most popular ones for discrete transistor applications. But even beyond that, Motorola offers its entire vast repertoire of discrete small-signal transistors for multiple-device packaging. For special applications where the devices in these tables might not quite fit the design requirements, special configurations can be supplied with quick turnaround time and at low premiums.

Specification Tables

The following short form specifications include Quad and Dual bipolar transistors listed in alphanumeric order. Some columns denote two different types of data indicated by either **bold** or *italic* typeface. See key and headings for proper identification. This applies to Table 1 and 2 of this section only.



KEY

TYPE NO.	ID	P_D Watts One Die Only	Ref. Point	V_{CE} Volts	Subscript	I_C Amp Max	h_{FE} Min	@ I_C	Unit	f_T MHz Min	C_{ob} pF Max	h_{FE1}/h_{FE2} *t_{on} ns Max*	ΔV_{BE} mV Max *t_{off} ns Max*	G_p dB Min / NF dB Max *$V_{CE(sat)}$ Volts Max*	@ f *@ I_C & I_C/I_B*	Unit	PACKAGE TO- No.	Case No.

Alphanumeric listing type numbers

Identification Code
1st Letter: Polarity
C — both types in multiple device
N — NPN
P — PNP
2nd Letter: Use
A — General Purpose Amplifier
E — Low Noise Audio Amplifier
F — Low Noise RF Amplifier
G — General Purpose Amplifier and Switch
H — Tuned RF IF Amplifier
M — Differential Amplifier
S — High Speed Switch
D — Darlington

Power Dissipation specified at 25°C Single die rating.
Ref. Point: A — Ambient temperature
C — Case temperature

Rated Minimum Collector-Emitter Voltage Subscript letter identifies base termination listed below in order of preference.
SUBSCRIPT:
0 — V_{CEO}, open

Continuous (DC) Collector Current

Common-emitter DC Current Gain

Units for test current:
A — ampere
m — mA
u — μA

Current-Gain-Bandwidth Product

G_p — Power Gain
NF — Noise Figure
f — Test Frequency
AUD — 10–15 kHz
Frequency Units:
H — Hertz **M — MHz**
K — kHz **G — GHz**
$V_{CE(sat)}$ — Collector-Emitter Saturation Voltage
I_C — Test Current
Current Units: u — μA
m — mA
A — Amp

JEDEC Outline
Motorola Package Outline

h_{FE1}/h_{FE2} — Current Gain Ratio
V_{BE} — Differential Base Voltage $|V_{BE1} - V_{BE2}|$. Differential Amplifiers
t_{on} — turn-on time
t_{off} — turn-off time

Output Capacitance, common-base. Shown without distinction:
C_{cb} — Collector-Base Capacitance
C_{re} — Common-Emitter Reverse Transfer Capacitance

MULTIPLE DEVICES (continued)

Table 1. Bipolar Transistors — Quads

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts	I_C Amp Max	h_{FE}@ Min	I_C	f_T MHz Min Typ*	C_{ob} pF Max Typ*	h_{FE1} / h_{FE2} t_{on} ns Max Typ*	ΔV_{BE} mV Max t_{off} ns Max Typ*	G_p dB Min V_{CE} (sat)@ Volts Max	NF @ dB Max Typ* I_C / I_B	f I_C	PACKAGE TO- No.	PACKAGE Case No.
2N6987	**PA**	0.525 A	60 O	0.6	50	500 m	250	8.0	_45_	_300_	_0.4_	_10_	_150 m_		632
2N6988	**PA**	0.525 A	60 O	0.6	50	500 m	250	8.0	_45_	_300_	_0.4_	_10_	_150 m_		607
2N6989	**NA**	0.525 A	50 O	0.8	30	500 m	250	8.0	_35_	_300_	_0.3_	_10_	_150 m_		632
2N6990	**NA**	0.525 A	50 O	0.8	30	500 m	250	8.0	_35_	_300_	_0.3_	_10_	_150 m_		607
MHQ918	**NA**	0.65	15	0.05	20	3.0 m	600	2.0	—	—	_0.4_	_10_	_10 m_	116	632
MHQ2222	**NA**	0.65	30 O	0.5	30	300 m	200	8.0	_25*_	_250*_	_0.4_	_10_	_15 m_	116	632
MHQ2369	**NS**	0.5 A	15 O	0.5	40	10 m	450	4.0	_9.0*_	_15*_	_0.25_	_10_	_10 m_	116	632
MHQ2906	**PG**	0.65 A	40 O	0.6	40	150 m	200	8.0	_30*_	_100*_	_0.4_	_10_	_150 m_	116	632
MHQ2907†	**PG**	0.65 A	40 O	0.6	100	150 m	200	8.0	_30*_	_100*_	_0.4_	_10_	_150 m_	116	632
MHQ3467†	**PS**	0.9 A	40 O	1.0	20	500 m	125	25	_40_	_90_	_0.5_	_10_	_500 m_	116	632
MHQ3546	**PS**	0.5 A	12 O	0.2	30	10 m	600	6.0	_0.15*_	_25*_	_0.25_	_10_	_10 m_	116	632
MHQ3798	**PA**	0.5 A	40 O	0.05	150	0.1 m	60	4.0				__3.0*__	__AUD__	116	632
MHQ4002A	**NS**	0.75 A	45 O	1.5	30	500 m	200	10	_40_	_75_	_0.52_	_10_	_500 m_	116	632
MHQ4013††	**NS**	0.75 A	40 O	1.5	35	500 m	200	10	_35_	_60_	_0.52_	_10_	_500 m_	116	632
MHQ4014	**NS**	0.75 A	45 O	1.5	35	500 m	200	10	_35_	_60_	_0.52_	_10_	_500 m_	116	632
MHQ6002	**CA**	0.65 A	30 O	0.5	100	150 m	200	8.0	_30*_	_225*_	_0.4_	_10_	_150 m_	116	632
MPQ1000	**NA**	0.65 A	20 O	0.5	50	10 m	175	8.0			_0.5_	_10_	_150 m_		646
MPQ2221	**NA**	0.65 A	30 O	0.5	40	150 m	200	8.0	_25*_	_250*_	_0.4_	_10_	_150 m_		646
MPQ2222	**NA**	0.65 A	30 O	0.5	100	150 m	200	8.0	_25*_	_250*_	_0.4_	_10_	_150 m_		646
MPQ2222A	**NA**	0.65 A	30 O	0.5	100	150 m	200	8.0	_25*_	_250*_	_0.4_	_10_	_150 m_		646
MPQ2369	**NS**	0.5 A	15 O	0.5	40	10 m	450	4.0	_9.0*_	_15*_	_0.25_	_10_	_10 m_		646
MPQ2483	**NA**	0.625 A	40 O	0.05	150	1.0 m	50					__3.0*__	__AUD__		646
MPQ2484	**NA**	0.625 A	40 O	0.05	300	1.0 m	50					__2.0*__	__AUD__		646
MPQ2906	**PA**	0.65 A	40 O	0.6	40	150 m	200	8.0	_30*_	_100*_	_0.4_	_10_	_150 m_		646
MPQ2907	**PA**	0.65 A	40 O	0.6	100	150 m	200	8.0	_30*_	_100*_	_0.4_	_10_	_150 m_		646
MPQ2907A	**PA**	0.65 A	60 O	0.6	100	150 m	200	8.0	_30*_	_100*_	_0.4_	_10_	_150 m_		646
MPQ3467	**PS**	0.75 A	40 O	1.0	20	500 m	125	25	_40_	_90_	_0.5_	_10_	_500 m_		646
MPQ3546	**PA**	0.5 A	12 O	0.2	30	10 m	600	6.0	_15*_	_25*_	_0.25_	_10_	_10 m_		646
MPQ3725†	**NS**	1.0 A	40 O	1.0	25	500 m	250	10	_35_	_60_	_0.45_	_10_	_500 m_		646
MPQ3725A	**NS**	1.0 A	50 O	1.0	30	500 m	200	10	_3.5_	_60_	_0.45_		_500 m_		646
MPQ3762	**PS**	0.75 A	40 O	1.5	35	150 m	150	15	_50_	_120_	_0.55_	_10_	_500 m_		646
MPQ3798	**PA**	0.625 A	40 O	0.05	150	0.1 m	60	4.0				__3.0*__	__AUD__		646
MPQ3799	**PA**	0.625 A	60 O	0.05	300	0.1 m	60	4.0				__2.0*__	__AUD__		646
MPQ3904	**NG**	0.5 A	40 O	0.2	75	10 m	250	4.0	_37*_	_136*_	_0.2_	_10_	_10 m_		646
MPQ3906	**PG**	0.5 A	40 O	0.2	75	10 m	200	4.5	_43*_	_155*_	_0.25_	_10_	_10 m_		646
MPQ6001	**CG**	0.65 A	30 O	0.5	40	150 m	200	8.0	_30*_	_225*_	_0.4_	_10_	_150 m_		646
MPQ6002	**CG**	0.65 A	30 O	0.5	100	150 m	200	8.0	_30*_	_225*_	_0.4_	_10_	_150 m_		646
MPQ6100	**CA**	0.5 A	40 O	0.05	75	1.0 m	50	4.0				__4.0*__	__AUD__		646
MPQ6100A	**CA**	0.5 A	45 O	0.05	150	1.0 m	50	4.0				__4.0*__	__AUD__		646
MPQ6426	**ND**	0.5 A	30 O	0.5	10K	100 m	125	8.0	—	—	_1.5_	_10_	_100 m_		646
MPQ6427	**ND**	0.5 A	40 O	0.5	10K	100 m	125	8.0	—	—	_1.5_	_10_	_100 m_		646
MPQ6501	**CG**	0.65 A	30 O	0.5	40	150 m	200	8.0	_30*_	_225*_	_0.4_	_10_	_150 m_		646
MPQ6502	**CG**	0.65 A	30 O	0.5	100	150 m	200	8.0	_30*_	_225*_	_0.4_	_10_	_150 m_		646
MPQ6600	**CA**	0.5 A	40 O	0.05	75	1.0 m	50	4.0				__4.0*__	__AUD__		646
MPQ6600A	**CA**	0.5 A	45 O	0.05	150	1.0 m	50	4.0			_0.25_	_4.0_	_1.0 m_		646
MPQ6700	**CA**	0.5 A	40 O	0.2	70	10 m	200	4.5			_0.25_	_4.0_	_1.0 m_		646
MPQ6842	**CA**	0.75 A	40 O	0.5	70	10 m	300	4.5	_45_	_150_	_0.15_	_10_	_0.5 m_		646
MPQ7041	**NA**	0.75 A	150 O	0.5	25	1.0 m	50	5.0			_0.5_	_10_	_20 m_		646
MPQ7042	**NA**	0.75 A	200 O	0.5	25	1.0 m	50	5.0			_0.5_	_10_	_20 m_		646
MPQ7043	**NA**	0.75 A	250 O	0.5	25	1.0 m	50	5.0			_0.5_	_10_	_20 m_		646
MPQ7091	**PA**	0.75 A	150 O	0.5	25	1.0 m	50	5.0			_0.5_	_10_	_20 m_		646
MPQ7092	**PA**	0.75 A	200 O	0.5	25	1.0 m	50	5.0			_0.5_	_10_	_20 m_		646
MPQ7093	**PA**	0.75 A	250 O	0.5	35	10 m	50	5.0			_0.5_	_10_	_20 m_		646
MQ918	**NA**	0.55 A	15 O	0.05	50	3.0 m	600	1.7				__6.0__	__60 M__		607
MQ982	**PA**	0.4 A	50 O	0.6	40	150 m	200	8.0			_0.5_	_10_	_150 m_		607

†H, HX, and HXV Suffixes also available.
††MHQ4013 is electrically equivalent to MHQ3725.

Some columns show 2 different types of data indicated by either **bold** or _italic_ typefaces. See key and headings.

Table 1. Bipolar Transistors — Quads (continued)

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts		I_C Amp Max	h_{FE}@ Min	I_C	f_T MHz Min Typ*	C_{ob} pF Max Typ*	**h_{FE1} / h_{FE2}** *t_{on} ns Max Typ**	**ΔV_{BE} mV Max** *t_{off} ns Max Typ**	**G_p dB Min** *V_{CE} (sat)@ Volts Max*	**NF dB Max Typ*** *I_C / I_B*	**@ f** *I_C*	PACKAGE TO- No.	PACKAGE Case No.
MQ1120	**PA**	0.4 A	30	O	0.5	50	10 m	200	8.0			*0.1*	*10*	*10 m*		607
MQ1129	**NA**	0.4 A	30	O	0.5	100	10 m	200	8.0			*0.15*	*10*	*10 m*		607
MQ2218	**NA**	0.4 A	30	O	0.5	40	150 m	200	8.0			*0.4*	*10*	*150 m*		607
MQ2218A	**NA**	0.6 A	40	O	0.5	40	150 m	200	8.0			*0.4*	*10*	*150 m*		607
MQ2219	**NA**	0.6 A	30	O	0.5	100	150 m	200	8.0			*0.3*	*10*	*150 m*		607
MQ2219A	**NA**	0.4 A	30	O	0.5	100	150 m	200	8.0			*0.3*	*10*	*150 m*		607
MQ2369	**NS**	0.4 A	15	O	0.5	40	10 m	500	4.0	*15*	*20*	*0.25*	*10*	*10 m*		607
MQ2484	**NE**	0.4 A	60	O	0.03	100	10 u	260*	6.0				**3.0**	**AUD**		607
MQ2905A	**PG**	0.4 A	60	O	0.6	100	150 m	300	8.0	*42*	*130*	*0.4*	*10*	*150 m*		607
MQ3251	**PA**	0.4 A	40	O	0.05	100	10 m	300	6.0			*0.25*	*10*	*10 m*		607
MQ3467	**PS**	0.4 A	40	O	1.0	20	500 m	150	20	*40*	*110*	*0.5*	*10*	*500 m*		607
MQ3725	**NS**	0.4 A	40	O	1.0	50	100 m	200	10	*45*	*75*	*0.26*	*10*	*100 m*		607
MQ3762	**PS**	0.4 A	40	O	1.5	20	1.0 A	150	20	*40*	*110*	*1.0*	*10*	*1.0 A*		607
MQ3798	**PA**	0.4 A	60	O	0.05	150	100 u	450*	4.0			*0.2*	*10*	*1.0 m*		607
MQ6001	**CG**	0.4 A	30	O	0.5	40	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		607
MQ7001	**PA**	0.4 A	30	O	0.6	70	1.0 m	200	8.0			*0.4*	*10*	*150 m*		607
MQ7003	**NA**	0.4 A	40	O	0.05	50	10 m	200	6.0			*0.35*	*10*	*1.0 m*		607
MQ7007	**PA**	0.4 A	40	O	0.2	30	1.0 m	300	8.0			*1.0*	*10*	*50 m*		607
MQ7021	**CG**	0.4 A	40	O	0.05	50	10 m	200	6.0	*28**	*72**	*0.35*	*10*	*10 m*		607
2N5146	**PA**	0.4 A	40	O	1.5	20	1.0 A	150	20	*40*	*110*	*1.0*	*10*	*1.0 A*		607

Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

Table 2. Bipolar Transistors — Dual

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts		I_C Amp Max	h_{FE}@ Min	I_C	f_T MHz Min Typ*	C_{ob} pF Max Typ*	**h_{FE1} / h_{FE2}** *t_{on} ns Max Typ**	**ΔV_{BE} mV Max** *t_{off} ns Max Typ**	**G_p dB Min** *V_{CE} (sat)@ Volts Max*	**NF dB Max Typ*** *I_C / I_B*	**@ f** *I_C*	PACKAGE TO- No.	PACKAGE Case No.
BFX11	**PM**	0.4 A	45	O	0.05	80	50 m	130	8.0	0.8	5.0	0.25	20	50 m	78	654
BFX15	**NM**	0.5 A	40	O	0.5	60	100 u	50	15	0.9	5.0	1.0	10	1.0 m	78	654
BFX36	**PM**	0.4 A	60	O	0.05	100	10 u	40	6.0	0.9	3.0	0.25	20	10 m	78	654
BFY81	**NM**	0.4 A	45	O	0.03	100	100 u	60	6.0	0.8	10	0.35	10	1.0 m	78	654
MD708	**NG**	0.55 A	15	O	0.2	40	10 m	300	5.0	*35*	*75*	*0.2*	*10*	*10 m*		654
MD708A	**NM**	0.55 A	15	O	0.2	40	10 m	300	5.0	**0.9**	**5.0**	*0.2*	*10*	*10 m*		654
MD708AF	**NM**	0.55 A	15	O	0.2	40	10 m	300	5.0	—	—	*0.85*	*10*	*100 m*		654
MD708B	**NM**	0.55 A	15	O	0.2	40	10 m	300	5.0	**0.8**	**10**	*0.2*	*10*	*10 m*		654
MD708BF	**NM**	0.55 A	15	O	0.2	40	10 m	300	5.0	—	—	*0.85*	*10*	*100 m*		654
MD708F	**NM**	0.55 A	15	O	0.2	40	10 m	300	5.0	—	—	0.85	10	100 m		654
MD918A	**NM**	0.55 A	15	O	0.05	50	3.0 m	600	1.7	**0.9**	**5.0**		**6.0**	**60 M**		654
MD918AF	**NM**	0.35 A	15	O	0.05	50	3.0 m	600	1.7	**0.9**	**5.0**		**6.0**	**60 M**		610A
MD918B	**NM**	0.55 A	15	O	0.05	50	3.0 m	600	1.7	**0.8**	**10**		**6.0**	**60 M**		654
MD918	**NM**	0.55 A	15	O	0.05	50	30 m	600	1.7	0.8	10		6.0	60 m		654
MD982,F	**PA**	0.4 A	50	O	0.6	40	150 m	200	8.0			*0.5*	*10*	*150 m*		610A
MD984	**PA**	0.575 A	20	O	0.2	25	10 m	250				*0.5*	*10*	*50 m*		654
MD985	**CA**	0.575 A	30	O	0.5	40	150 m	200	8.0			*0.5*	*10*	*150 m*		654
MD986	**CA**	0.55 A	15	O	0.2	25	10 m	200	4.0			*0.5*	*10*	*50 m*		654
MD1121	**NM**	0.575 A	30	O	0.5	50	10 m	200	8.0	**0.9**	**10**	*0.1*	*10*	*10 m*		654
MD1121F	**NM**	0.35 A	30	O	0.5	50	10 m	200	8.0	**0.9**	**10**	*0.1*	*10*	*10 m*		654
MD1122F	**NM**	0.35 A	30	O	0.5	50	20 m	200	8.0	**0.9**	**5.0**	*0.1*	*10*	*10 m*		654
MD1132	**NM**	0.3 A	15	O	0.05	50	1.0 m	600	1.7	**0.9**	**5.0**	0.4	*10*	*10 m*		654
MD2060F	**NM**	0.35 A	60	O	0.5	30	0.1 m	100	15	**0.9**	**5.0**	0.1	*8.0*	*10 m*		610A
MD1122	**NM**	0.575 A	30	O	0.5	50	10 m	250	3.5	0.8	5.0	0.1	10	10 m		654
MD1123	**NM**	0.575 A	40	O	0.2	50	10 m	250	3.5	0.8	10	0.18	10	0.1 m		654
MD1130	**NM**	0.575 A	40	O	0.2	100	10 m	200	3.5	0.9	5.0	0.18	5	1.0 m		654
MD3467	**NG**	0.6 A	40	O	1.5	20	500 m	150	80	40	120	0.5	10	500 m		654
MD4260	**NH**	0.55 A	12	O	0.05	30	10 m	1000	2.5	0.8	10	0.3	10	10 m		654
MD4261	**NH**	0.55 A	12	O	0.05	30	10 m	1000	2.5	0.8	10	0.3	10	10 m		654

Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

MULTIPLE DEVICES (continued)

Table 2. Bipolar Transistors — Duals (continued)

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts		I_C Amp Max	h_{FE} @ I_C Min		f_T MHz Min Typ*	C_{ob} pF Max Typ*	$\frac{h_{FE1}}{h_{FE2}}$	ΔV_{BE} mV Max	G_p dB Min	NF @ dB Max Typ*	f	PACKAGE	
										t_{on} ns Max Typ*	t_{off} ns Max Typ*	V_{CE} (sat) @ Volts Max	$\frac{I_C}{I_B}$	I_C	TO- No.	Case No.
MD2218	**NG**	0.575 A	30	O	0.5	40	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		654
MD2218A	**NG**	0.575 A	30	O	0.5	40	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		654
MD2218AF	**NG**	0.35 A	30	O	0.5	40	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		610A
MD2219	**NG**	0.575 A	30	O	0.5	50	150 m	200	8.0	—	—	*0.35*	*10*	*300 m*		654
MD2219A	**NG**	0.575 A	30	O	0.5	100	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		654
MD2219AF	**NG**	0.35 A	30	O	0.5	100	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		610A
MD2369	**NS**	0.55 A	15	O	0.5	40	10 m	500	4.0	*15*	*20*	*0.25*	*10*	*10 m*		654
MD2369A	**NM**	0.55 A	15	O	0.5	40	10 m	500	4.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		654
MD2369AF	**NM**	0.35 A	15	O	0.5	40	10 m	500	4.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		610A
MD2369B	**NM**	0.55 A	15	O	0.5	40	10 m	500	4.0	**0.8**	**10**	*0.25*	*10*	*10 m*		654
MD2369BF	**NM**	0.35 A	15	O	0.5	40	10 m	500	4.0	**0.8**	**10**	*0.25*	*10*	*10 m*		610A
MD2904	**PG**	0.575 A	40	O	0.6	40	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		654
MD2904A	**PG**	0.575 A	60	O	0.6	40	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		654
MD2904AF	**PG**	0.35 A	60	O	0.6	40	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		610A
MD2905	**PG**	0.575 A	40	O	0.6	100	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		654
MD2905A	**PG**	0.575 A	60	O	0.6	100	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		654
MD2905AF	**PG**	0.35 A	60	O	0.6	100	150 m	200	8.0	*45*	*130*	*0.4*	*10*	*150 m*		610A
MD3250	**PA**	0.575 A	40	O	0.2	50	1.0 m	200	6.0			*0.25*	*10*	*10 m*		654
MD3250A	**PM**	0.575 A	40	O	0.2	50	1.0 m	200	6.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		654
MD3250AF	**PM**	0.35 A	40	O	0.2	50	1.0 m	200	6.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		610A
MD3251	**PA**	0.575 A	40	O	0.2	100	1.0 m	250	6.0			*0.25*	*10*	*10 m*		654
MD3251A	**PM**	0.575 A	40	O	0.2	100	1.0 m	250	6.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		654
MD3251AF	**PM**	0.35 A	40	O	0.2	100	1.0 m	250	6.0	**0.9**	**5.0**	*0.25*	*10*	*10 m*		610A
MD3409	**NM**	0.575 A	30	O	0.5	50	10 m	200	8.0	**0.8**	**10**	*0.15*	*10*	*10 m*		654
MD3410	**NM**	0.575 A	30	O	0.5	50	10 m	200	8.0	**0.9**	**10**	*0.15*	*10*	*10 m*		654
MD3725	**NS**	0.6 A	40	O	1.0	50	100 m	200	10	*45*	*75*	*0.26*	*10*	*100 m*		654
MD3725F	**NS**	0.35 A	40	O	1.0	50	100 m	200	10	*45*	*75*	*0.26*	*10*	*100 m*		610A
MD3762	**PS**	0.6 A	40	O	1.5	20	1.0 A	150	20	*40*	*110*	*1.0*	*10*	*1.0 A*		654
MD3762F	**PS**	0.35 A	40	O	1.5	20	1.0 A	150	20	*40*	*110*	*1.0*	*10*	*1.0 A*		610A
MD5000	**PH**	0.3 A	15	O	0.05	20	3.0 m	600	1.7			**15**		**200 M**		654
MD5000A	**PM**	0.3 A	15	O	0.05	20	3.0 m	600	1.7	**0.9**	**5.0**	**15**		**200 M**		654
MD5000B	**PM**	0.3 A	15	O	0.05	20	3.0 m	600	1.7	**0.8**	**10**	**15**		**200 M**		654
MD6001	**CG**	0.575 A	30	O	0.5	40	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		654
MD6001F	**CG**	0.35 A	30	O	0.5	40	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		610A
MD6002	**CG**	0.575 A	30	O	0.5	100	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		654
MD6002F	**CG**	0.35 A	30	O	0.5	100	150 m	200	8.0	*60*	*350*	*0.4*	*10*	*150 m*		610A
MD6003	**CG**	0.575 A	30	O	0.5	20	150 m	200	—			*0.59*	*10*	*300 m*		654
MD6100	**CA**	0.5 A	45	O	0.05	100	0.1 m	30	4.0			*0.25*	*10*	*1.0 m*		654
MD6100F	**CA**	0.35 A	45	O	0.05	100	0.1 m	30	4.0			*0.25*	*10*	*10 m*		610A
MD7000	**NA**	0.575 A	30	O	0.5	70	150 m	200	8.0			*0.4*	*10*	*150 m*		654
MD7001	**PA**	0.6 A	30	O	0.6	70	150 m	200	8.0			*0.4*	*10*	*150 m*		654
MD7001F	**PA**	0.35 A	30	O	0.6	70	150 m	200	8.0			*0.4*	*10*	*150 m*		610A
MD7002	**NA**	0.575 A	40	O	0.03	40	100 u	200	6.0			*0.35*	*10*	*10 m*		654
MD7002A	**NM**	0.575 A	40	O	0.03	40	100 u	200	6.0	**0.75**	**25**	*0.35*	*10*	*10 m*		654
MD7002B	**NM**	0.575 A	40	O	0.03	40	100 u	200	6.0	**0.85**	**15**	*0.35*	*10*	*10 m*		654
MD7003	**NA**	0.55 A	40	O	0.05	50	10 m	200	6.0			*0.35*	*10*	*1.0 m*		654
MD7003A	**NM**	0.55 A	40	O	0.05	50	10 m	200	6.0	**0.75**	**25**	*0.35*	*10*	*1.0 m*		654
MD7003B	**NM**	0.55 A	40	O	0.05	50	10 m	200	6.0	**0.85**	**15**	*0.35*	*10*	*1.0 m*		654

Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

Table 2. Bipolar Transistors — Duals (continued)

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts		I_C Amp Max	h_{FE}@ Min	I_C	f_T MHz Min Typ*	C_{ob} pF Max Typ*	h_{FE1} / h_{FE2} *t_{on} ns Max Typ**	ΔV_{BE} mV Max *t_{off} ns Max Typ**	G_p dB Min *V_{CE} (sat)@ Volts Max*	NF @ dB Max Typ* *I_C / I_B*	f *I_C*	PACKAGE TO- No.	PACKAGE Case No.
MD7004	**NA**	0.55 A	13	O	0.2	30	10 m	675*	4.0			*0.4*	*10*	*10 m*		654
MD7005	**PA**	0.55 A	12	O	0.05	30	3.0 m	650	3.0			*0.4*	*10*	*10 m*		654
MD7007	**PA**	0.575 A	40	O	0.2	30	1.0 m	300	8.0			*1.0*	*10*	*50 m*		654
MD7007A	**PM**	0.575 A	50	O	0.2	30	1.0 m	300	8.0	**0.75**	**20**	*1.0*	*10*	*50 m*		654
MD7007B	**PM**	0.575 A	60	O	0.2	30	1.0 m	300	8.0	**0.85**	**10**	*1.0*	*10*	*50 m*		654
MD7007BF	**PM**	0.35 A	40	O	0.2	30	1.0 m	300	8.0	**0.85**	**10**	*1.0*	*10*	*50 m*		610A
MD7021	**CG**	0.55 A	40	O	0.05	50	10 m	200	6.0	_28*_	_72*_	*0.35*	*10*	*10 m*		654
MD7021F	**CG**	0.35 A	40	O	0.05	50	10 m	200	6.0	_28*_	_72*_	*0.35*	*10*	*10 m*		610A
MD8001	**NM**	0.575 A	40	O	0.03	100	1.0 m	260*	2.6*		**15**					654
MD8002	**NM**	0.575 A	40	O	0.03	100	1.0 m	260*	2.6*		**15**					654
MD8003	**NM**	0.575 A	40	O	0.03	100	1.0 m	260*	2.6*		**15**					654
2N2060	**NM**	0.5 A	60	O	0.5	30	100 u	60	15	**0.9**	**5.0**		**8.0**	**1000 H**	78	654
2N2223	**NM**	0.5 A	60	O	0.5	25	100 u	50	15	**0.8**	**15**	*1.2*	*10*	*50 m*	78	654
2N2223A	**NM**	0.5 A	60	O	0.5	25	100 u	50	15	**0.9**	**5.0**	*1.2*	*10*	*50 m*	78	654
2N2453	**NM**	0.5 A	30	O	0.05	80	10 u	60	8.0	**0.9**	**3.0**		**7.0**	**1000 H**	78	654
2N2453A	**NM**	0.5 A	50	O	0.05	80	10 u	60	8.0	**0.9**	**3.0**		**4.0**	**1000 H**	78	654
2N2480A	**NM**	0.3 A	40	O	0.5	50	1.0 m	50	18	**0.8**	**5.0**	*1.3*	*10*	*50 m*	78	654
2N2639	**NM**	0.3 A	45	O	0.03	50	10 u	80	8.0	**0.9**	**5.0**		**4.0**	**AUD**	78	654
2N2640	**NM**	0.3 A	45	O	0.03	50	10 u	80	8.0	**0.8**	**10**		**4.0**	**AUD**	78	654
2N2641	**NE**	0.3 A	45	O	0.03	50	10 u	80	8.0				**4.0**	**AUD**	78	654
2N2642	**NM**	0.3 A	45	O	0.03	100	10 u	80	8.0	**0.9**	**5.0**		**4.0**	**AUD**	78	654
2N2643	**NM**	0.3 A	45	O	0.03	100	10 u	80	8.0	**0.8**	**10**		**4.0**	**AUD**	78	654
2N2644	**NE**	0.3 A	45	O	0.03	100	10 u	80	8.0				**4.0**	**AUD**	78	654
2N2652	**NM**	0.3 A	60	O	0.5	50	1.0 m	60	15	**0.85**	**3.0**	*1.2*	*10*	*50 m*	78	654
2N2652A	**NM**	0.3 A	60	O	0.5	50	1.0 m	60	15	**0.9**	**3.0**		**8.0**	**1000 H**	78	654
2N2721	**NM**	0.3 A	60	O	0.04	30	0.1 m	80	6.0	**0.8**	**10**	*1.0*	*10*	*10 m*	78	654
2N2722	**NM**	0.3 A	45	O	0.04	50	1.0 u	100	6.0	**0.9**	**5.0**	*1.0*	*20*	*10 m*	78	654
2N2903	**NM**	0.6 C	30	O	0.05	125	1.0 m	60	8.0	**0.8**	**10**		**7.0**	**1000 H**	78	654
2N2913	**NE**	0.3 A	45	O	0.03	60	10 u	60	6.0				**4.0**	**AUD**		654
2N2914	**NE**	0.3 A	45	O	0.03	150	10 u	60	6.0				**3.0**	**AUD**		654
2N2915	**NM**	0.3 A	45	O	0.03	60	10 u	60	6.0	**0.9**	**5.0**		**4.0**	**AUD**		654
2N2916	**NM**	0.3 A	45	O	0.03	150	10 u	60	6.0	**0.9**	**5.0**		**3.0**	**AUD**		654
2N2917	**NM**	0.3 A	45	O	0.03	60	10 u	60	6.0	**0.8**	**10**		**4.0**	**AUD**		654
2N2918	**NM**	0.3 A	45	O	0.03	150	10 u	60	6.0	**0.8**	**10**		**3.0**	**AUD**		654
2N2919	**NM**	0.3 A	60	O	0.03	60	10 u	60	6.0	**0.9**	**5.0**		**4.0**	**AUD**		654
2N2920	**NM**	0.3 A	60	O	0.03	150	10 u	60	6.0	**0.9**	**5.0**		**3.0**	**AUD**		654
2N4854	**CG**	0.3 A	40	O	0.6	35	0.3 m	200	—	—	—	—	*8.0*	*100 u*		654
2N4855	**CG**	0.3 A	40	O	0.6	20	0.3 m	200	—	—	—	—	*8.0*	*100 u*		654
2N3043	**NM**	0.25 A	45	O	0.03	100	10 u	30	8.0	**0.9**	**5.0**		**5.0**	**AUD**		610A
2N3044	**NM**	0.25 A	45	O	0.03	100	10 u	30	8.0	**0.8**	**10**		**5.0**	**AUD**		610A
2N3045	**NE**	0.25 A	45	O	0.03	100	10 u	30	8.0				**5.0**	**AUD**		610A
2N3048	**NE**	0.25 A	45	O	0.03	50	10 u	30	8.0				**5.0**	**AUD**		610A
2N3425	**NA**	0.3	15		0.05	30	10 m	300	6.0							654
2N3726	**PE**	0.4 A	45	O	0.3	135	1.0 m	200	8.0	**0.9**	**5.0**		**4.0**	**1000 H**		654
2N3727	**PE**	0.4 A	45	O	0.3	135	1.0 m	200	8.0	**0.9**	**2.5**		**4.0**	**1000 H**		654
2N3806	**PE**	0.5 A	60	O	0.05	150	0.1 m	100	4.0				**7.0**	**100 H**		654
2N3807	**PE**	0.5 A	60	O	0.05	300	0.1 m	100	4.0				**4.0**	**100 H**		654
2N3808	**PM**	0.5 A	60	O	0.05	150	0.1 m	100	4.0	**0.8**	**5.0**		**7.0**	**100 H**		654
2N3809	**PM**	0.5 A	60	O	0.05	300	0.1 m	100	4.0	**0.8**	**5.0**		**4.0**	**100 H**		654
2N3810	**PM**	0.5 A	60	O	0.05	150	0.1 m	100	4.0	**0.9**	**3.0**		**7.0**	**100 H**		654
2N3810A	**PM**	0.5 A	60	O	0.05	150	0.1 m	100	4.0	**0.95**	**1.5**		**3.0**	**100 H**		654
2N3811	**PM**	0.5 A	60	O	0.05	300	0.1 m	100	4.0	**0.9**	**3.0**		**4.0**	**100 H**		654
2N3811A	**PM**	0.5 A	60	O	0.05	300	0.1 m	100	4.0	**0.95**	**1.5**		**1.5**	**100 H**		654

Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

MULTIPLE DEVICES (continued)

Table 2. Bipolar Transistors — Duals (continued)

TYPE NO.	I_D	P_D Watts One Die Only	V_{CE}- Volts	I_C Amp Max	h_{FE} Min	@ I_C	f_T MHz Min Typ*	C_{ob} pF Max Typ*	**h_{FE1}/h_{FE2}** *t_{on} ns Max Typ**	**ΔV_{BE} mV Max** *t_{off} ns Max Typ**	**G_p dB Min** *V_{CE} (sat) @ Volts Max*	**NF @ dB Max Typ*** *I_C/I_B*	**f** *I_C*	PACKAGE TO- No.	Case No.
2N3817	**PM**	0.5 A	60 O	0.05	300	0.1 m	100	4.0	**0.9**	**3.0**		**4.0**	**100 H**		610A
2N3838	**CE**	0.25 A	40 O	0.6	100	150 m	200	8.0	*50*	*340*		**8.0**	**1000 H**		610A
2N4015	**PM**	0.4 A	60 O	0.3	135	1.0 m	200	8.0	**0.9**	**5.0**		**4.0**	**1000 H**		654
2N4016	**PM**	0.4 A	60 O	0.3	135	1.0 m	200	8.0	**0.9**	**2.5**		**4.0**	**1000 H**		654
2N4854	**CE**	0.3 A	40 O	0.6	100	150 m	200	8.0	*60*	*350*		**8.0**	**1000 H**		654
2N4855	**CE**	0.3 A	40 O	0.6	40	150 m	200	8.0	*60*	*350*		**8.0**	**1000 H**		654
2N4937	**PM**	0.6 A	40 O	0.05	50	1.0 m	300	5.0	**0.9**	**3.0**		**4.0**	**AUD**		654
2N4938	**PM**	0.6 A	40 O	0.05	50	1.0 m	300	5.0	**0.8**	**5.0**		**4.0**	**AUD**		654
2N4939	**PE**	0.6 A	40 O	0.05	50	1.0 m	300	5.0				**40**	**AUD**		654
2N4941	**PM**	0.6 A	40 O	0.05	50	1.0 m	300	5.0	**0.9**	**3.0**		**4.0**	**AUD**		610A
2N5793	**NG**	0.5 A	40 O	0.6	40	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		654
2N5794	**NG**	0.5 A	40 O	0.6	100	150 m	200	8.0	*45*	*310*	*0.3*	*10*	*150 m*		654
2N5795	**NG**	0.5 A	60 O	0.6	40	150 m	200	8.0	*47*	*140*	*0.4*	*10*	*150 m*		654
2N5796	**NG**	0.5 A	60 O	0.6	100	150 m	200	8.0	*47*	*140*	*0.4*	*10*	*150 m*		654

Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

Surface Mount Multiples

Table 3. Bipolar Quad Transistors — SO-16

Device	$V_{(BR)CEO}$	$V_{(BR)CBO}$	h_{FE} Min	@ I_C mA	f_T MHz Min	@ I_C (mA)	Package
MMPQ2222	40	60	30	300	350*	20	751B
MMPQ2222A	40	75	40	500	350*	20	751B
MMPQ2369	15	40	20	100	450	10	751B
MMPQ2907	40	40	30	300	350*	50	751B
MMPQ2907A	50	60	50	500	350*	50	751B
MMPQ3467	40	40	20	500	125	50	751B
MMPQ3725	40	60	25	500	250	50	751B
MMPQ3725A	50	70	30	500	200	50	751B
MMPQ3762	40	40	20	1000	150	50	751B

*Typ

Table 4. TMOS FETs — Quads

N-CHANNEL TMOS QUAD — CASE 646-06 (14-PIN DIP)

Device	$r_{DS(on)}$ Ω Max	@ I_D A	$V_{GS(th)}$ V Min	Max	$V_{(BR)DSS}$ V Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max
MFQ930P	1.4	1.0	1.0	3.5	35	70	18	15	15
MFQ960P	1.7	1.0	1.0	3.5	60	70	18	15	15

N-CHANNEL TMOS QUAD — CASE 648-06 (16-PIN DIP)

Device	$r_{DS(on)}$ Ω Max	@ mA	$V_{(BR)DSS}$ Volt Min	$I_{D(on)}$ V_{GS} = 10 V V_{DS} = 5.0 V Amp	G_{fs} mhos Min	@ 5.0 V Amp	C_{iss} @ 25 V pF Max	C_{oss} @ 25 V pF Max	C_{rss} @ 25 V pF Max	$t_{d(on)}$ ns Max	t_r ns Max	$t_{d(off)}$ ns Max	t_f ns Max
IRFE110	0.6	800	100	1.0	0.8	0.8	200	100	25	20	25	25	20
IRFE113	0.8	800	60	0.8	0.8	0.8	200	100	25	20	25	25	20

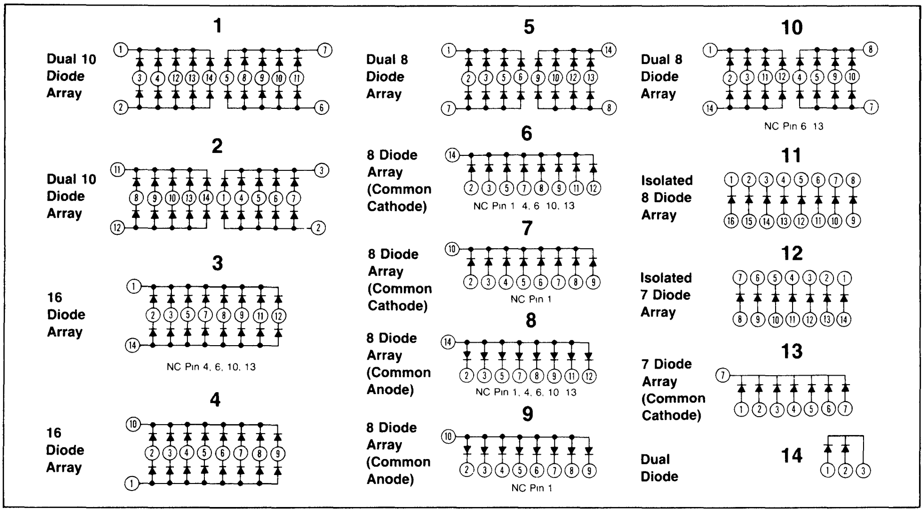
P-CHANNEL TMOS QUAD — CASE 648-06 (16-PIN DIP)

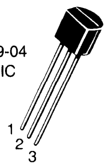
IRFE9120	0.8	800	100	1.0	0.8	0.8	450	350	100	50	100	100	100
IRFE9123	0.6	800	60	0.8	0.8	0.8	450	350	100	50	100	100	100

Multiple Switching Diodes

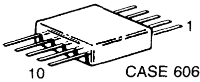
Multiple diode configurations utilize monolithic structures fabricated by the planar process. They are designed to satisfy fast switching requirements as in core driver and encoding/decoding applications where their monolithic configurations offer lower cost, higher reliability and space savings.

Diode Array Diagrams

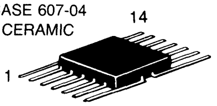




CASE 29-04
PLASTIC



CASE 606-04
CERAMIC



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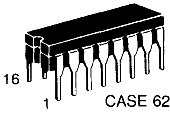
CERAMIC



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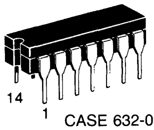
CERAMIC



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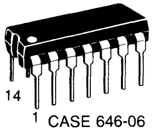
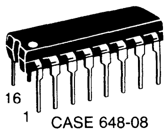
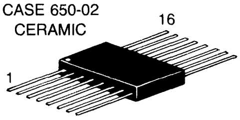
CERAMIC



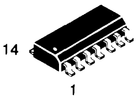
CASE 646-06
PLASTIC



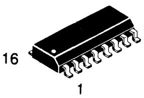
CASE 648-08
PLASTIC



CASE 650-02
CERAMIC



CASE 751A-02
PLASTIC



CASE 751B-03
PLASTIC

MULTIPLE DEVICES (continued)

Table 5. Diode Arrays

Device	Function	Pin Connections	
		Package	Diagram No.
MAD130C	Dual 10 Diode Array	632-02	1
MAD130P	Dual 10 Diode Array	646-06	1
MMAD130	Dual 10 Diode Array	751A-02	2
MAD1103C	16 Diode Array	632-02	3
MAD1103F	16 Diode Array	606-04	4
MAD1103P	16 Diode Array	646-06	3
MMAD1103	16 Diode Array	751A-02	3
MAD1104C	Dual 8 Diode Array	632-02	5
MAD1104F	Dual 8 Diode Array	607-04	5
MAD1104P	Dual 8 Diode Array	646-06	5
MMAD1104	Dual 8 Diode Array	751A-02	5
MAD1105C	8 Diode Common Cathode Array	632-02	6
MAD1105F	8 Diode Common Cathode Array	606-04	7
MAD1105P	8 Diode Common Cathode Array	646-06	6
MMAD1105	8 Diode Common Cathode Array	751A-02	6
MAD1106C	8 Diode Common Anode Array	632-02	8
MAD1106F	8 Diode Common Anode Array	606-04	9
MAD1106P	8 Diode Common Anode Array	646-06	8
MMAD1106	8 Diode Common Anode Array	751A-02	8
MAD1107C	Dual 8 Diode Array	632-02	10
MAD1107F	Dual 8 Diode Array	607-04	10
MAD1107P	Dual 8 Diode Array	646-06	10
MMAD1107	Dual 8 Diode Array	751A-02	10
MAD1108C	8 Isolated Diode Array	620-02	11
MAD1108F	8 Isolated Diode Array	650-02	11
MAD1108P	8 Isolated Diode Array	648-06	11
MMAD1108	8 Isolated Diode Array	751B-03	11
MAD1109C	7 Isolated Diode Array	632-02	12
MAD1109F	7 Isolated Diode Array	607-04	12
MAD1109P	7 Isolated Diode Array	646-06	12
MMAD1109	7 Isolated Diode Array	751A-02	12
MMAD1185	7 Diode Common Cathode Array	751A-02	13

Table 6. Dual Diodes

Device	$V_{(BR)}$ Volts Min	@ $I_{(BR)}$ µA	I_R µA Max	@ V_R Volts	V_F Volts Min/Max	@ I_F mA	C @ $V_R = 0$ pF (Max)	t_{rr} ns Max	Package	Diagram No.
MSD6100	100	100	100	50	0.67/0.82	10	1.5	4.0	TO-226AA (TO-92)	14
MSD6101	50	100	100	40	0.67/0.82	10	2.0	10		14
MSD6102	70	100	100	50	0.67/1.0	10	3.0	100		14
MSD6150	70	100	100	50	−/1.0	10	8.0	100		14

Devices for Hi-Rel and Military Applications

JAN, JANTX, JANTXV, and JANS

Motorola offers over 650 devices listed in QPL-19500, and is certified to supply small-signal bipolar devices to ALL FOUR quality levels of MIL-S-19500.

The following tables list the Motorola discrete devices and slash-sheet number as they appear on the Qualified Products List.

Table 1. Switching and High-Frequency Transistors (MIL-S-19500)

2N703 JAN	/153	2N2905 JAN,JTX,JTXV	/290	2N3506 JAN,JTX,JTXV	/349
2N706 JAN	/120	2N2905A JAN,JTX,JTXV	/290	2N3507 JAN,JTX,JTXV	/349
2N708 JAN,JTX	/312	2N2905AL JANS	/	2N3634 JAN,JTX,JTXV	/357
2N718A JAN,JTX,JTXV	/181	2N2906 JAN,JTX,JTXV	/291	2N3635 JAN,JTX,JTXV	/357
2N869A JAN,JTX	/283	2N2906A JAN,JTX,JTXV	/291	2N3636 JAN,JTX,JTXV	/357
2N914 JAN,JTX	/373	2N2907 JAN,JTX,JTXV	/291	2N3637 JAN,JTX,JTXV	/357
2N916 JAN	/271	2N2907A JAN,JTX,JTXV,JANS	/291	2N3700 JAN,JTX,JTXV	/391
2N918 JAN,JTX,JTXV,JANS	/301	2N2944A JAN,JTX,JTXV	/	2N3735 JAN,JTX,JTXV	/395
2N930 JAN,JTX	/253	2N2945A JAN,JTX,JTXV	/	2N3737 JAN,JTX,JTXV	/395
2N1132 JAN	/177	2N2946A JAN,JTX,JTXV	/	2N3743 JAN,JTX,JTXV	/397
2N1613 JAN,JTX,JTXV	/181	2N3013 JAN,JTX	/287	2N3762 JAN,JTX,JTXV	/396
2N2218 JAN,JTX,JTXV	/251	2N3019,S JAN,JTX,JTSV	/391	2N3763 JAN,JTX,JTXV	/396
2N2218A JAN,JTX,JTXV	/251	2N3250A JAN,JTX,JTXV	/323	2N3764 JAN,JTX,JTXV	/396
2N2219 JAN,JTX,JTXV	/251	2N3251A JAN,JTX,JTXV	/323	2N3765 JAN,JTX,JTXV	/396
2N2219A JAN,JTX,JTXV	/251	2N3253 JAN	/347	2N4033 JAN,JTX,JTXV	/511
2N22219AL JANS	/	2N3444 JAN,JTX	/347	2N4261 JAN,JTX,JTXV	/511
2N2221 JAN,JTX,JTXV	/255	2N3467 JAN,JTX,JTXV	/348	2N4405 JAN,JTX,JTXV	/488
2N2221A JAN,JTX,JTXV	/255	2N3468 JAN,JTX,JTXV	/348	2N4449 JAN,JTX,JTXV	/317
2N2222 JAN,JTX,JTXV	/255	2N3485A JAN,JTX	/392	2N4453 JAN,JTX	/283
2N2222A JAN,JTX,JTXV,JANS	/225	2N3486A JAN,JTX	/392	2N4930 JAN,JTX,JTXV	/397
2N2369A JAN,JTX,JTXV,JANS	/317	2N3498 JAN,JTX,JTXV	/366	2N4931 JAN,JTX,JTXV	/397
2N2481 JAN,JTX	/268	2N3499 JAN,JTX,JTXV	/366	2N5581 JAN,JTX	/423
2N2904 JAN,JTX,JTXV	/290	2N3500 JAN,JTX,JTXV	/366	2N5582 JAN,JTX	/423
2N2904A JAN,JTX,JTXV	/	2N3501 JAN,JTX,JTXV	/366		

Table 2. Multiple Devices (MIL-S-19500)

2N2060 JAN,JTX,JTXV	/270	2N3811 JAN,JTX,JTXV	/336	2N5794 JAN,JTX,JTXV	/495
2N2919 JAN,JTX,JTXV	/355	2N4854 JAN,JTX,JTXV	/421	2N5795 JAN,JTX,JTXV	/496
2N2920 JAN,JTX,JTXV	/355	2N5793 JAN,JTX,JTXV	/495	2N5796 JAN,JTX,JTXV	/496
2N3810 JAN,JTX,JTXV	/336				

Table 3. Field-Effect Transistors (MIL-S-19500)

2N2608 JAN	/295	2N3823 JAN,JTX,JTXV	/375	2N4860 JAN,JTX,JTXV	/385
2N2609 JAN	/296	2N4856 JAN,JTX,JTXV	/385	2N4861 JAN,JTX,JTXV	/385
2N3330 JAN,JTX	/378	2N4857 JAN,JTX,JTXV	/385	2N4091 JAN,JTX,JTXV	/431
2N3821 JAN,JTX,JTXV	/375	2N4858 JAN,JTX,JTXV	/385	2N4092 JAN,JTX,JTXV	/431
2N3822 JAN,JTX,JTXV	/375	2N4859 JAN,JTX,JTXV	/385	2N4093 JAN,JTX,JTXV	/431

CECC

All CECC types are available to assessment levels E, F, L

Table 4. Qualified Types

2N1613	2N2219	2N2222A	2N3019	2N2906	2N3439	2N5416
2N1711	2N2219A	2N2368	2N2904	2N2906A	2N3440	BC107-108-109
2N1893	2N2221	2N2369	2N2904A	2N2907	2N3501	CV9507
2N2218	2N2221A	2N2369A	2N2905	2N2907A	2N4033	PO7726
2N2218A	2N2222	2N2484	2N2905A	2N2894	2N5415	

Qualified products to CECC 50,000

Tuning and Switching Diodes

Tuning Diodes — A wide range of voltage-variable capacitance diodes for electronic tuning and control of RF circuits from HF through UHF.

Hot Carrier Diodes — For high-efficiency VHF and UHF switching and mixer applications.

PIN Diodes — Particularly useful for bandswitching and detector circuits in the VHF range.

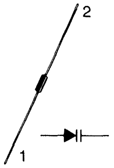
Tuning Diodes — Abrupt Junction

Table 1. General-Purpose Glass

Motorola supplies voltage-variable capacitance diodes serving the entire range of frequencies from HF through UHF. Used in RF receivers and transmitters, they have a variety of applications, including:

- Phase-locked loop tuning systems
- Local oscillator tuning
- Tuned RF preselectors
- RF filters
- RF phase shifters
- RF amplifiers
- Automatic frequency control
- Video filters and delay lines
- Harmonic Generators
- FM modulators

Two families of devices are available: Abrupt Junction and Hyper Abrupt Junction. The Abrupt Junction family includes devices suitable for virtually all tuned-circuit and narrow-range tuning applications throughout the spectrum. The Hyper Abrupt family exhibits higher capacitance, and a much larger capacitance ratio. It is particularly well suited for wider-range applications such as AM/FM radio and TV tuning.



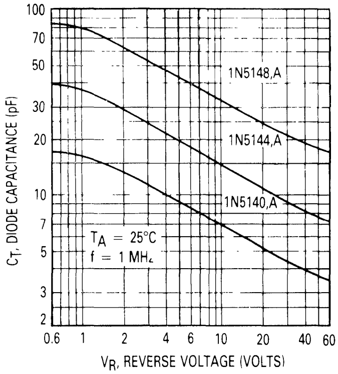
CASE 51-02
DO-204AA
(DO-7)

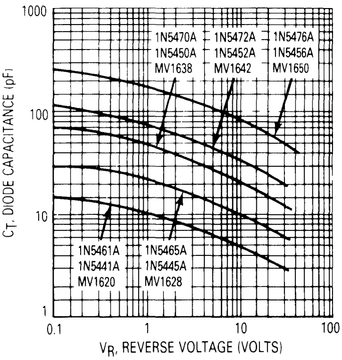
- High Q
- Capacitance TOL
  10% — No Suffix
  5% — Suffix A

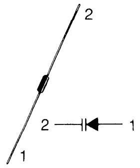
		60 Volts		
		Cap Ratio C4/C60 Min	**Q @ 4 V 50 MHz Min**	**Device Type**
C_T Nominal Capacitance pF ±10% @ V_R = 4 V f = 1 MHz	**6.8**	2.7	350	1N5139,A
	8.2			
	10	2.8	300	1N5140,A
	12	2.8	300	1N5141,A
	15	2.8	250	1N5142,A
	18	2.8	250	1N5143,A
	20			
	22	3.2	200	1N5144,A
	27	3.2	200	1N5145,A
	33	3.2	200	1N5146,A
	39	3.2	200	1N5147,A
	47	3.2	200	1N5148,A
	56			
	68			
	82			
	100			

TYPICAL CHARACTERISTICS

Diode Capacitance versus Reverse Voltage





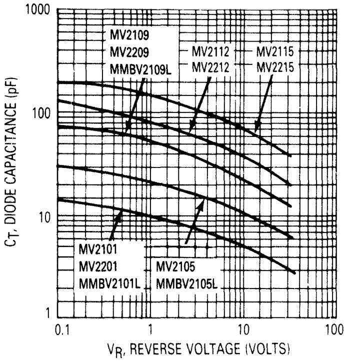


CASE 51-02
DO-204AA
(DO-7)

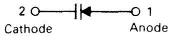
• Premium 30 V • Very High Q • Guaranteed High CR • Capacitance TOL 10% – A, 5% – B, 2% – C			• High Q • Controlled CR • Capacitance TOL 10% – A, 5% – B, 2% – C			• General-Purpose			
Maximum Working Voltage						Maximum Working Voltage			
30 Volts						20 Volts			
Cap Ratio C2/C30 Min	**Q @ 4 V 50 MHz Min**	**Device Type**	**Cap Ratio C2/C30 Min**	**Q @ 4 V 50 MHz Min**	**Device Type**	**Cap Ratio C2/C20 Min**	**Q @ 4 V 50 MHz Min**	**Device Type**	**C_T Nominal pF ±10% @ V_R = 4 V f = 1 MHz**
2.7	600	1N5461A	2.5	450	1N5441A	2	300	MV1620	**6.8**
2.8	600	1N5462A	2 5	450	1N5442A	2	300	MV1622	**8.2**
2.8	550	1N5463A	2.6	400	1N5443A	2	300	MV1624	**10**
2 8	550	1N5464A	2 6	400	1N5444A	2	300	MV1626	**12**
2.8	550	1N5465A	2.6	450	1N5445A	2	250	MV1628	**15**
2.9	500	1N5466A	2.6	350	1N5446A	2	250	MV1630	**18**
2.9	500	1N5467A	2.6	350	1N5447A	2	250	MV1632	**20**
2.9	500	1N5468A	2.6	350	1N5448A	2	250	MV1634	**22**
2.9	500	1N5469A	2.6	350	1N5449A	2	200	MV1636	**27**
2.9	500	1N5470A	2.6	350	1N5450A	2	200	MV1638	**33**
2.9	450	1N5471A	2.6	300	1N5451A	2	200	MV1640	**39**
2.9	400	1N5472A	2.6	250	1N5452A	2	200	MV1642	**47**
2.9	300	1N5473A	2.6	200	1N5453A	2	150	MV1644	**56**
2.9	250	1N5474A	2.7	175	1N5454A	2	150	MV1646	**68**
2.9	225	1N5475A	2.7	175	1N5455A	2	150	MV1648	**82**
2.9	200	1N5476A	2.7	175	1N5456A	2	150	MV1650	**100**

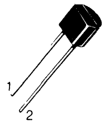
TYPICAL CHARACTERISTICS

Diode Capacitance versus Reverse Voltage

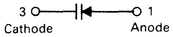


CASE 182-02
(TO-92)
STYLE 1





CASE 318-03
(TO-236AB)
STYLE 8



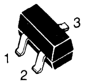
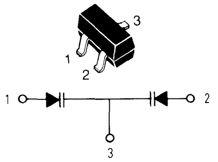


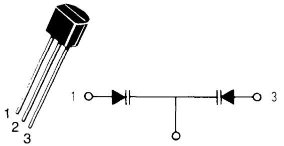
Table 2. General-Purpose Plastic

		• Low-Cost • High Volume			• Lower Cost • General-Purpose			• Low-Cost • High Volume		
		Maximum Working Voltage								
		30 Volts			25 Volts			30 Volts		
		CASE 182-02 2-Lead TO-92						CASE 318-02 TO-236AA		
		Cap Ratio C2/C30 Min	**Q @ 4 V 50 MHz Min**	**Device Type**	**Cap Ratio C1/C10 Min**	**Q @ 4 V 50 MHz Min**	**Device Type C_T ±20%**	**Cap Ratio C2/C30 Min**	**Q @ 4 V 50 MHz Typ**	**Device Type**
C_T Nominal Capacitance pF ±10% @ V_R = 4 V f = 1 MHz	**6.8**	2.5	450	MV2101	1.9	300	MV2201	2.5	400	MMBV2101L
	8.2	2.5	450	MV2102				2.5	350	MMBV2102L
	10	2.5	400	MV2103	2	200	MV2203	2.5	350	MMBV2103L
	12	2.5	400	MV2104				2.5	350	MMBV2104L
	15	2.5	400	MV2105	2	200	MV2205	2.5	350	MMBV2105L
	18	2.5	350	MV2106				2.5	300	MMBV2106L
	22	2.5	350	MV2107	2	150	MV2207	2.5	300	MMBV2107L
	27	2.5	300	MV2108				2.5	250	MMBV2108L
	33	2.5	200	MV2109	2	150	MV2209	2.5	200	MMBV2109L
	39	2.5	150	MV2110						
	47	2.5	150	MV2111	2	100	MV2211			
	56	2.6	150	MV2112						
	68	2.6	150	MV2113	2	100	MV2213			
	82	2.6	100	MV2114						
	100	2.6	100	MV2115	2	50	MV2215			

Table 3. Dual Diodes



CASE 318-03
(TO-236AB)
STYLE 9



CASE 29-04
TO-226AA
(TO-92)
STYLE 15

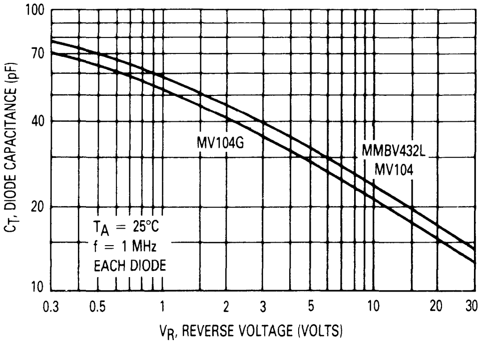
- High Q
- Guaranteed Capacitance Range
- Monolithic Dual

Maximum Working Voltage

32 Volts

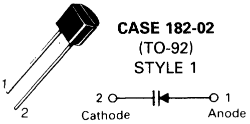
C_T Capacitance			Cap Ratio C3/C30	Q @ 3 V 50 MHz	Device Type
pF		@ V_R			
Min	Max	Volts	Min	Min	
34	39	3	2.5	100	MV104G(1)
37	42	3	2.5	100	MV104(1)
43	48.1	2	1.5*	100	MMBV432L(2)

(1) Case 29 (2) Case 318 *C2/C8

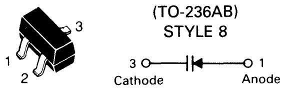


Tuning Diodes Hyper-Abrupt Junction

Table 4. For FM Radio and TV



CASE 182-02
(TO-92)
STYLE 1



CASE 318-03
(TO-236AB)
STYLE 8

- High Q
- Guaranteed Capacitance Range

Maximum Working Voltage

30 Volts

C_T Capacitance pF @		V_R	Cap Ratio C3/C25	Q @ 3 V 50 MHz	Device Type
Min	**Max**	**Volts**	**Min**	**Typ**	
1.8	2.8	25	4	350	MMBV105GL*
20	25	3	4.5	300	MMBV3102L*
26	32	3	5	250	MMBV109L*
26	32	3	5	250	MV209**

*Case 318 **Case 182

TYPICAL CHARACTERISTICS

Diode Capacitance versus Reverse Voltage

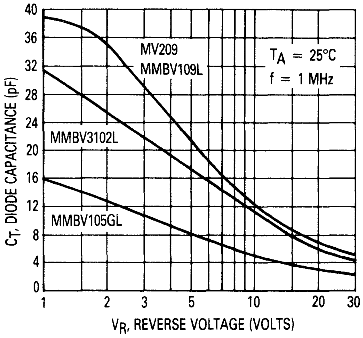
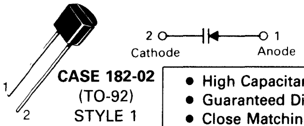


Table 5. For AM Radio



CASE 182-02
(TO-92)
STYLE 1

- High Capacitance Ratio
- Guaranteed Diode Capacitance
- Close Matching

C_T		Q @ 1 Vdc, 1 MHz = 150 (Min)			
V_R=1 V, f=1 MHz pF		$V_{BR(R)}$ Min	Cap Ratio Min	@ V_R Volts	Device Type
Min	**Max**				
440	**560**	12	15	1/8	MVAM108
400	**520**	15	12	1/9	MVAM109
440	**560**	18	15	1/15	MVAM115
440	**560**	28	15	1/25	MVAM125

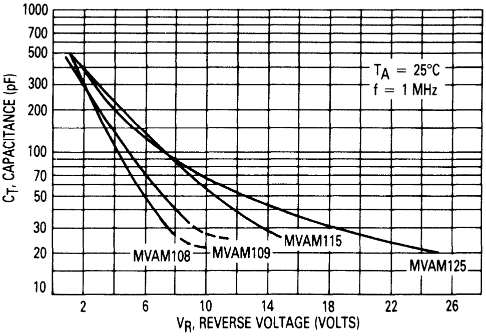
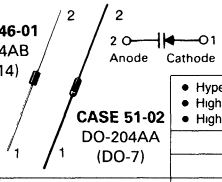


Table 6. For High Capacitance and High Reliability Applications

100% Screening to High Rel electrical and environmental specifications, H suffix.



CASE 146-01
DO-204AB
(DO-14)

CASE 51-02
DO-204AA
(DO-7)

- Hyper-Abrupt
- High Tuning Ratio
- High Rel — Suffix H

Maximum Working Voltage

12 Volts

C_T, Nominal Capacitance pF @	V_R	Cap Ratio C2/C10	Q @ 2 V 1 MHz	Device Type	
Nom ± 20%	**Volts**	**Min**	**Min**	**Case 51**	**Case 146**
120	2	10	200	MV1404,H	
175	2	10	200	MV1403,H	
250	2	10	200	MV1405,H	
550*	1	14(1)	200		MV1401,H

* ± 15% (1)Cap Ratio @ C1/C10 V

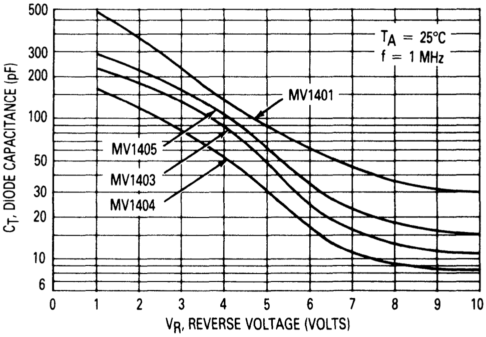
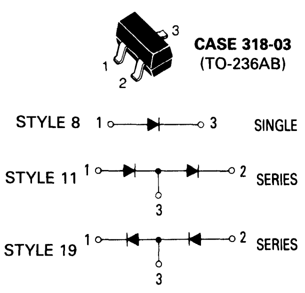
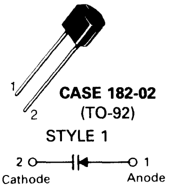


Table 7. Hot-Carrier (Schottky) Diodes



Hot-Carrier diodes are ideal for VHF and UHF mixer and detector applications as well as many higher frequency applications. They provide stable electrical characteristics by eliminating the point-contact diode presently used in many applications.

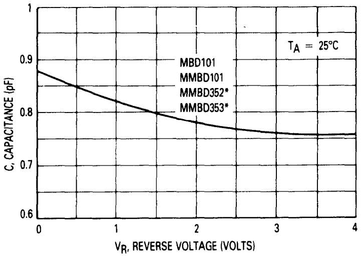


$V_{(BR)R}$ I_R = 10 µA Volts Min	C_T f = 1 MHz pF Max	V_R @ Volts	V_F I_F = 10 mA Volts Max	I_R nA Max	V_R @ Volts	Device Type
CASE 182, STYLE 1						
4	1	0	0.6	250	3	MBD101L
20	1.5	15	0.6	200	15	MBD201L
30	1.5	15	0.6	200	25	MBD301L
50	1	20	1.2	200	25	MBD501L
70	1	20	1.2	200	35	MBD701L
CASE 318, STYLE 8						
4	1	0	0.6	250	3	MMBD101L
20	1.5	15	0.6	200	15	MMBD201L
30	1.5	15	0.6	200	25	MMBD301L
50	1	20	1.2	200	25	MMBD501L
70	1	20	1.2	200	35	MMBD701L
DUAL DIODES, CASE 318						
4	1	0	0.6	250	3	MMBD352L*
4	1	0	0.6	250	3	MMBD353L**

*Style 11 **Style 19

TYPICAL CHARACTERISTICS

Capacitance versus Reverse Voltage



*EACH DIODE

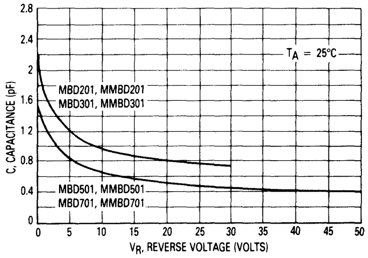
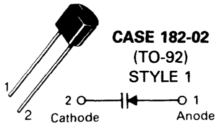
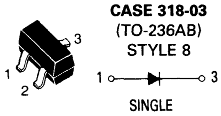


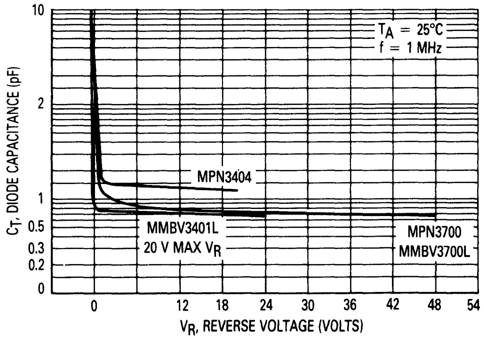
Table 8. PIN Switching Diodes





. . . designed for VHF band switching and general-purpose switching.

$V_{(BR)R}$ I_R = 10 µAdc Volts Min	R_S I_F = 10 mAdc f = 100 MHz Ohms Max	C_T V_R = 20 V f = 1 MHz pF Max	Device Type
CASE 182, STYLE 1			
20	0.85	2	MPN3404
200	1	1	MPN3700
CASE 318, STYLE 8			
35	0.7	1	MMBV3401L
200	1	1	MMBV3700L



Signal and Switching Diodes

SOT-23 Surface Mount Diode Configurations

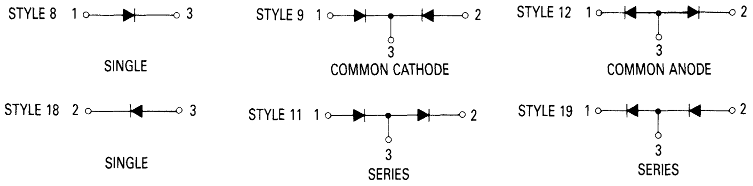
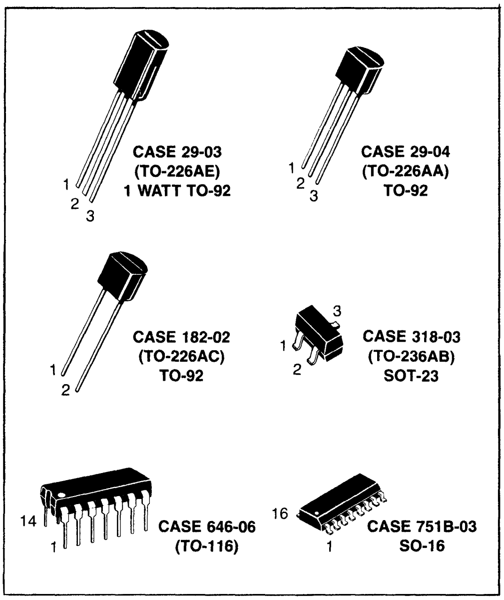


Table 9. General-Purpose Switching Diodes

		$V_{(BR)R}$		I_R		V_F			C_T	t_{rr}	Pin Out
Device	**Marking**	**Min (V)**	**@ I_{BR} (µA)**	**Max (µA)**	**@ V_R (V)**	**Min (V)**	**Max (V)**	**@ I_F (mA)**	**Max (pF)**	**Max (ns)**	**Case Style**
SINGLES											
MMBD6050L	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0	8
MMBD914L	5D	100	100	5.0	75		1.0	10	4.0	4.0	8
BAS16L	A6	75	100	1.0	75		1.3	100	2.0	4.0	8
BAL99L	TF	70	10	2.5	70		1.1	50	1.5	4.0	18
DUALS											
MBAV70L	A4X	70	100	5.0	70		1.1	50	1.5	15	9
MBAW56L	A1X	70	100	2.5	70		1.1	50	1.5	15	12
MBAV99L	A7X	70	100	2.5	70		1.1	50	1.5	15	11
MBAV74	JAX	50	5.0	0.1	50		1.0	100	2.0		9
MMBD2835XL	A3X	35	100	0.1	30		1.0	10	4.0	15	12
MMBD2836XL	A2X	75	100	0.1	50		1.0	10	4.0	15	12
MMBD2837XL	A5X	35	100	0.1	30		1.0	10	4.0	15	9
MMBD2838XL	A6X	75	100	0.1	50		1.0	10	4.0	15	9
MMBD6100L	5B	70	100	0.1	50	0.85	1.1	100	2.5	15	9
MMBD7000L	5C	100	100	0.3	50	0.75	1.1	100	1.5	15	11

Plastic-Encapsulated Transistors

2



Motorola's plastic transistors and diodes encompass hundreds of devices spanning the gamut from general-purpose amplifiers and switches with a wide variety of characteristics to dedicated special-purpose devices for the most demanding applications. The popular high-volume TO-226AA (TO-92) package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems.

As an additional service to our customers Motorola will, upon request, supply the following:

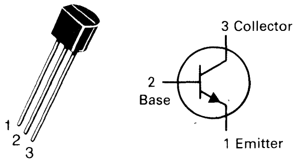
- Radial tape and reel
- Axial tape and reel
- TO-205AA (TO-5) lead forming
- TO-206AA (TO-18) lead forming

Contact your Motorola representative for ordering information.

This section contains both single and multiple plastic-encapsulated transistors.

2N3903
2N3904

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltge	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

*Indicates Data in addition to JEDEC Requirements.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	—	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain(1)	h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) 2N3903		20	—	
2N3904		40	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) 2N3903		35	—	
2N3904		70	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc) 2N3903		50	150	
2N3904		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) 2N3903		30	—	
2N3904		60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc) 2N3903		15	—	
2N3904		30	—	
Collector-Emitter Saturation Voltage(1)	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.3	
Base-Emitter Saturation Voltage(1)	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.95	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product	f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) 2N3903		250	—	
2N3904		300	—	

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

Characteristic		Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903 2N3904	h_{ie}	1.0 1.0	8.0 10	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903 2N3904	h_{re}	0.1 0.5	5.0 8.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903 2N3904	h_{fe}	50 100	200 400	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	40	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohms, f = 1.0 kHz)	2N3903 2N3904	NF	— —	6.0 5.0	dB

SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	—	35	ns
Rise Time			t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	2N3903 2N3904	t_s	— —	175 200	ns
Fall Time			t_f	—	50	ns

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

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

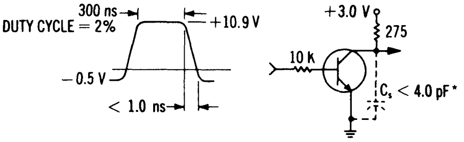
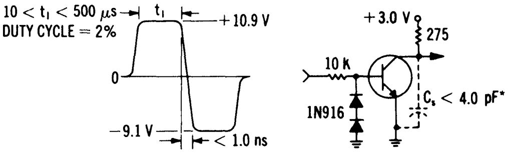


FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TYPICAL TRANSIENT CHARACTERISTICS

— T_J = 25°C - - - T_J = 125°C

FIGURE 3 – CAPACITANCE

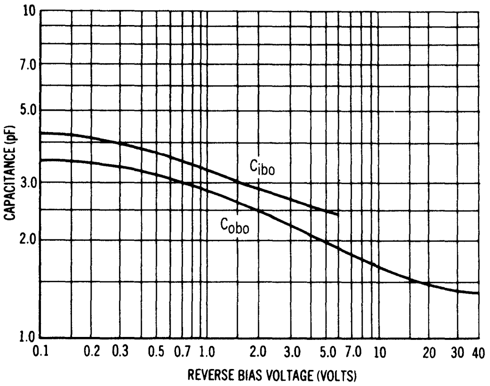


FIGURE 4 – CHARGE DATA

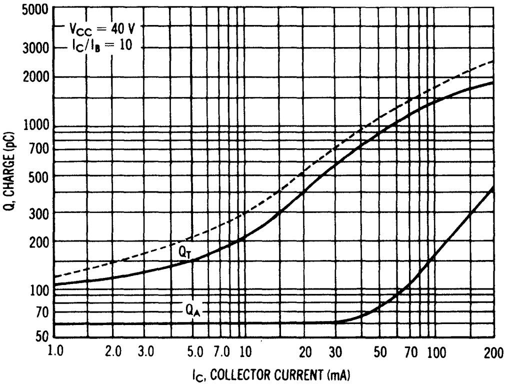


FIGURE 5 – TURN-ON TIME

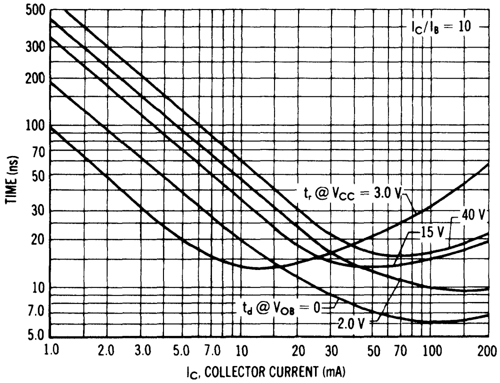


FIGURE 6 – RISE TIME

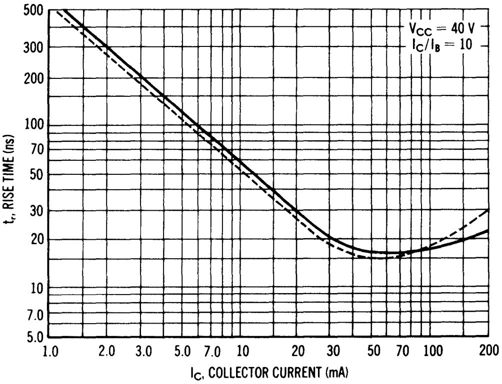


FIGURE 7 – STORAGE TIME

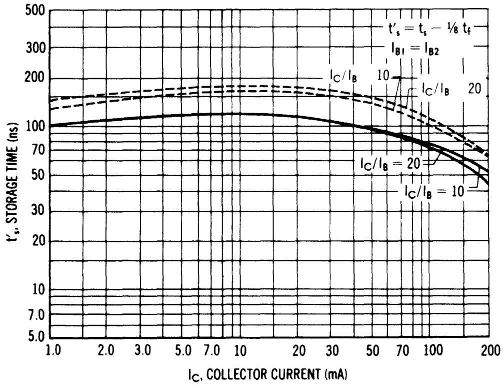
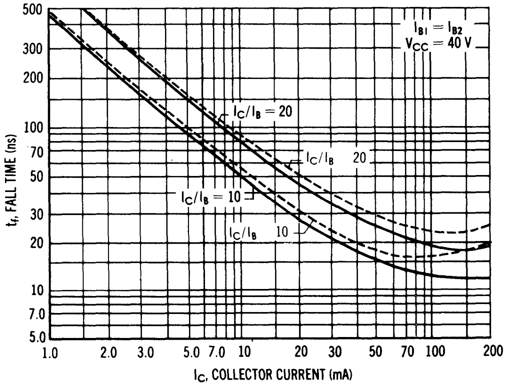


FIGURE 8 – FALL TIME



TYPICAL AUDIO SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

V_{CE} = 5.0 Vdc, T_A = 25°C,
Bandwidth = 1.0 Hz

FIGURE 9

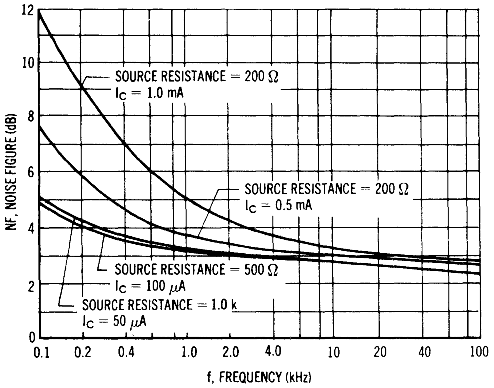
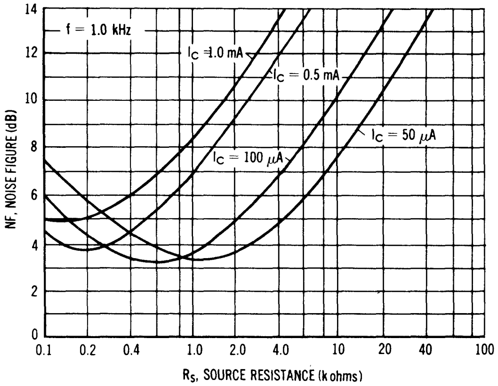


FIGURE 10



h PARAMETERS

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

FIGURE 11 — CURRENT GAIN

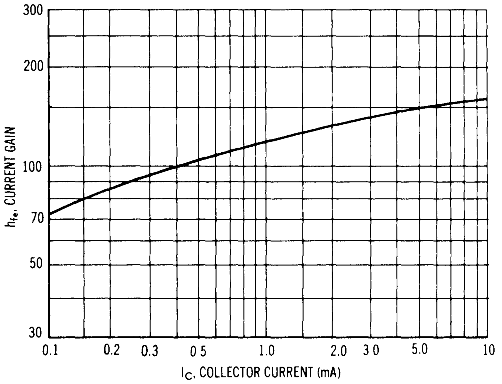


FIGURE 12 — OUTPUT ADMITTANCE

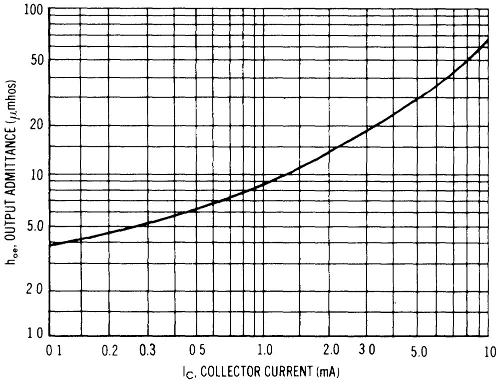


FIGURE 13 — INPUT IMPEDANCE

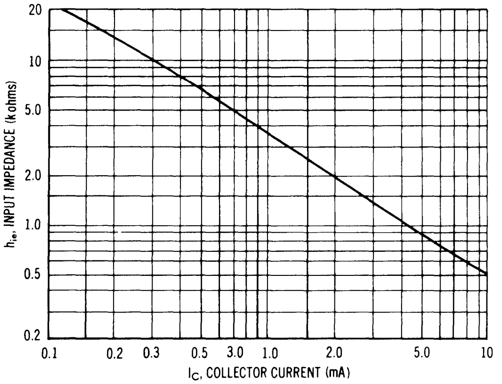
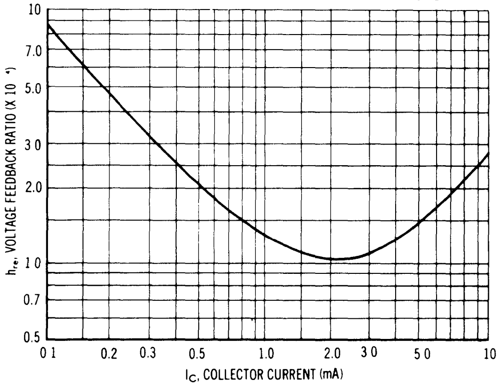


FIGURE 14 — VOLTAGE FEEDBACK RATIO



TYPICAL STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN

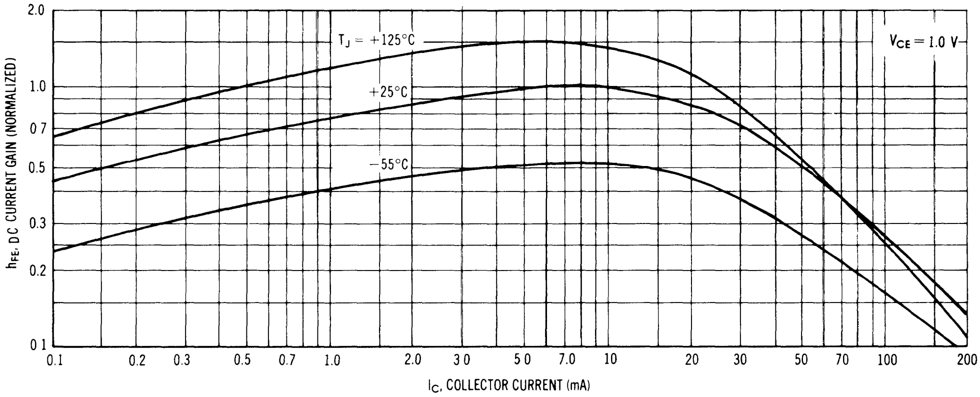


FIGURE 16 – COLLECTOR SATURATION REGION

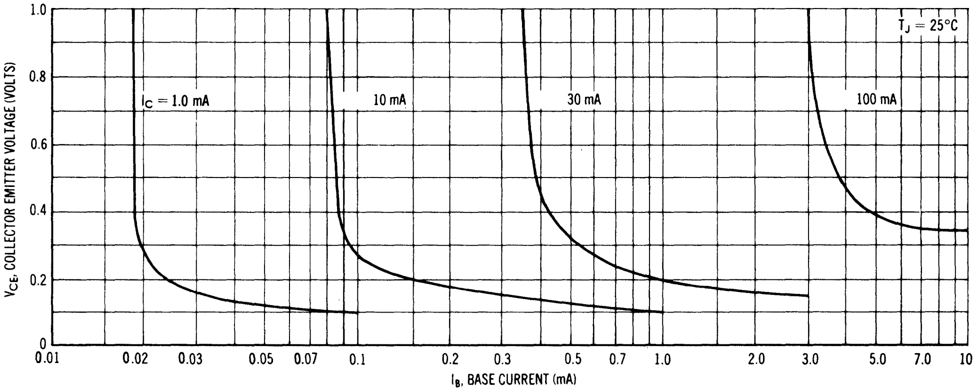


FIGURE 17 – "ON" VOLTAGES

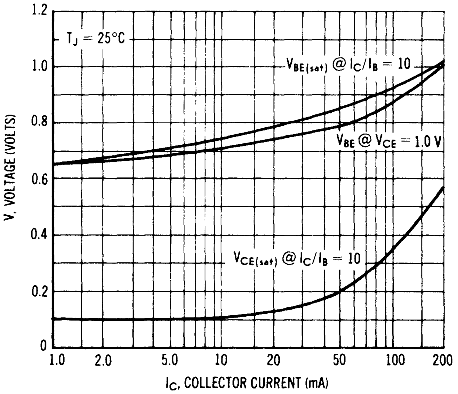
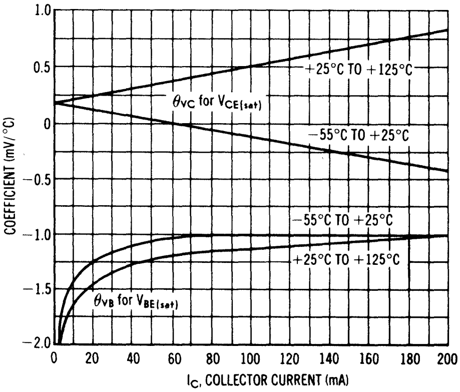
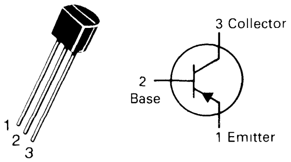


FIGURE 18 – TEMPERATURE COEFFICIENTS



2N3905
2N3906

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ $T_A = 60°C$	P_D	250	mW
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

*THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 3.0 Vdc)		I_{BL}	—	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 3.0 Vdc)		I_{CEX}	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	2N3905		30	—	
	2N3906		60	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N3905		40	—	
	2N3906		80	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N3905		50	150	
	2N3906		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	2N3905		30	—	
	2N3906		60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N3905		15	—	
	2N3906		30	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	0.25	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.4	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.95	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N3905		200	—	
	2N3906		250	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.5	pF

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

Characteristic		Symbol	Min	Max	Unit
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	10.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h_{ie}	0.5 2.0	8.0 12	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h_{re}	0.1 0.1	5.0 10	$X\ 10^{-4}$
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h_{fe}	50 100	200 400	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3905 2N3906	h_{oe}	1.0 3.0	40 60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 1.0 kHz)	2N3905 2N3906	NF	— —	5.0 4.0	dB

SWITCHING CHARACTERISTICS

			Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	—	35	ns
Rise Time			t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	2N3905 2N3906	t_s	— —	200 225	ns
Fall Time		2N3905 2N3906	t_f	— —	60 75	ns

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

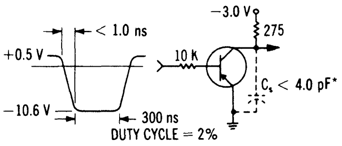
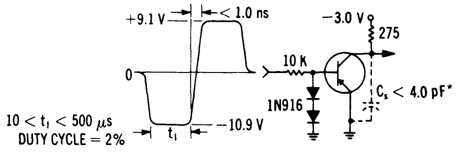


FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

TRANSIENT CHARACTERISTICS

—— T_J = 25°C - - - T_J = 125°C

FIGURE 3 – CAPACITANCE

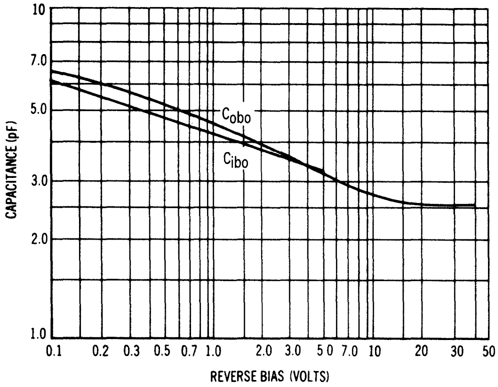


FIGURE 4 – CHARGE DATA

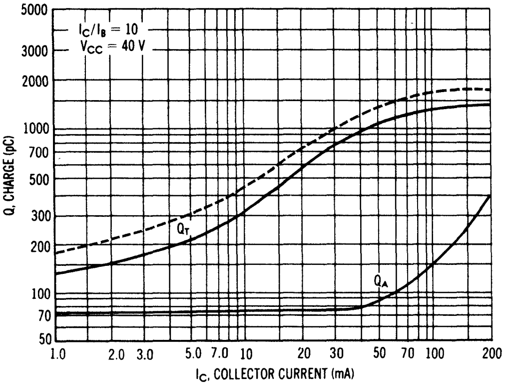


FIGURE 5 — TURN-ON TIME

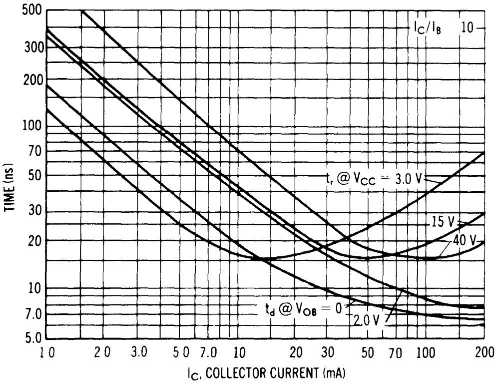
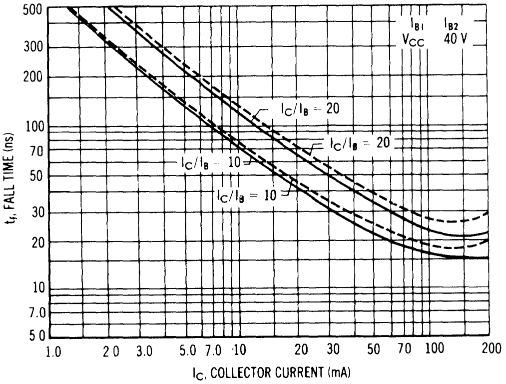


FIGURE 6 — FALL TIME



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE VARIATIONS

V_{CE} = 5.0 Vdc, T_A = 25°C,
Bandwidth = 1.0 Hz

FIGURE 7 —

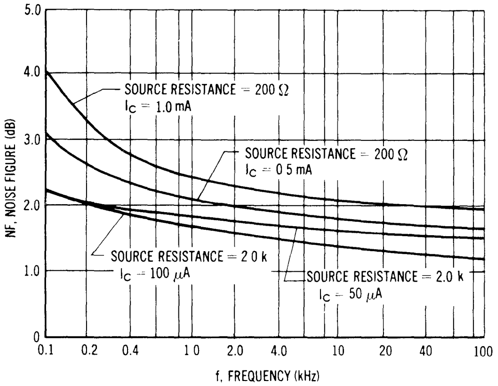
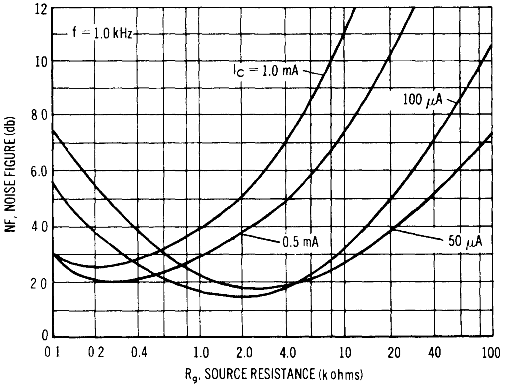


FIGURE 8 —



h PARAMETERS

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

FIGURE 9 — CURRENT GAIN

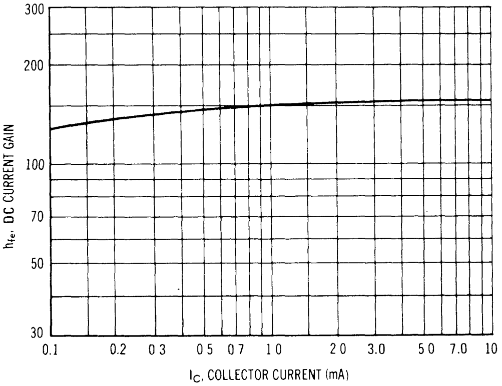


FIGURE 10 — OUTPUT ADMITTANCE

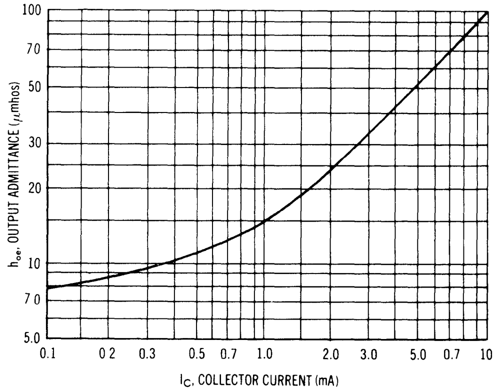


FIGURE 11 — INPUT IMPEDANCE

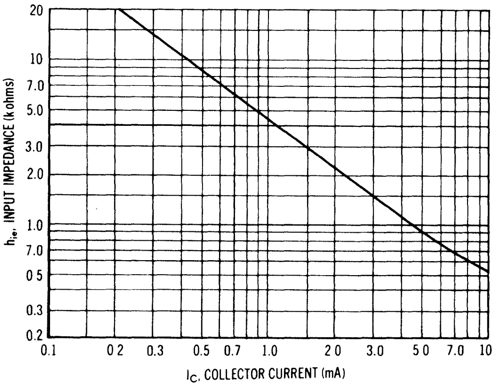
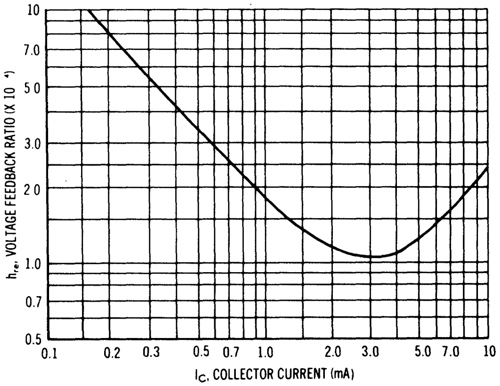


FIGURE 12 — VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 13 — DC CURRENT GAIN

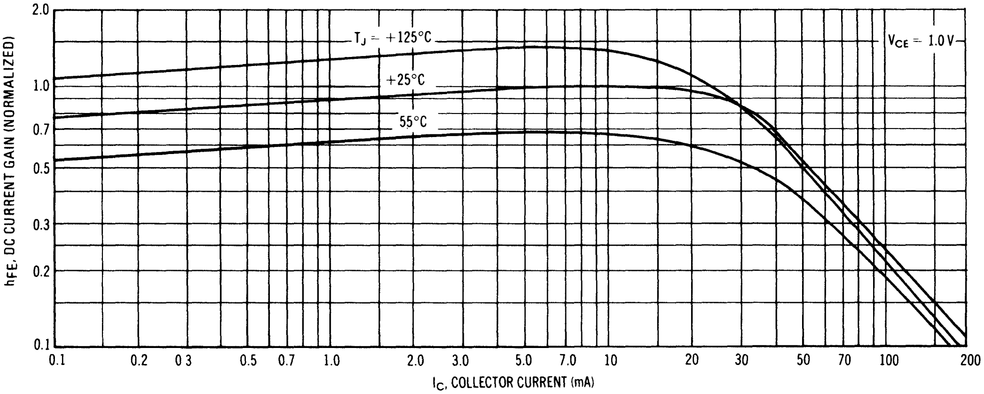


FIGURE 14 — COLLECTOR SATURATION REGION

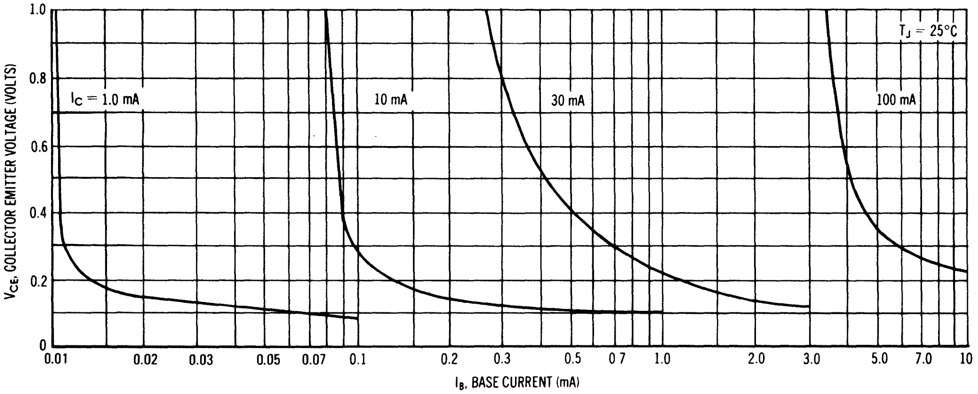


FIGURE 15 — "ON" VOLTAGES

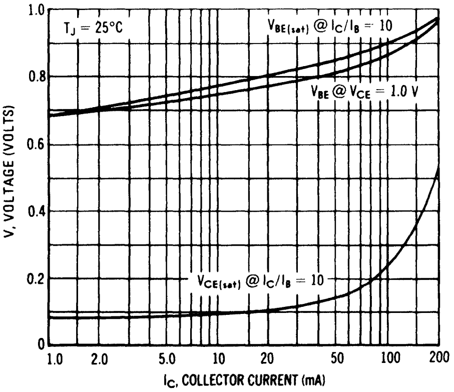
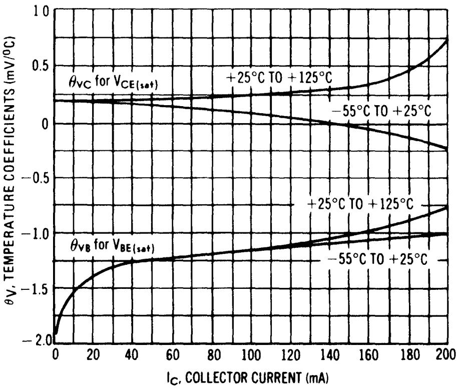
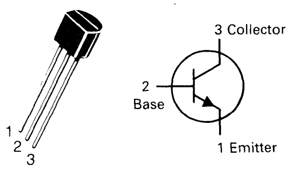


FIGURE 16 — TEMPERATURE COEFFICIENTS



2N4123
2N4124

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4123	2N4124	Unit
Collector-Emitter Voltage	V_{CEO}	30	25	Vdc
Collector-Base Voltage	V_{CBO}	40	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
($I_C = 1.0$ mAdc, $I_E = 0$)	2N4123		30	—	
	2N4124		25	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 10$ μAdc, $I_E = 0$)	2N4123		40	—	
	2N4124		30	—	
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
($I_C = 2.0$ mAdc, $V_{CE} = 1.0$ Vdc)	2N4123		50	150	
	2N4124		120	360	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	2N4123		25	—	
	2N4124		60	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	2N4123		250	—	
	2N4124		300	—	
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 MHz)		C_{obo}	—	4.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)		C_{ibo}	—	8.0	pF
Collector-Base Capacitance ($I_E = 0$, $V_{CB} = 5.0$ V, f = 100 kHz)		C_{cb}	—	4.0	pF
Small-Signal Current Gain		h_{fe}			—
($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	2N4123		50	200	
	2N4124		120	480	

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

Characteristic		Symbol	Min	Max	Unit
Current Gain — High Frequency		$\|h_{fe}\|$			—
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N4123		2.5	—	
	2N4124		3.0	—	
(I_C = 2.0 mAdc, V_{CE} = 10 V, f = 1.0 kHz)	2N4123		50	200	
(I_C = 2.0 mAdc, V_{CE} = 10 V, f = 1.0 kHz)	2N4124		120	480	
Noise Figure		NF			dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm,	2N4123		—	6.0	
f = 1.0 kHz)	2N4124		—	5.0	

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 — CAPACITANCE

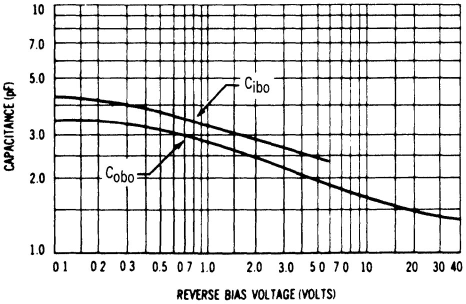
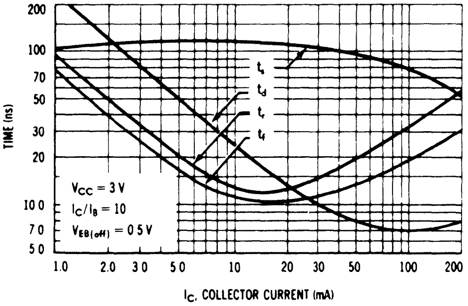


FIGURE 2 — SWITCHING TIMES



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE

(V_{CE} = 5 Vdc, T_A = 25°C)
Bandwidth = 1.0 Hz

FIGURE 3 — FREQUENCY VARIATIONS

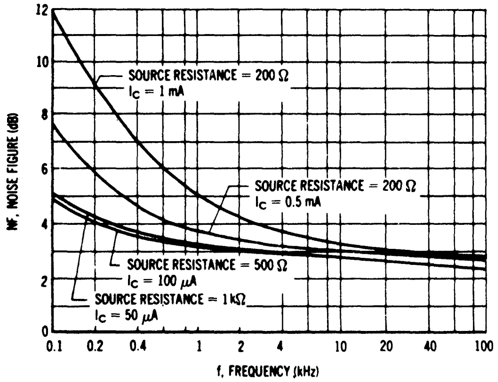
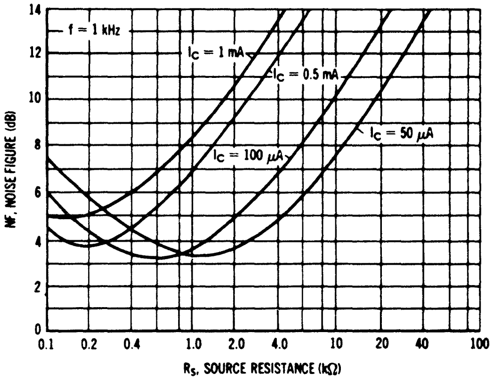


FIGURE 4 — SOURCE RESISTANCE



h PARAMETERS

V_{CE} = 10 V, f = 1 kHz, T_A = 25°C

FIGURE 5 — CURRENT GAIN

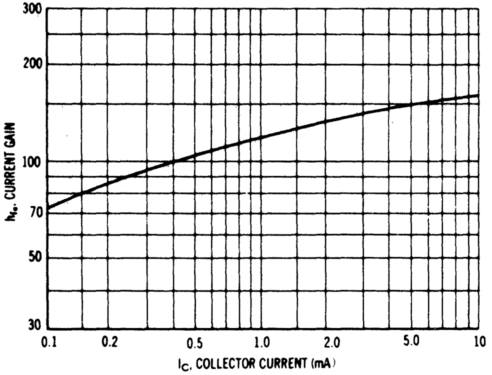


FIGURE 6 — OUTPUT ADMITTANCE

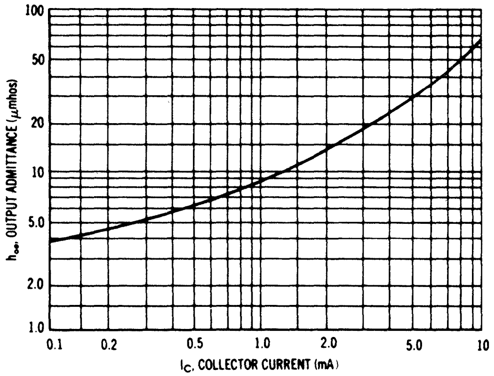


FIGURE 7 — INPUT IMPEDANCE

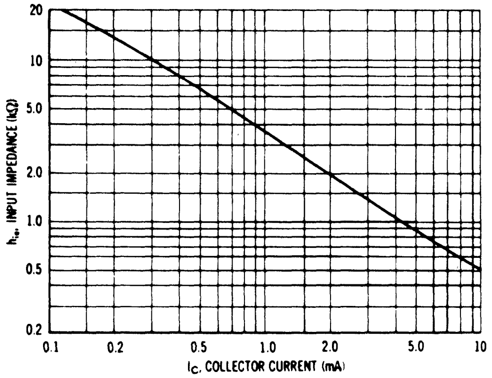
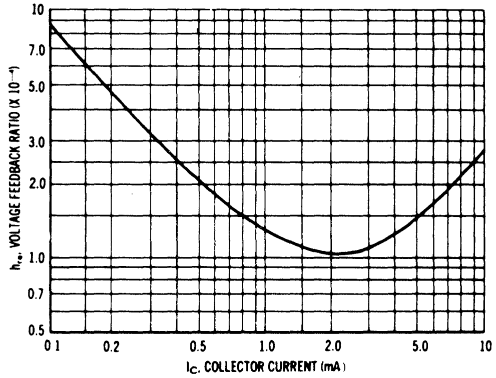


FIGURE 8 — VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 9 — DC CURRENT GAIN

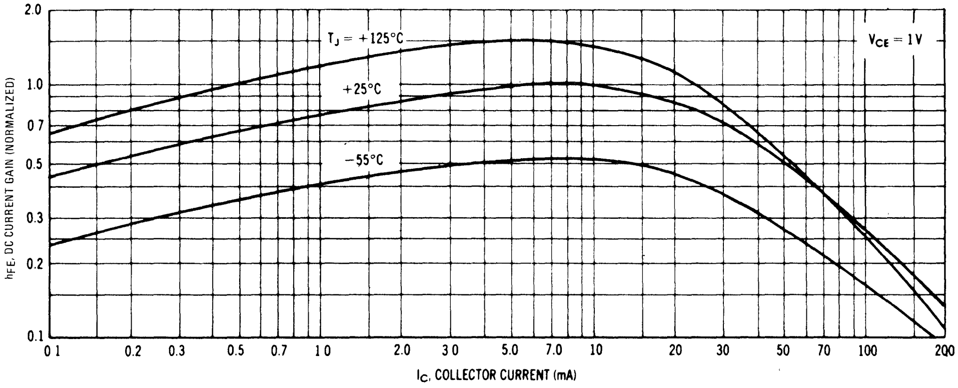


FIGURE 10 — COLLECTOR SATURATION REGION

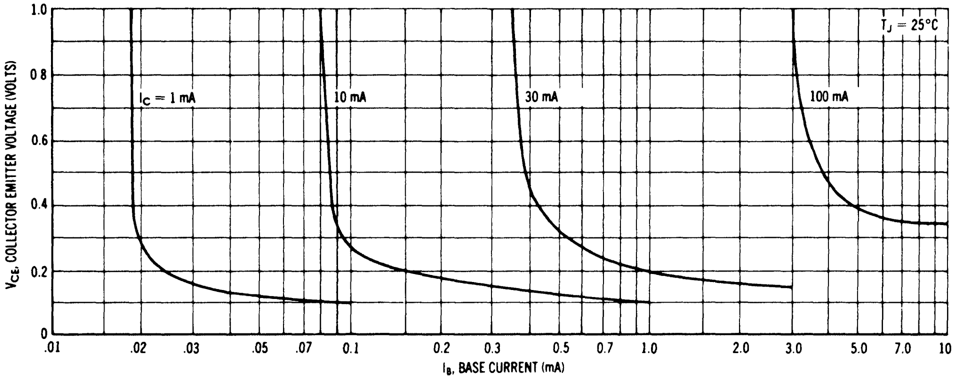


FIGURE 11 — "ON" VOLTAGES

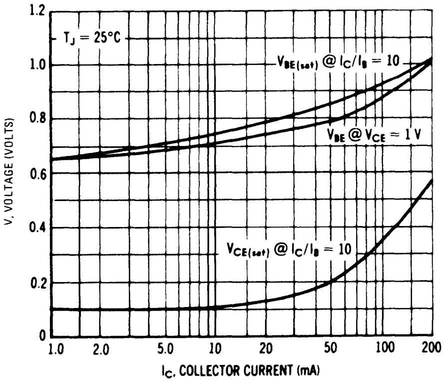
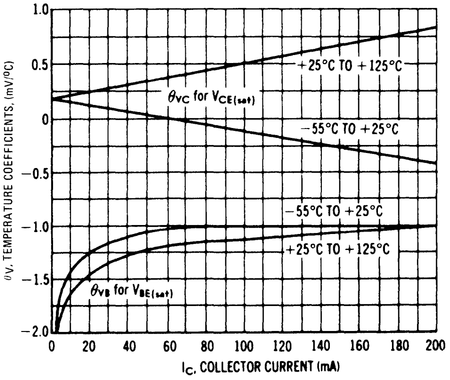
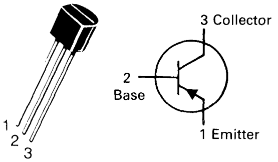


FIGURE 12 — TEMPERATURE COEFFICIENTS



2N4125
2N4126

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4125	2N4126	Unit
Collector-Emitter Voltage	V_{CEO}	30	25	Vdc
Collector-Base Voltage	V_{CBO}	30	25	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_E = 0) 2N4125	$V_{(BR)CEO}$	30	—	Vdc
2N4126		25	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0) 2N4125	$V_{(BR)CBO}$	30	—	Vdc
2N4126		25	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain(1)	h_{FE}			—
(I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc) 2N4125		50	150	
2N4126		120	360	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) 2N4125		25	—	
2N4126		60	—	
Collector-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product	f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) 2N4125		200	—	
2N4126		250	—	
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	10	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	4.5	pF
Small-Signal Current Gain	h_{fe}			—
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N4125		50	200	
2N4126		120	480	
Current Gain — High Frequency	$\lvert h_{fe} \rvert$			—
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) 2N4125		2.0	—	
2N4126		2.5	—	
Noise Figure	NF			dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_G = 1.0 k ohm, Noise Bandwidth = 10 Hz to 15.7 kHz) 2N4125		—	5.0	
2N4126		—	4.0	

(1) Pulse Test: Pulse Width ≤ 300 μsec, Duty Cycle = 2.0%.

FIGURE 1 — CAPACITANCE

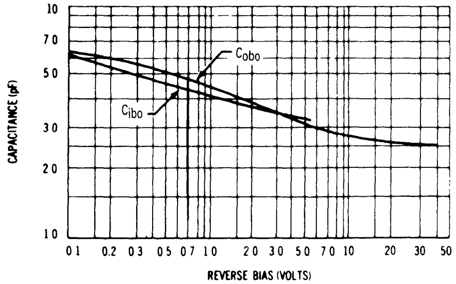
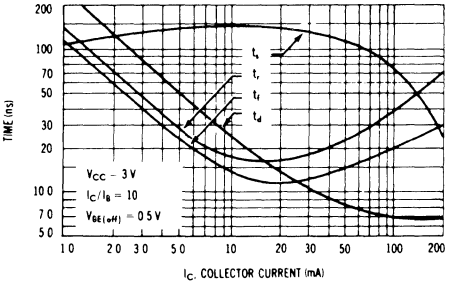


FIGURE 2 — SWITCHING TIMES



AUDIO SMALL SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 5.0 Vdc, T_A = 25°C,
Bandwidth = 1.0 Hz

FIGURE 3 — FREQUENCY VARIATIONS

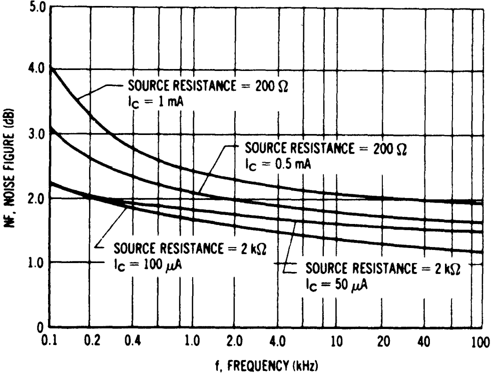
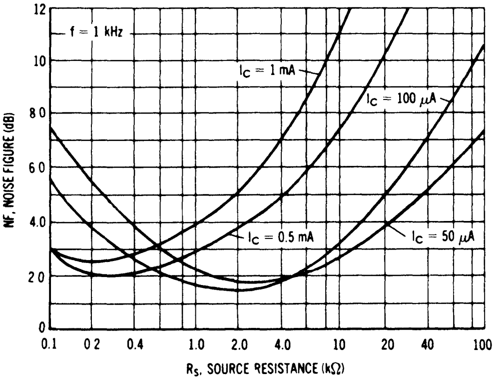


FIGURE 4 — SOURCE RESISTANCE



h PARAMETERS

V_{CE} = 10 V, f = 1 kHz, T_A = 25°C

FIGURE 5 — CURRENT GAIN

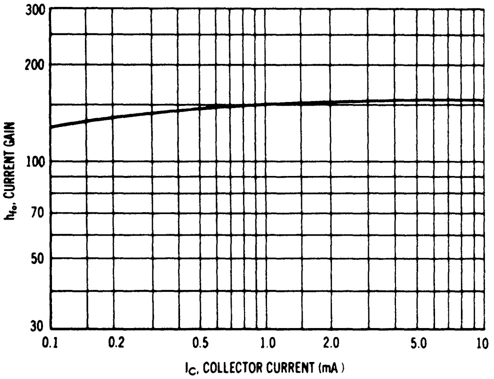


FIGURE 6 — OUTPUT ADMITTANCE

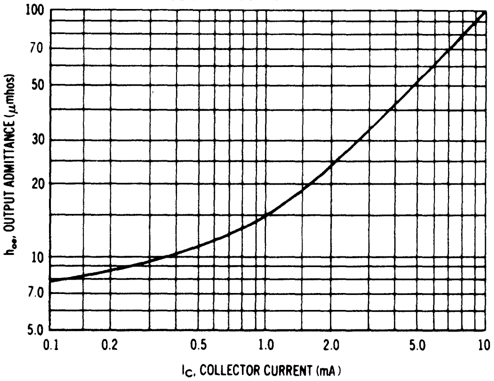


FIGURE 7 — INPUT IMPEDANCE

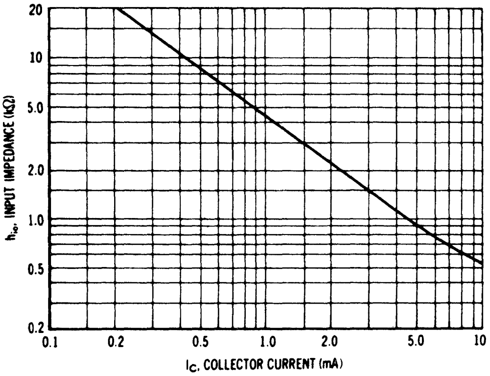
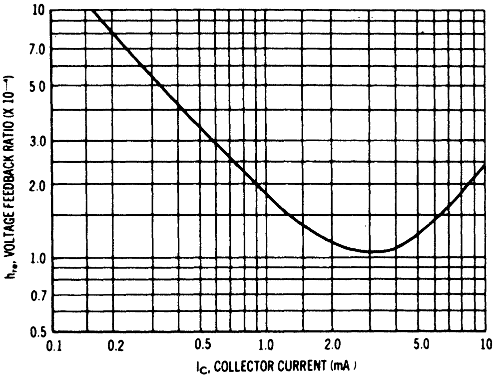


FIGURE 8 — VOLTAGE FEEDBACK RATIO



STATIC CHARACTERISTICS

FIGURE 9 — DC CURRENT GAIN

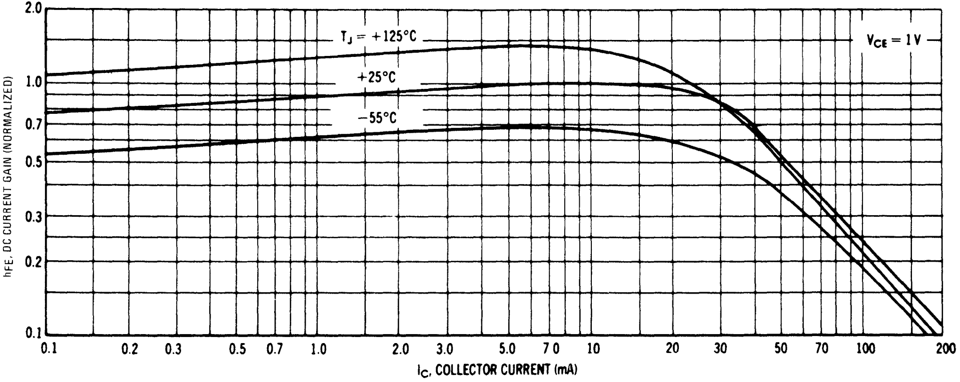


FIGURE 10 — COLLECTOR SATURATION REGION

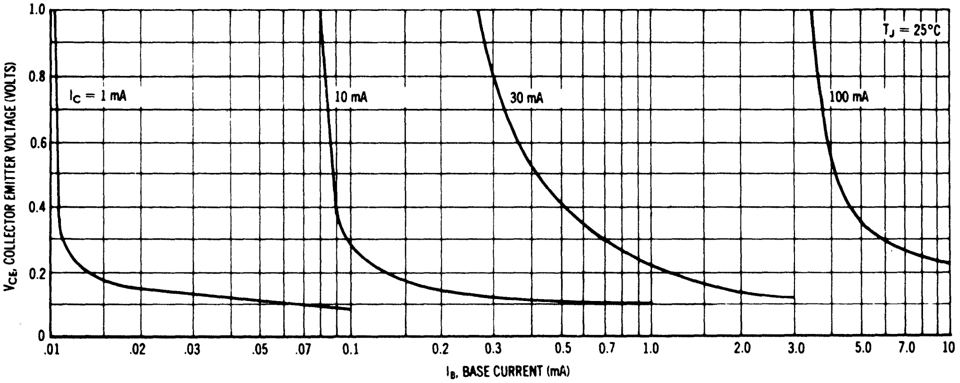


FIGURE 11 — "ON" VOLTAGES

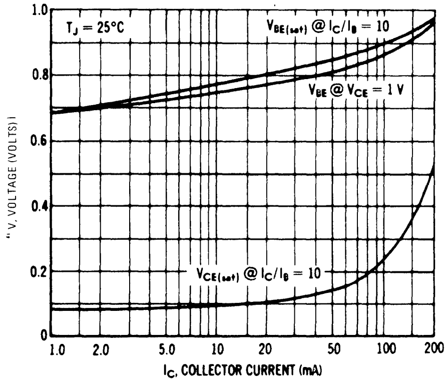
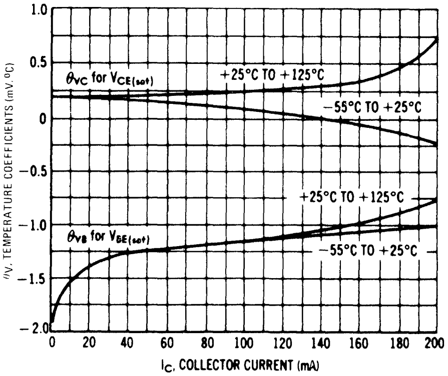
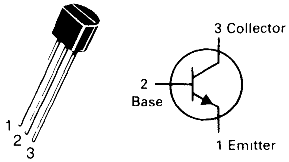


FIGURE 12 — TEMPERATURE COEFFICIENTS



2N4264
2N4265

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Characteristic	Symbol	2N4264	2N4265	Unit
Collector-Emitter Voltage	V_{CEO}	15	12	Vdc
Collector-Base Voltage	V_{CBO}	30		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_E = 0) 2N4264		15	—	
2N4265		12	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current	I_{BEV}			μAdc
(V_{CE} = 12 Vdc, $V_{EB(off)}$ = 0.25 Vdc)		—	0.1	
(V_{CE} = 12 Vdc, $V_{EB(off)}$ = 0.25 Vdc, T_A = 100°C)		—	10	
Collector Cutoff Current (V_{CE} = 12 Vdc, $V_{EB(off)}$ = 0.25 Vdc)	I_{CEX}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) 2N4264		25	—	
2N4265		30	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc) 2N4264		40	160	
2N4265		100	400	
(I_C = 30 mAdc, V_{CE} = 1.0 Vdc) 2N4264		40	—	
2N4265		90	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)(1) 2N4264		30	—	
2N4265		55	—	
(I_C = 200 mAdc, V_{CE} = 1.0 Vdc)(1) 2N4264		20	—	
2N4265		35	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.22	
(I_C = 100 mAdc, I_B = 10 mAdc)(1)		—	0.35	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		0.65	0.8	
(I_C = 100 mAdc, I_B = 10 mAdc)(1)		0.75	0.95	

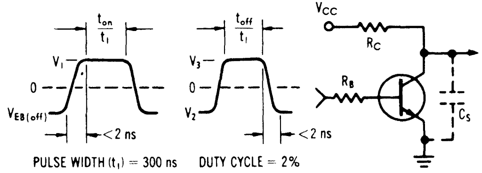
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	300	—	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	4.0	pF
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 10 Vdc, $V_{EB(off)}$ = 2.0 Vdc, I_C = 100 mAdc, I_{B1} = 10 mAdc) (Fig. 1, Test Condition C)	t_d	—	8.0	ns
Rise Time		t_r	—	15	ns
Storage Time	V_{CC} = 10 Vdc, (I_C = 10 mAdc, for t_s) (I_C = 100 mA for t_f) I_{B1} = I_{B2} = 10 mAdc) (Fig. 1, Test Condition C)	t_s	—	20	ns
Fall Time		t_f	—	15	ns
Turn-On Time	(V_{CC} = 3.0 Vdc, $V_{EB(off)}$ = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc) (Fig. 1, Test Condition A)	t_{on}	—	25	ns
Turn-Off Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc) (Fig. 1, Test Condition A)	t_{off}	—	35	ns
Storage Time	(V_{CC} = 10 Vdc, I_C = 10 mA I_{B1} = I_{B2} = 10 mAdc) (Fig. 1, Test Condition B)	t_s	—	20	ns
Total Control Charge	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_B = mAdc) (Fig. 3, Test Condition A)	Q_T	—	80	pC

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 — SWITCHING TIME EQUIVALENT TEST CIRCUIT

TEST CONDITION	I_C	V_{CC}	R_B	R_C	$C_{S(max)}$	$V_{EB(off)}$	V_1	V_2	V_3
	mA	V	Ω	Ω	pF	V	V	V	V
A	10	3	3300	270	4	−1.5	10.55	−4.15	10.70
B	10	10	560	960	4	—	—	−4.65	6.55
C	100	10	560	96	12	−2.0	6.35	−4.65	6.55



CURRENT GAIN CHARACTERISTICS

FIGURE 2 — MINIMUM CURRENT GAIN

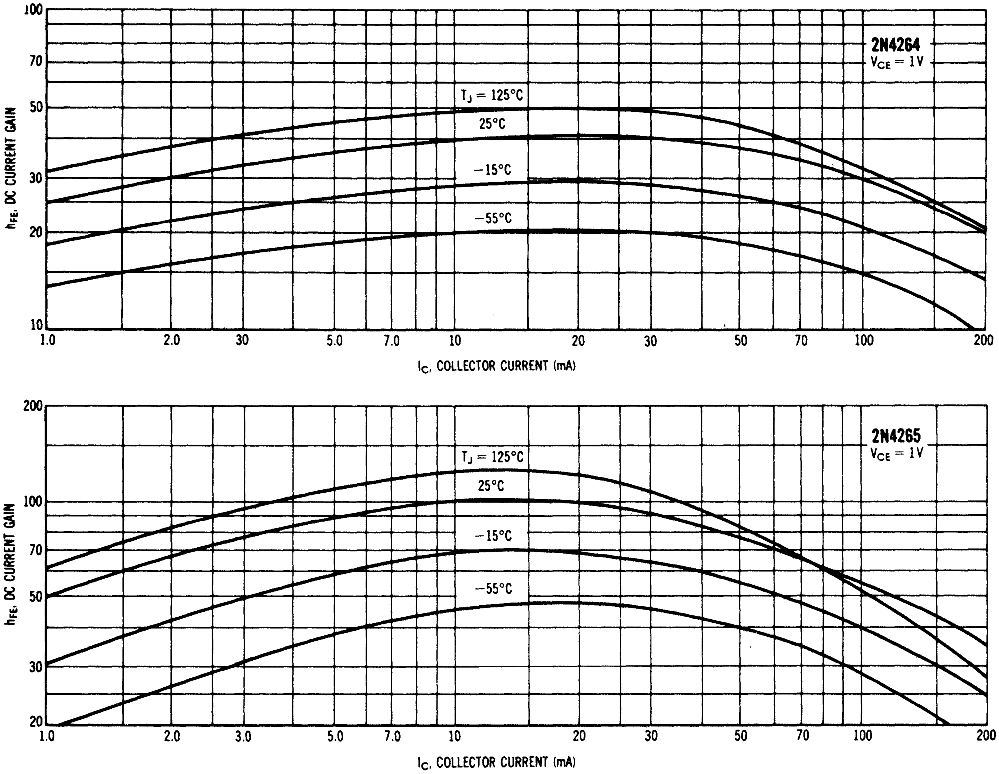


FIGURE 3 — Q_T TEST CIRCUIT

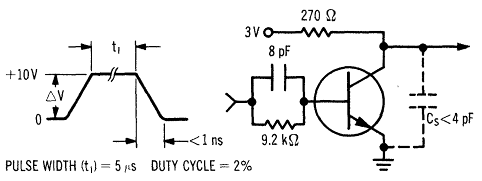
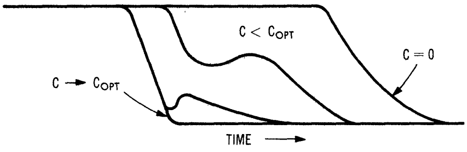


FIGURE 4 — TURN-OFF WAVEFORM



NOTE 1

When a transistor is held in a conductive state by a base current, I_B, a charge, Q_S, is developed or "stored" in the transistor. Q_S may be written: $Q_S = Q_I + Q_V + Q_X$.

Q_I is the charge required to develop the required collector current. This charge is primarily a function of alpha cutoff frequency. Q_V is the charge required to charge the collector-base feedback capacity. Q_X is excess charge resulting from overdrive, i.e., operation in saturation.

The charge required to turn a transistor "on" to the edge of saturation is the sum of Q_I and Q_V which is defined as the active region charge, Q_A. $Q_A = I_{BI}t_r$ when the transistor is driven by a constant current step (I_{BI}) and $I_{BI} << \frac{I_C}{h_{FE}}$.

If I_B were suddenly removed, the transistor would continue to conduct until Q_S is removed from the active regions through an external path or through internal recombination. Since the internal recombination time is long compared to the ultimate capability of a transistor, a charge, Q_T, of opposite polarity, equal in magnitude, can be stored on an external capacitor, C, to neutralize the internal charge and considerably reduce the turn-off time of the transistor. Figure 3 shows the test circuit and Figure 4 the turn-off waveform. Given Q_T from Figure 13, the external C for worst-case turn-off in any circuit is: $C = Q_T/\triangle V$, where $\triangle V$ is defined in Figure 3.

"ON" CONDITION CHARACTERISTICS

FIGURE 5 — COLLECTOR SATURATION REGION

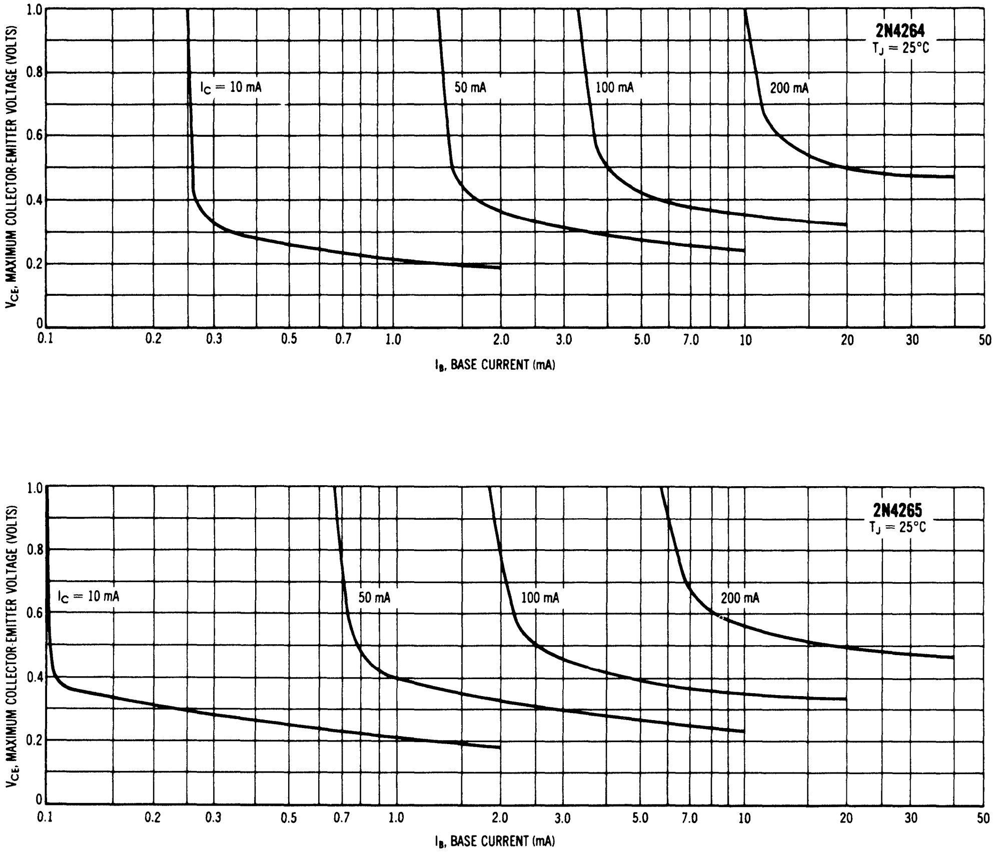


FIGURE 6 — SATURATION VOLTAGE LIMITS

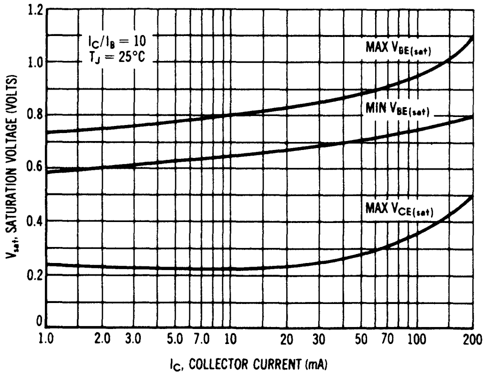
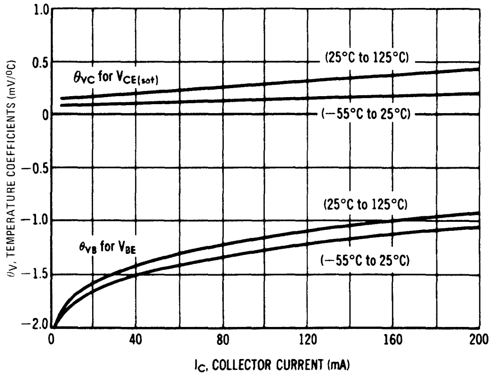


FIGURE 7 — TEMPERATURE COEFFICIENTS



DYNAMIC CHARACTERISTICS

FIGURE 8 — DELAY TIME

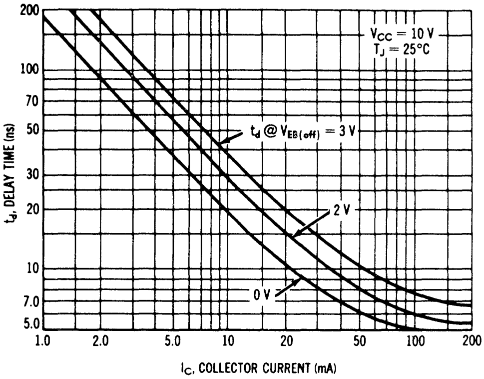


FIGURE 9 — RISE TIME

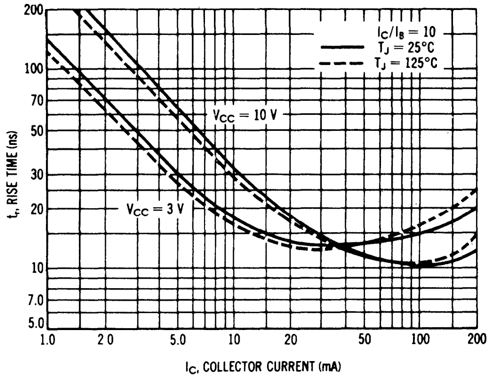


FIGURE 10 — STORAGE TIME

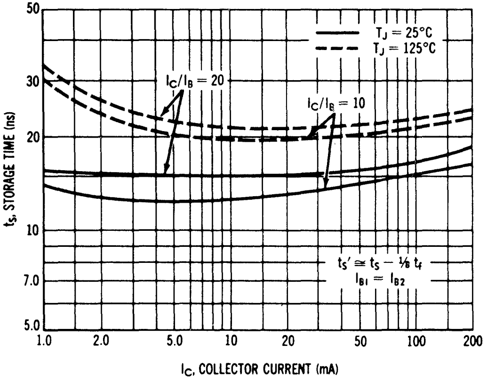


FIGURE 11 — FALL TIME

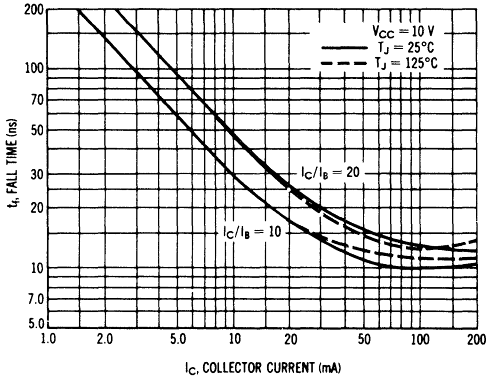


FIGURE 12 — JUNCTION CAPACITANCE

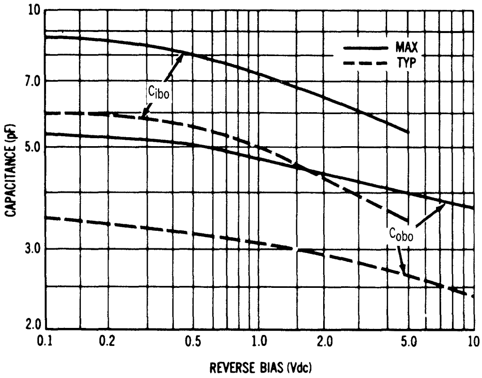
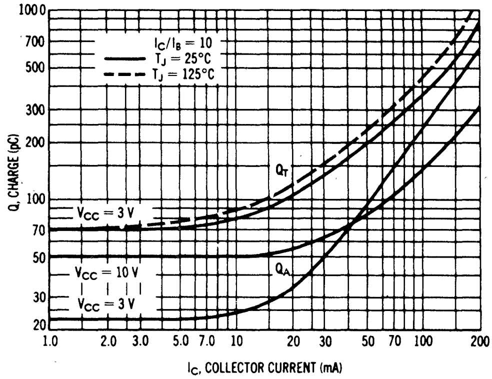
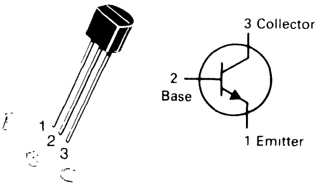


FIGURE 13 — MAXIMUM CHARGE DATA



2N4400
2N4401

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)		I_{BEV}	—	0.1	μAdc
Collector Cutoff Current (V_{CE} = 35 Vdc, V_{EB} = 0.4 Vdc)		I_{CEX}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	2N4401		20	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N4400 2N4401		20 40	— —	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N4400 2N4401		40 80	— —	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	2N4400 2N4401		50 100	150 300	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	2N4400 2N4401		20 40	— —	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	 — —	 0.4 0.75	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$	 0.75 —	 0.95 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	 2N4400 2N4401	f_T	 200 250	 — —	MHz
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{cb}	—	6.5	pF

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

Characteristic		Symbol	Min	Max	Unit
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{eb}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N4400 2N4401	h_{ie}	0.5 1.0	7.5 15	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	0.1	8.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N4400 2N4401	h_{fe}	20 40	250 500	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	30	μmhos

SWITCHING CHARACTERISTICS

		Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 30 Vdc, V_{EB} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	20	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	30	ns

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

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 — TURN-ON TIME

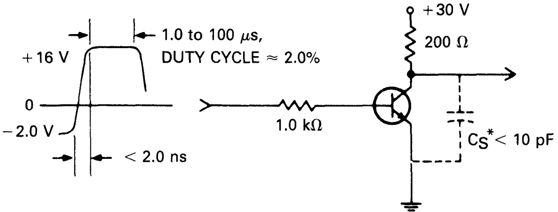
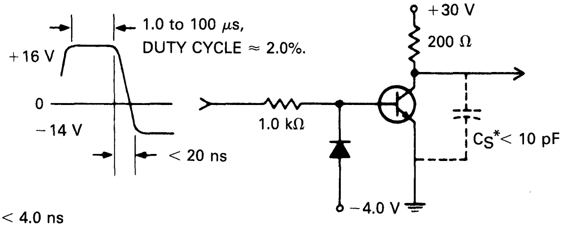


FIGURE 2 — TURN-OFF TIME



Scope rise time < 4.0 ns

*Total shunt capacitance of test jig connectors, and oscilloscope

TRANSIENT CHARACTERISTICS

—— 25°C – – – 100°C

FIGURE 3 — CAPACITANCES

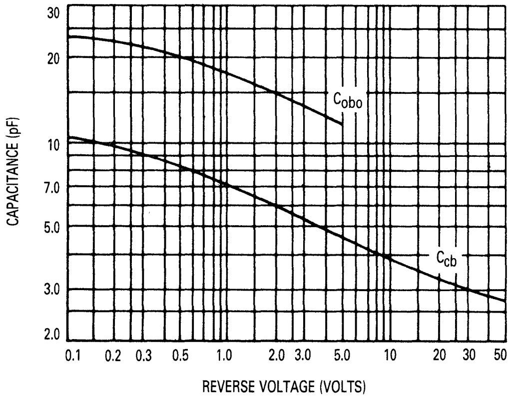


FIGURE 4 — CHARGE DATA

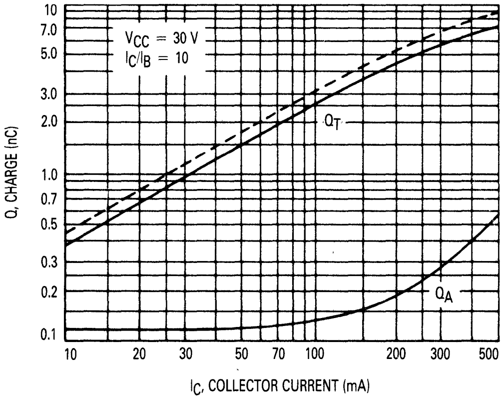


FIGURE 5 — TURN-ON TIME

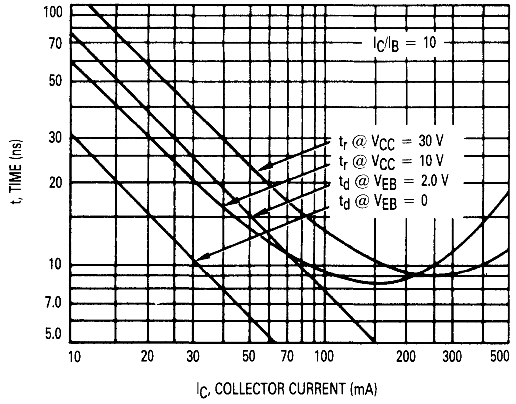


FIGURE 6 — RISE AND FALL TIMES

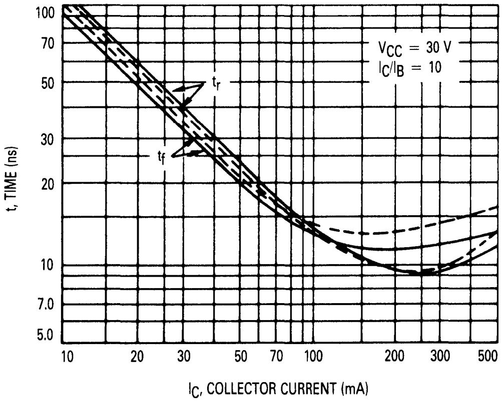


FIGURE 7 — STORAGE TIME

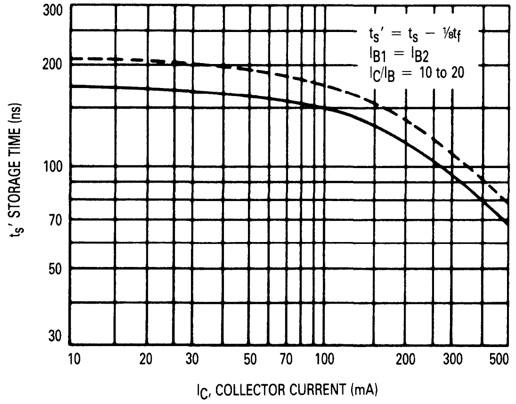
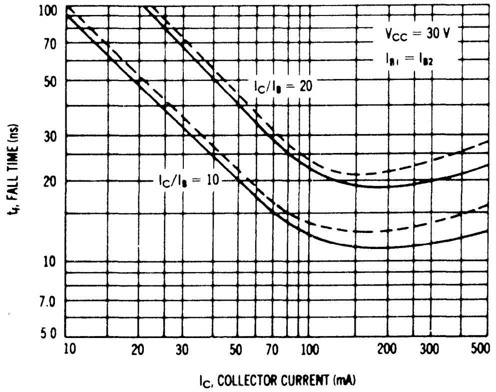


FIGURE 8 — FALL TIME



SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

Bandwidth = 1.0 Hz

FIGURE 9 — FREQUENCY EFFECTS

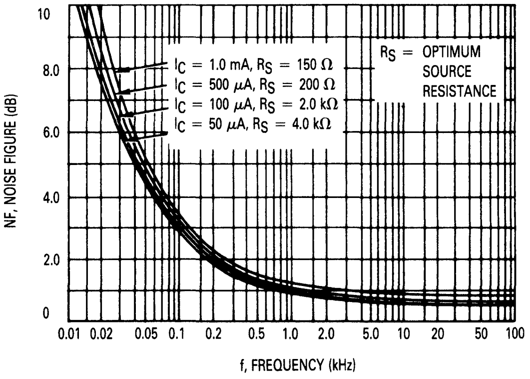
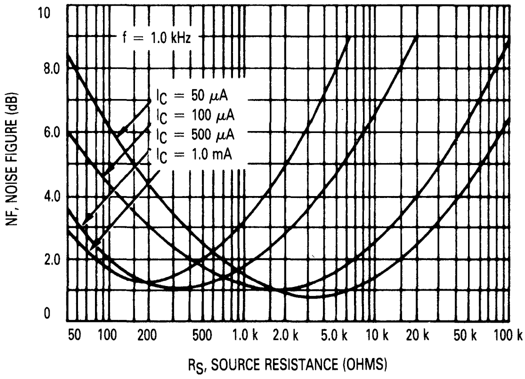


FIGURE 10 — SOURCE RESISTANCE EFFECTS



h PARAMETERS

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

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from both the 2N4400 and 2N4401 lines, and the same units were used to develop the correspondingly numbered curves on each graph.

FIGURE 11 — CURRENT GAIN

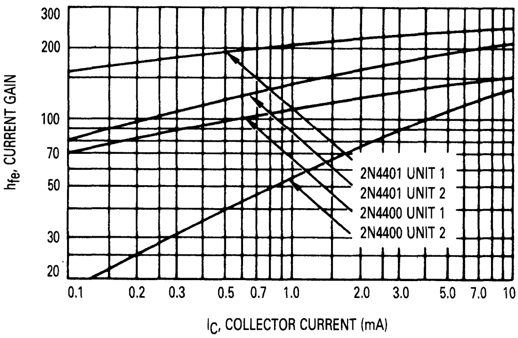


FIGURE 12 — INPUT IMPEDANCE

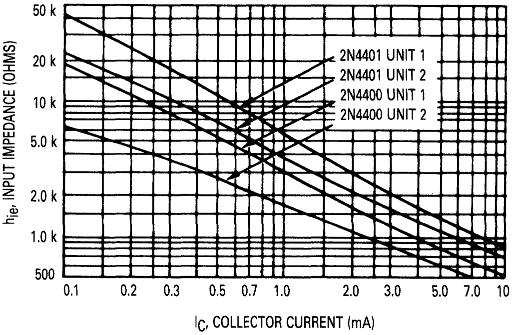


FIGURE 13 — VOLTAGE FEEDBACK RATIO

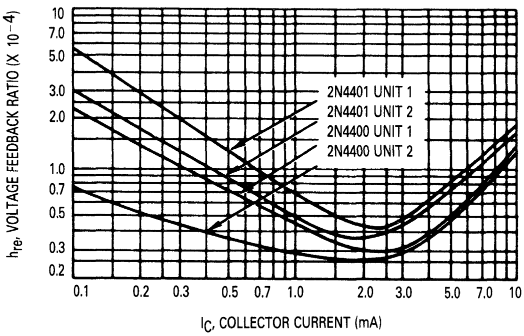
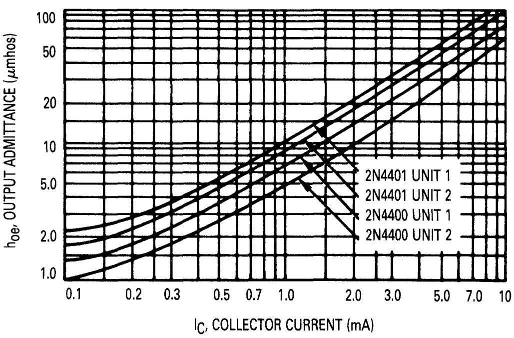


FIGURE 14 — OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN

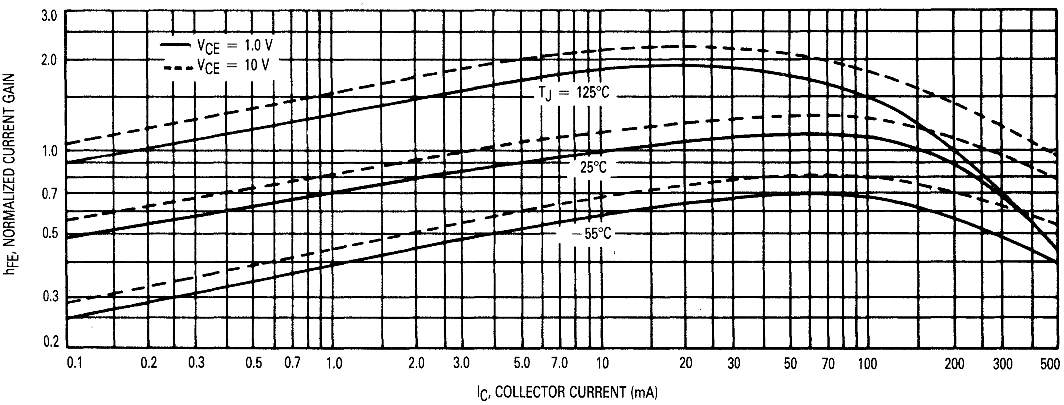


FIGURE 16 — COLLECTOR SATURATION REGION

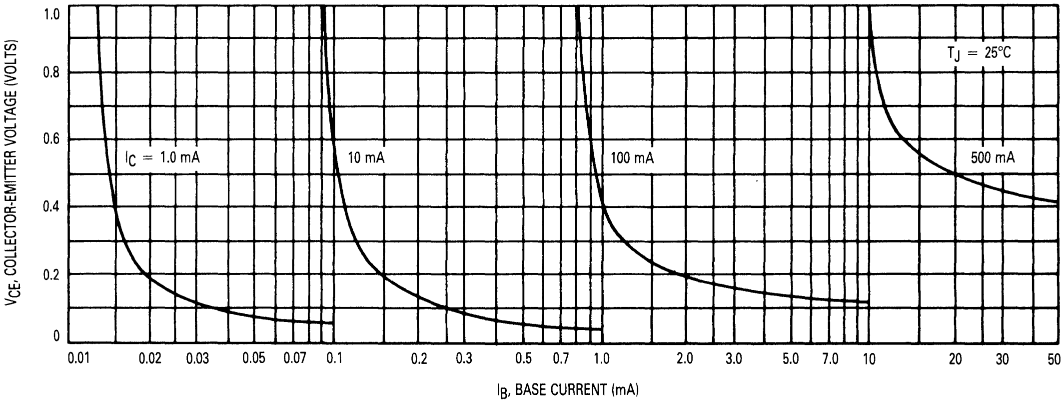


FIGURE 17 — "ON" VOLTAGES

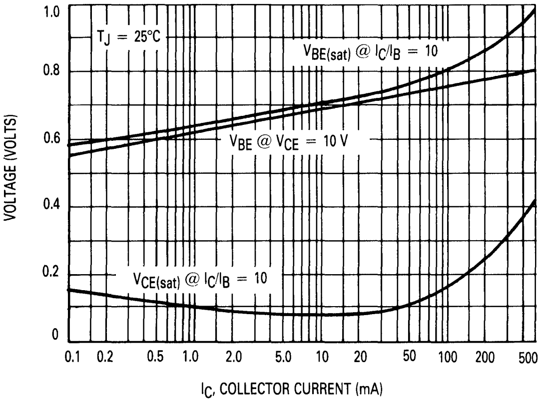
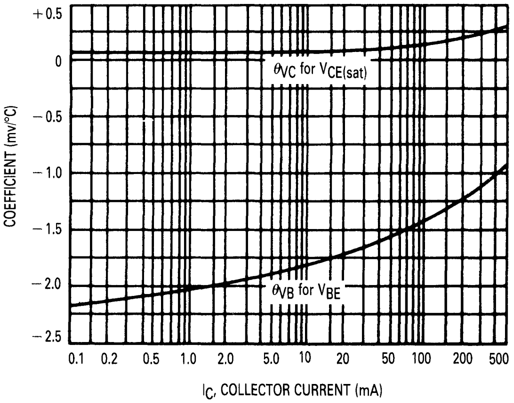
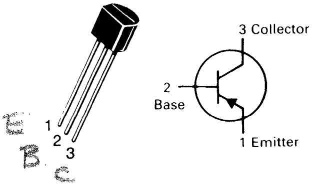


FIGURE 18 — TEMPERATURE COEFFICIENTS



2N4402
2N4403

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current ($V_{CE} = 35$ Vdc, $V_{BE} = 0.4$ Vdc)		I_{BEV}	—	0.1	μAdc
Collector Cutoff Current ($V_{CE} = 35$ Vdc, $V_{BE} = 0.4$ Vdc)		I_{CEX}	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	2N4403		30	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	2N4402 2N4403		30 60	— —	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	2N4402 2N4403		50 100	— —	
($I_C = 150$ mAdc, $V_{CE} = 2.0$ Vdc)(1)	2N4402 2N4403		50 100	150 300	
($I_C = 500$ mAdc, $V_{CE} = 2.0$ Vdc)(1)	Both		20	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)		$V_{CE(sat)}$	 — —	 0.4 0.75	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)		$V_{BE(sat)}$	 0.75 —	 0.95 1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	 2N4402 2N4403	f_T	 150 200	 — —	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)		C_{cb}	—	8.5	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)		C_{eb}	—	30	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	 2N4402 2N4403	h_{ie}	 750 1.5k	 7.5k 15k	ohms

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

Characteristic		Symbol	Min	Max	Unit
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	0.1	8.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}			—
	2N4402		30	250	
	2N4403		60	500	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	100	µmhos

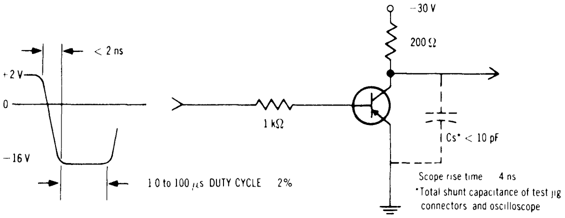
SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 30 Vdc, V_{BE} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	20	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	30	ns

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

SWITCHING TIME EQUIVALENT TEST CIRCUIT

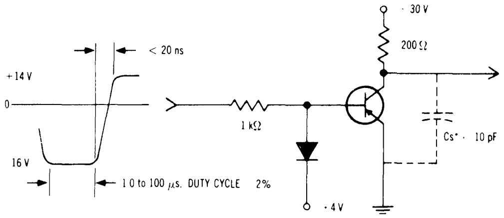
FIGURE 1 — TURN-ON TIME



Scope rise time 4 ns

*Total shunt capacitance of test jig connectors and oscilloscope

FIGURE 2 — TURN-OFF TIME



TRANSIENT CHARACTERISTICS

—— 25°C ——— 100°C

FIGURE 3 — CAPACITANCES

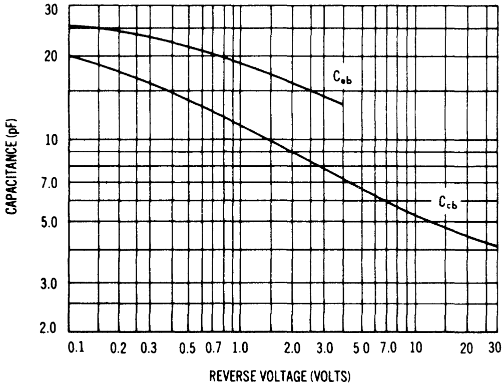


FIGURE 4 — CHARGE DATA

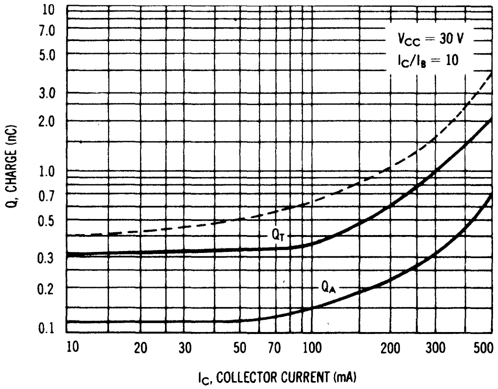


FIGURE 5 — TURN-ON TIME

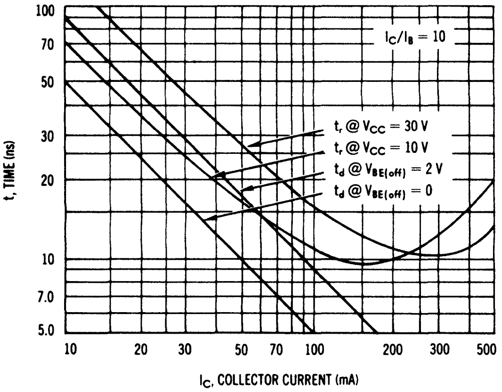


FIGURE 6 — RISE TIME

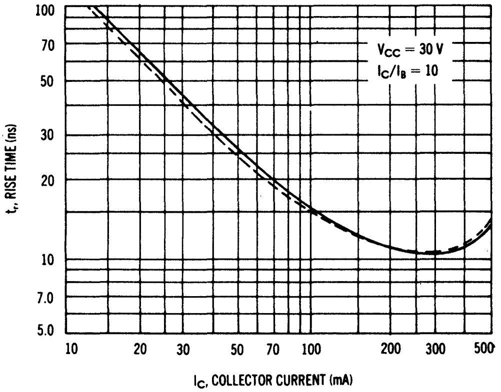
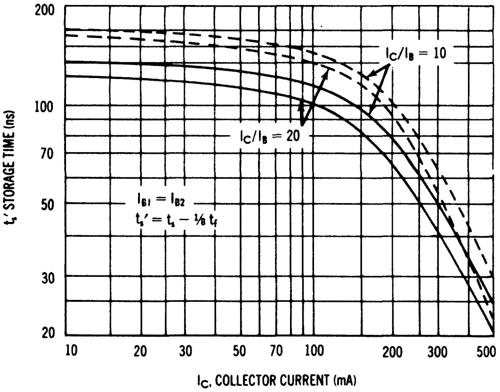


FIGURE 7 — STORAGE TIME



SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

$V_{CE} = 10$ Vdc, $T_A = 25^\circ C$
Bandwidth = 1.0 Hz

FIGURE 8 — FREQUENCY EFFECTS

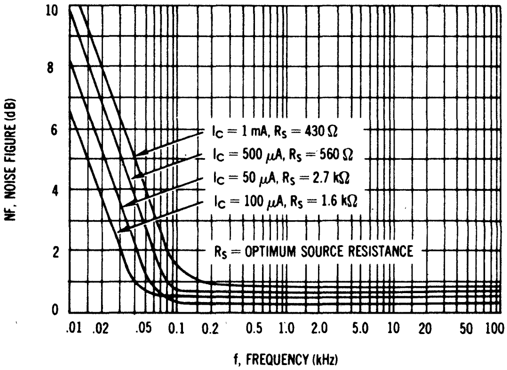
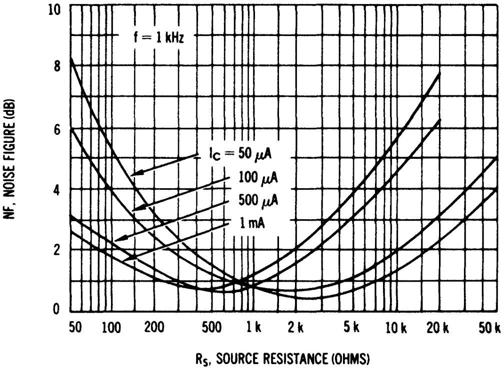


FIGURE 9 — SOURCE RESISTANCE EFFECTS



h PARAMETERS

V_{CE} = 10 Vdc, f = 1 kHz, T_A = 25°C

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected from both the 2N4402 and 2N4403 lines, and the same units were used to develop the correspondingly-numbered curves on each graph.

FIGURE 10 — CURRENT GAIN

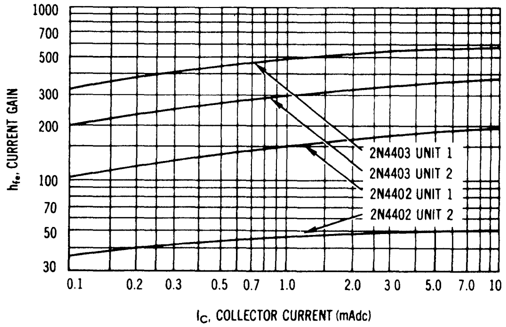


FIGURE 11 — INPUT IMPEDANCE

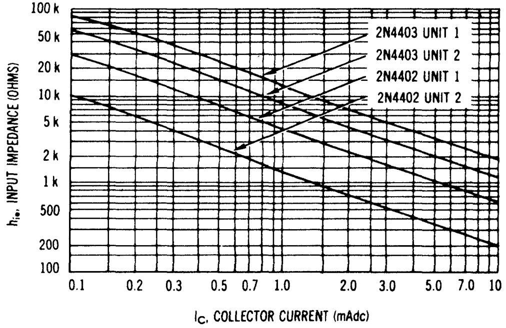


FIGURE 12 — VOLTAGE FEEDBACK RATIO

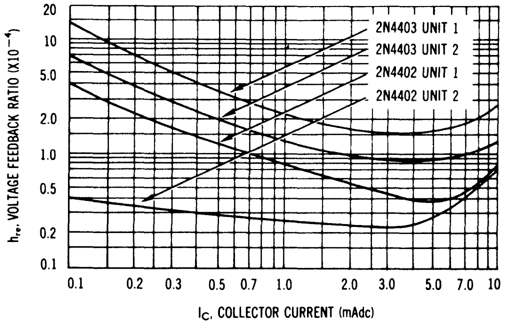
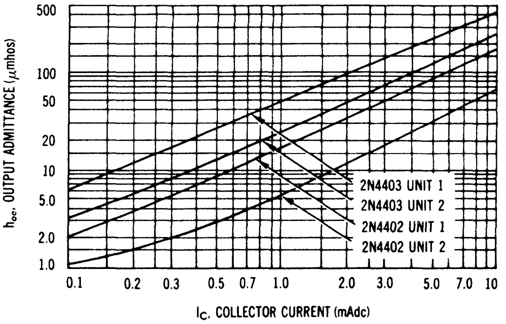


FIGURE 13 — OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 14 — DC CURRENT GAIN

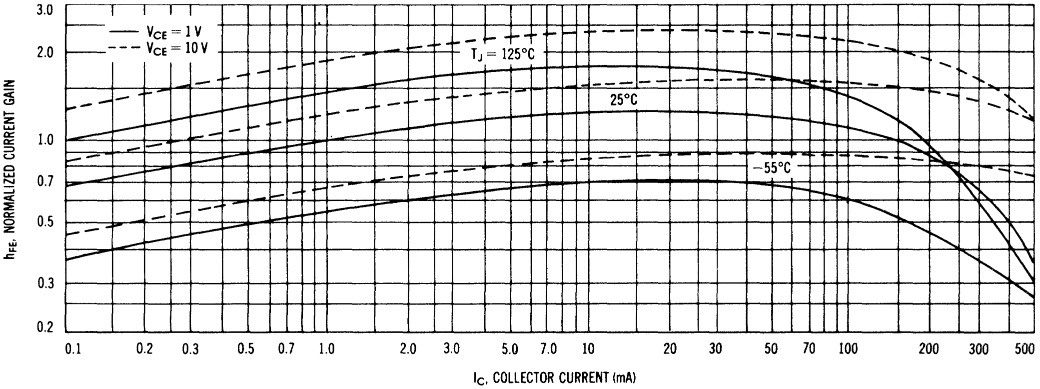


FIGURE 15 — COLLECTOR SATURATION REGION

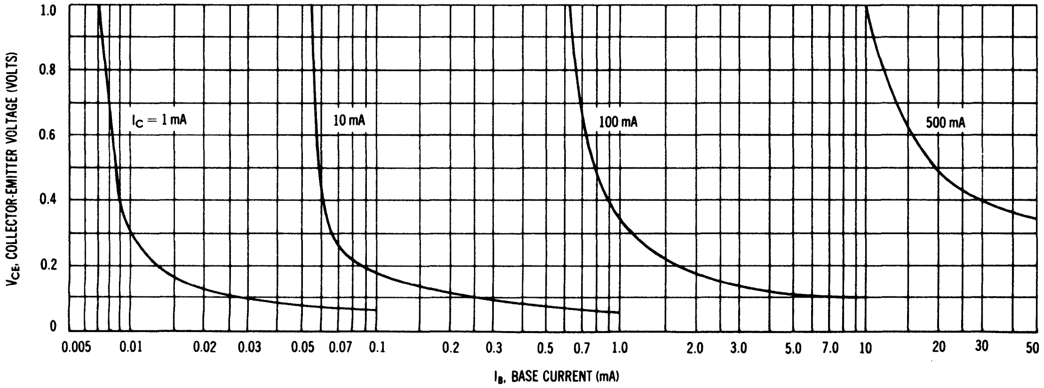


FIGURE 16 — "ON" VOLTAGES

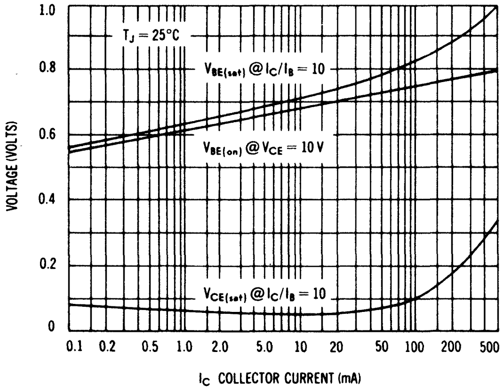
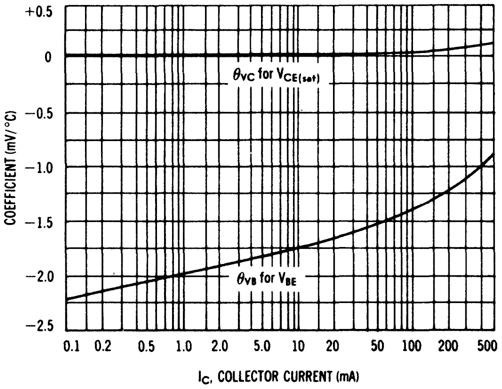
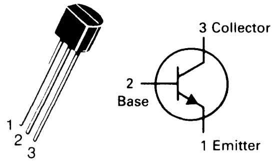


FIGURE 17 — TEMPERATURE COEFFICIENTS



2N4409
2N4410

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N5550 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N4409	2N4410	Unit
Collector-Emitter Voltage	V_{CEO}	50	80	Vdc
Collector-Base Voltage	V_{CBO}	80	120	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	250		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

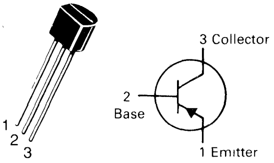
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 2N4409 2N4410	$V_{(BR)CEO}$	50 80	 — —	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 500$ µAdc, $V_{BE} = 5.0$ Vdc, $R_{BE} = 8.2$ kohms)	 2N4409 2N4410	$V_{(BR)CEX}$	 80 120	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ µAdc, $I_E = 0$)	 2N4409 2N4410	$V_{(BR)CBO}$	 80 120	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ µAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_A = 100°C$) ($V_{CB} = 100$ Vdc, $I_E = 0$) ($V_{CB} = 100$ Vdc, $I_E = 0$, $T_A = 100°C$)	 2N4409 2N4409 2N4410 2N4410	I_{CBO}	 — — — —	 0.01 1.0 0.01 1.0	µAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	µAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	60 60	— 400	—
Collector-Emitter Saturation Voltage ($I_C = 1.0$ mAdc, $I_B = 0.1$ mAdc)		$V_{CE(sat)}$	—	0.2	Vdc
Base-Emitter Saturation Voltage ($I_C = 1.0$ mAdc, $I_B = 0.1$ mAdc)		$V_{BE(sat)}$	—	0.8	Vdc
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 30 MHz)		f_T	60	300	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz, emitter guarded)		C_{cb}	—	12	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz, collector guarded)		C_{eb}	—	50	pF

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

2N5086
2N5087

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	50	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$) ($V_{CB} = 35$ Vdc, $I_E = 0$)		I_{CBO}	 — —	 10 50	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc)	 2N5086 2N5087	h_{FE}	 150 250	 500 800	—
($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	2N5086 2N5087		150 250	— —	
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)(2)	2N5086 2N5087		150 250	— —	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 500$ μAdc, $V_{CE} = 5.0$ Vdc, f = 20 MHz)		f_T	40	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)		C_{cb}	—	4.0	pF
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	 2N5086 2N5087	h_{fe}	 150 250	 600 900	—
Noise Figure ($I_C = 20$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ k ohms, f = 10 Hz to 15.7 kHz)	 2N5086 2N5087	NF	 — —	 3.0 2.0	dB
($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 3.0$ k ohms, f = 1.0 kHz)	2N5086 2N5087		— —	3.0 2.0	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL NOISE CHARACTERISTICS
$(V_{CE} = 5.0\ \text{Vdc}, T_A = 25^{\circ}\text{C})$

FIGURE 1 — NOISE VOLTAGE

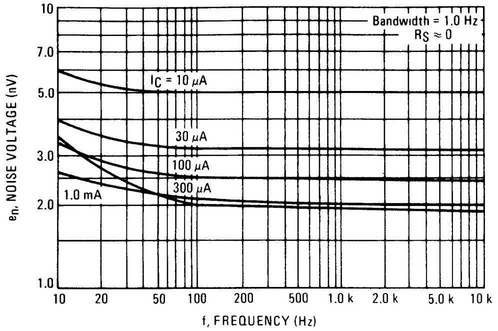
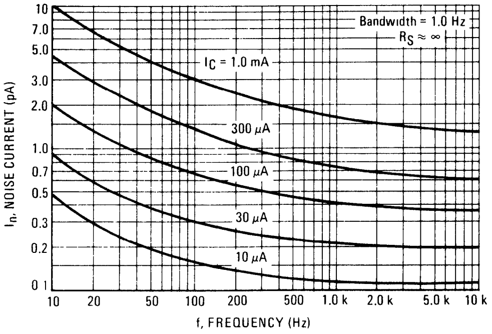


FIGURE 2 — NOISE CURRENT



NOISE FIGURE CONTOURS
$(V_{CE} = 5.0\ \text{Vdc}, T_A = 25^{\circ}\text{C})$

FIGURE 3 — NARROW BAND, 100 Hz

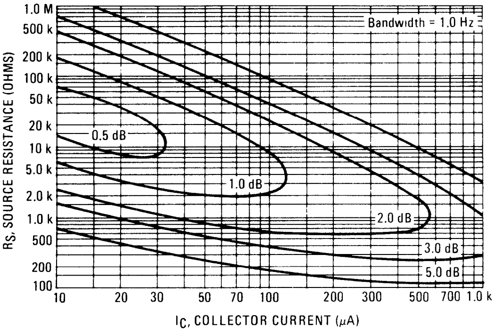


FIGURE 4 — NARROW BAND, 1.0 KHz

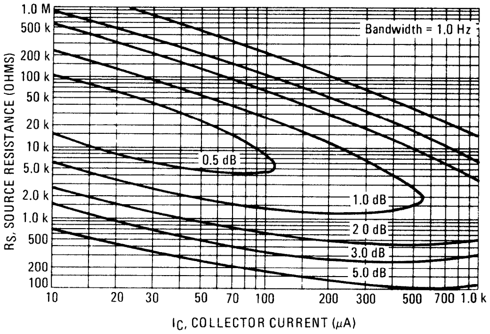
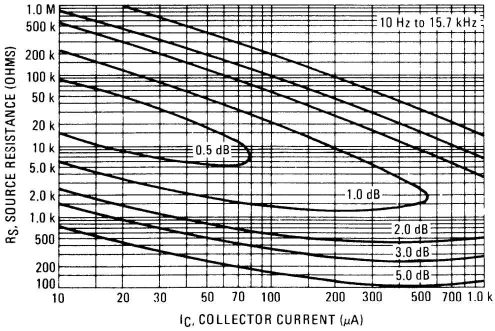


FIGURE 5 — WIDEBAND



Noise Figure is Defined as:

$$NF = 20 \log_{10} \left[\frac{e_n{}^2 + 4KTR_S + I_n{}^2 R_S{}^2}{4KTR_S} \right]^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)

I_n = Noise Current of the transistor referred to the input (Figure 4)

K = Boltzman's Constant (1.38×10^{-23} j/°K)

T = Temperature of the Source Resistance (°K)

R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

FIGURE 6 — DC CURRENT GAIN

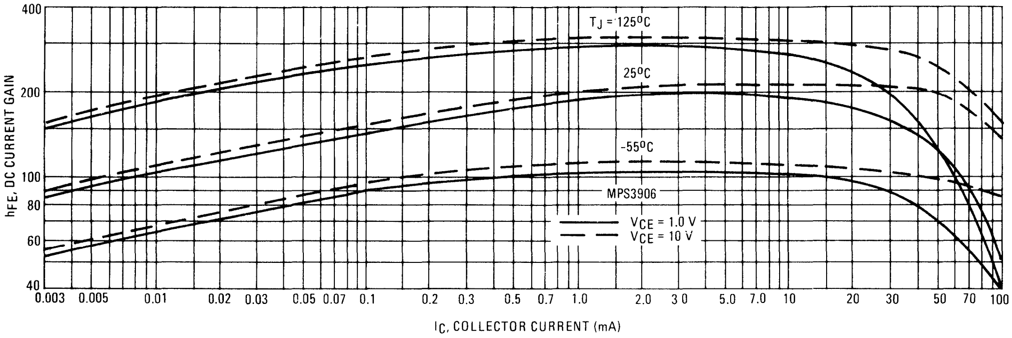


FIGURE 7 — COLLECTOR SATURATION REGION

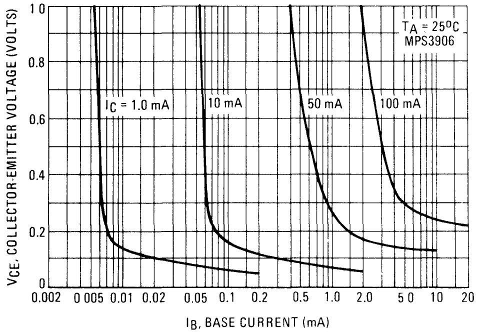


FIGURE 8 — COLLECTOR CHARACTERISTICS

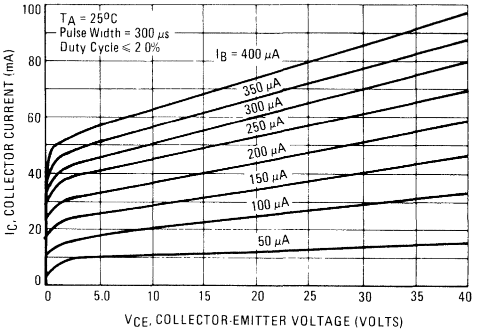


FIGURE 9 — "ON" VOLTAGES

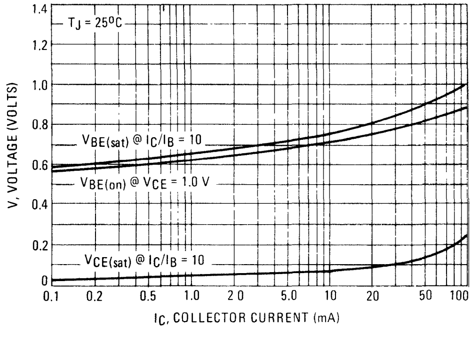
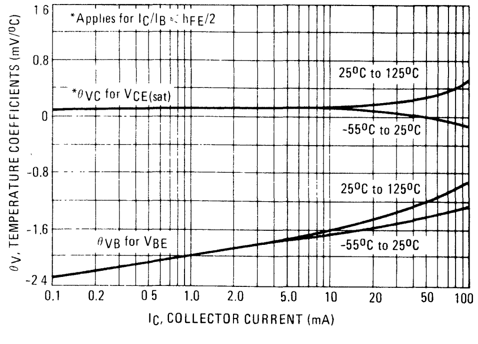


FIGURE 10 — TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 11 — TURN-ON TIME

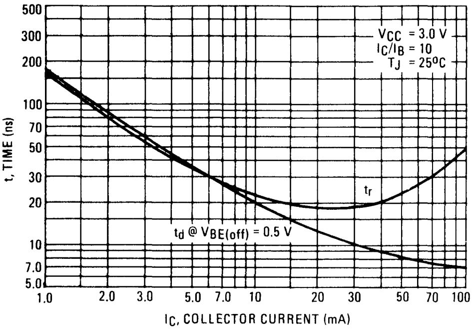


FIGURE 12 — TURN-OFF TIME

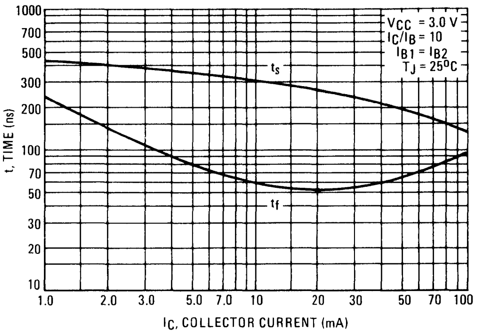


FIGURE 13 — CURRENT-GAIN — BANDWIDTH PRODUCT

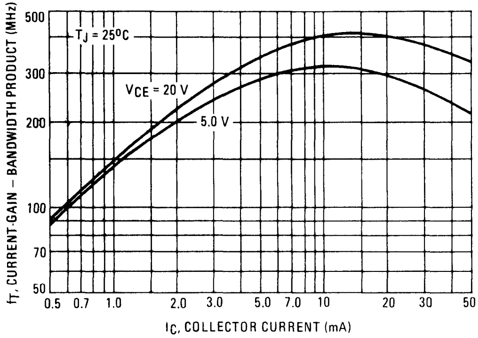


FIGURE 14 — CAPACITANCE

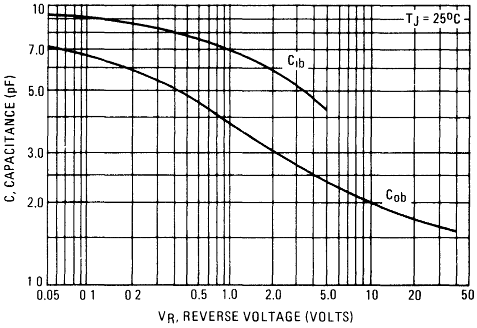


FIGURE 15 — INPUT IMPEDANCE

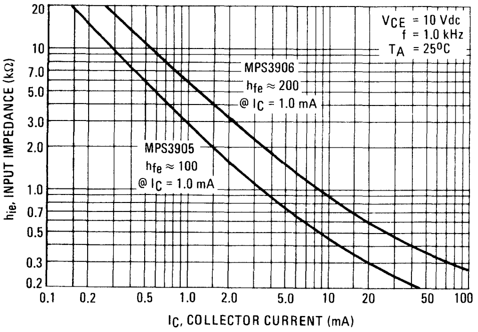


FIGURE 16 — OUTPUT ADMITTANCE

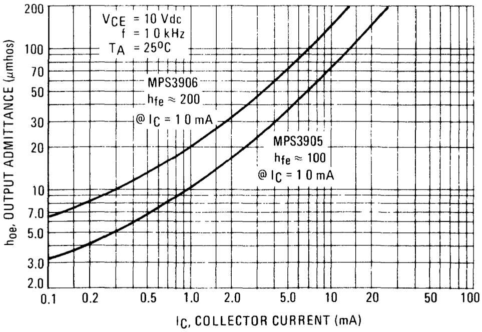


FIGURE 17 — THERMAL RESPONSE

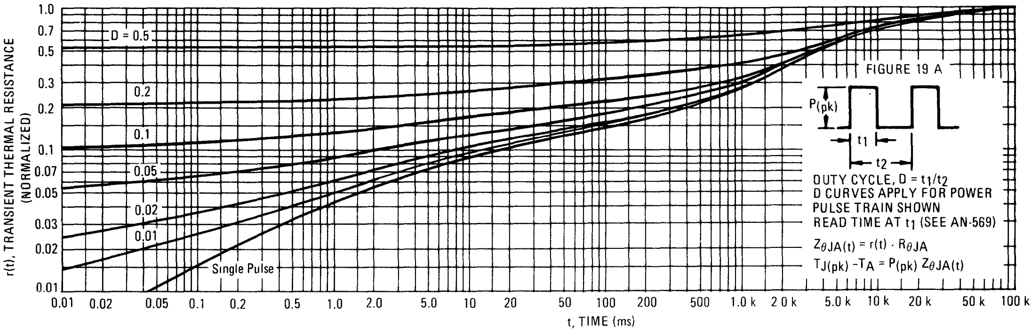
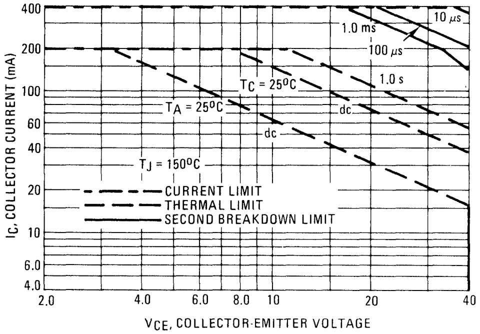


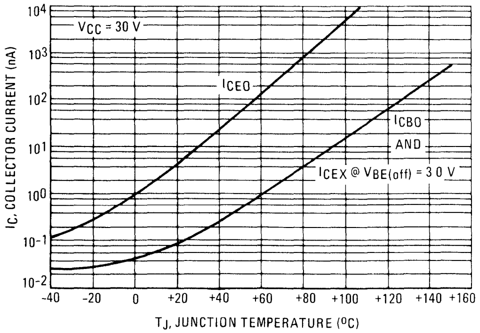
FIGURE 18 — ACTIVE-REGION SAFE OPERATING AREA



The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150^\circ C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 150^\circ C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415A).

FIGURE 19 — TYPICAL COLLECTOR LEAKAGE CURRENT



DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$.

Example:

The MPS3905 is dissipating 2.0 watts peak under the following conditions:

t1 = 1.0 ms, t2 = 5.0 ms (D = 0.2)

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

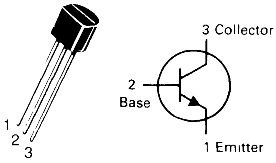
The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88^\circ C$.

For more information, see AN-569.

2N5088
2N5089

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N5088	2N5089	Unit
Collector-Emitter Voltage	V_{CEO}	30	25	Vdc
Collector-Base Voltage	V_{CBO}	35	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

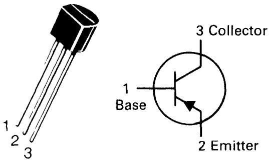
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) ($I_C = 1.0$ mAdc, $I_B = 0$) 2N5088 2N5089	$V_{(BR)CEO}$	30 25	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$) 2N5088 2N5089	$V_{(BR)CBO}$	35 30	— —	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) 2N5088 ($V_{CB} = 15$ Vdc, $I_E = 0$) 2N5089	I_{CBO}	— —	50 50	nAdc
Emitter Cutoff Current ($V_{EB(off)} = 3.0$ Vdc, $I_C = 0$) ($V_{EB(off)} = 4.5$ Vdc, $I_C = 0$)	I_{EBO}	— —	50 100	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc) 2N5088 2N5089 ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc) 2N5088 2N5089 ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)(2) 2N5088 2N5089	h_{FE}	 300 400 350 450 300 400	 900 1200 — — — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)(2)	$V_{BE(on)}$	—	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 500$ μAdc, $V_{CE} = 5.0$ Vdc, f = 20 MHz)	f_T	50	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{cb}	—	4.0	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{eb}	—	10	pF
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) 2N5088 2N5089	h_{fe}	 350 450	 1400 1800	—
Noise Figure ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ kohms, 2N5088 f = 10 Hz to 15.7 kHz) 2N5089	NF	 — —	 3.0 2.0	dB

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2N5208

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	625 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

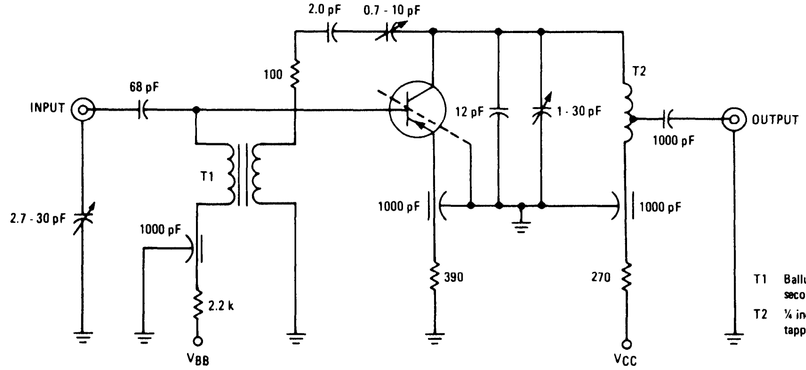
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	10	nAdc
Emitter Cutoff Current ($V_{BE} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	20	120	—
Base-Emitter On Voltage ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc)	$V_{BE(on)}$	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	300	1200	MHz
Input Capacitance ($V_{BE} = 2.0$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	4.0	pF
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	1.0	pF
Collector Base Time Constant ($I_E = 2.0$ mAdc, $V_{CB} = 10$ Vdc, f = 31.8 MHz)	$rb'C_c$	—	10	ps
Noise Figure ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 75$ ohms, f = 100 MHz, BW = 1.0 MHz)	NF	—	3.0	dB
FUNCTIONAL TEST				
Amplifier Power Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	G_{pe}	22	—	dB

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

FIGURE 1 - 100 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT



T1 Ballun Core, 5 turns primary, 5 turns secondary, No. 24 bifilar wound.
T2 ¼ inch inner diameter, 5½ turns tapped up ½ turn, No. 16 buss wire.

COMMON-EMITTER Y PARAMETERS (Polar Plots)

V_{CE} = 10 Vdc, T_A = 25°C

FIGURE 2 - INPUT ADMITTANCE

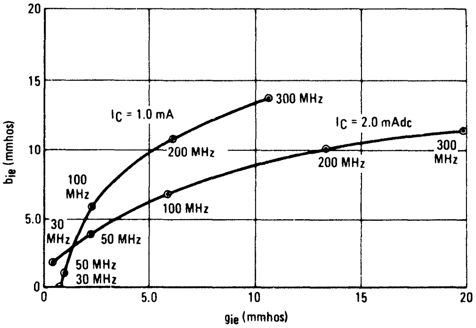


FIGURE 3 - OUTPUT ADMITTANCE

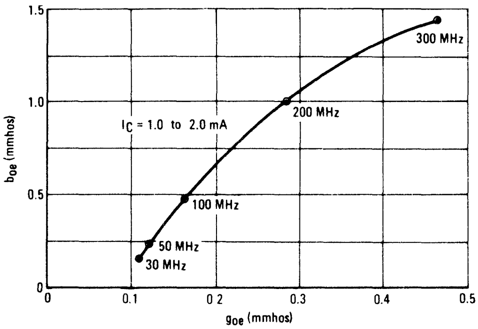


FIGURE 4 - FORWARD TRANSFER ADMITTANCE

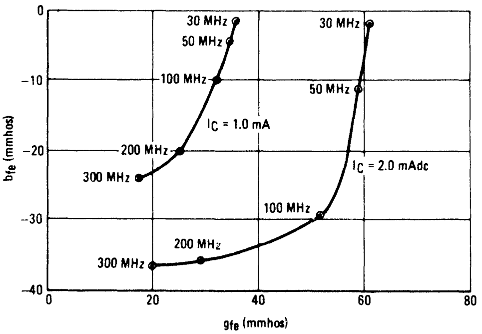
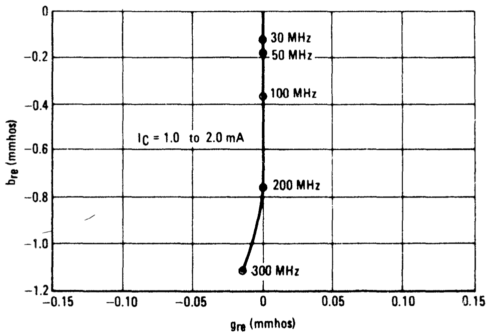


FIGURE 5 - REVERSE TRANSFER ADMITTANCE



STABILITY FACTOR CURVE

FIGURE 6 - POWER GAIN AND NOISE FIGURE

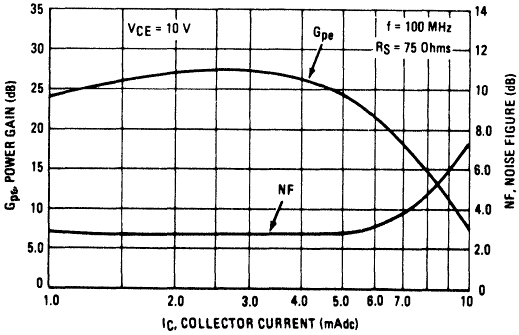
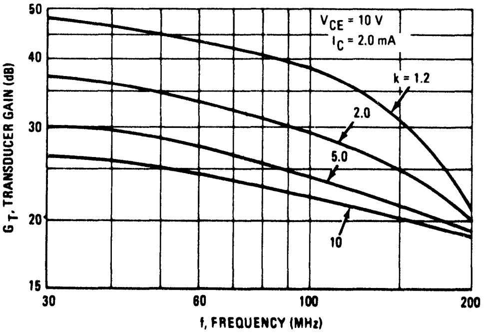


FIGURE 7 - MAXIMUM TRANSDUCER GAIN



COMMON-EMITTER Y PARAMETERS vs FREQUENCY

V_{CE} = 10 Vdc, T_A = 25°C

FIGURE 8 - INPUT ADMITTANCE

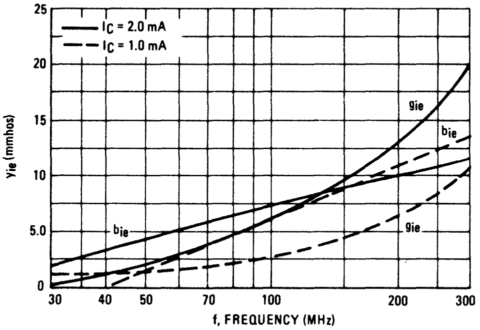


FIGURE 9 - OUTPUT ADMITTANCE

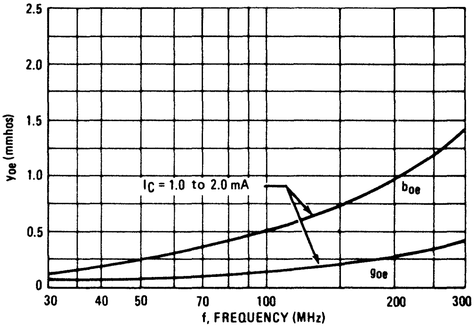


FIGURE 10 - FORWARD TRANSFER ADMITTANCE

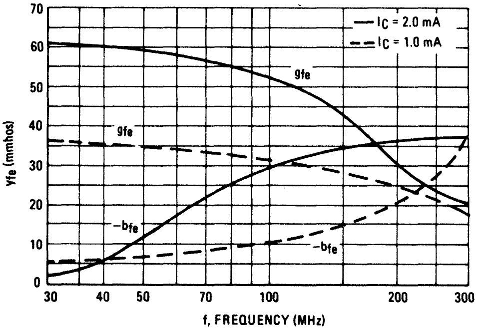
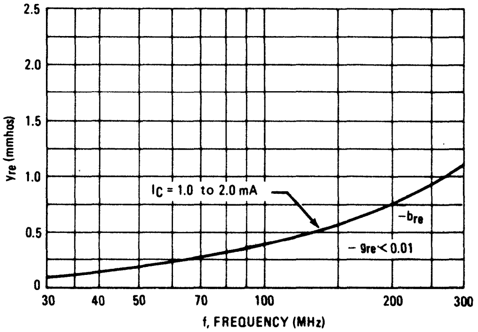


FIGURE 11 - REVERSE TRANSFER ADMITTANCE



STABILITY FACTOR CURVES

FIGURE 12 - OPTIMUM SOURCE ADMITTANCE

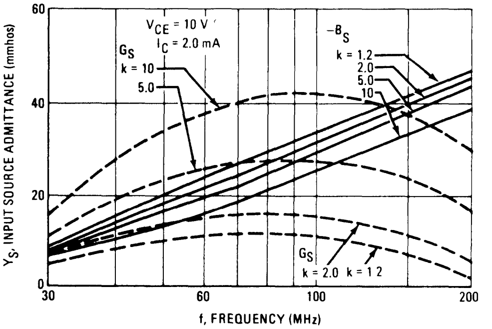
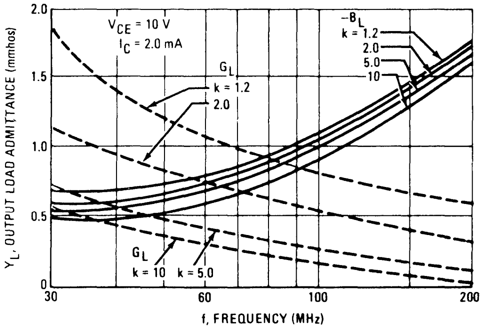


FIGURE 13 - OPTIMUM LOAD ADMITTANCE



When a potentially unstable device is operated without feedback, there is an infinite number of combinations of source and load admittance associated with any given circuit stability factor (k). Equations have been developed for determining the optimum source and load admittance for maximum gain. Figures 7, 12 and 13 provide a solution to the equations for the 2N5208.

NOISE FIGURE

FIGURE 14 - FREQUENCY EFFECTS

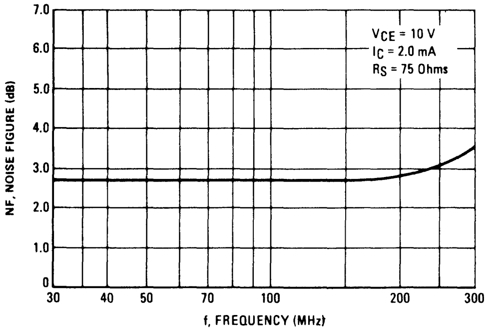


FIGURE 15 - SOURCE RESISTANCE EFFECTS

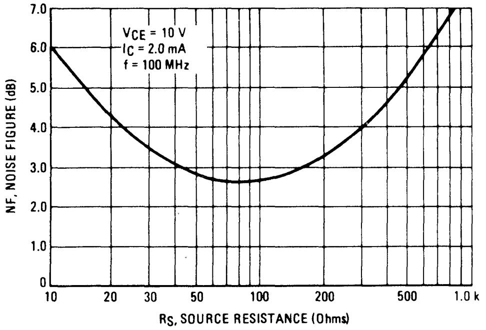


FIGURE 16 - CURRENT-GAIN — BANDWIDTH PRODUCT

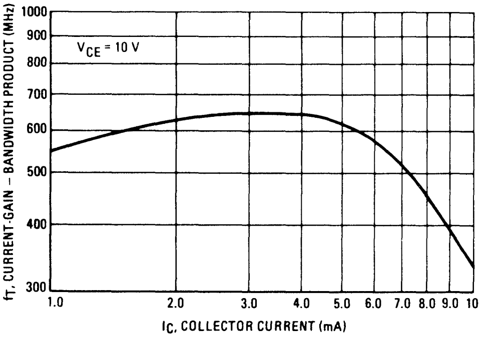


FIGURE 17 - CAPACITANCES

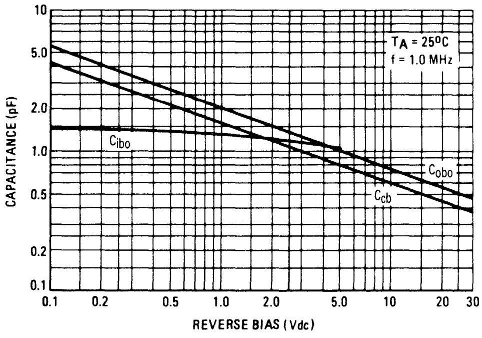
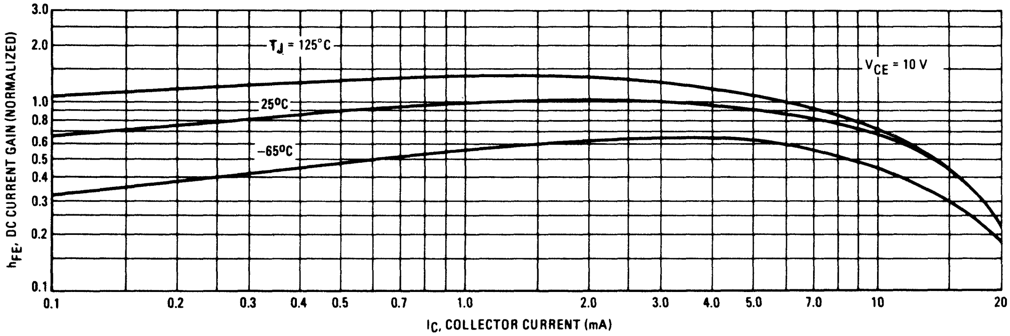
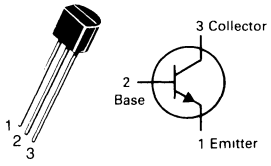


FIGURE 18 - DC CURRENT GAIN



2N5209
2N5210

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

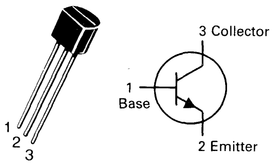
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)		$V_{(BR)CBO}$	50	—	Vdc
Collector Cutoff Current ($V_{CB} = 35$ Vdc, $I_E = 0$)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc)	2N5209		100	300	
	2N5210		200	600	
($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	2N5209		150	—	
	2N5210		250	—	
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)(2)	2N5209		150	—	
	2N5210		250	—	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{CE(sat)}$	—	0.7	Vdc
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 500$ μAdc, $V_{CE} = 5.0$ Vdc, f = 20 MHz)		f_T	30	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)		C_{cb}	—	4.0	pF
Small-Signal Current Gain		h_{fe}			—
($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	2N5209		150	600	
	2N5210		250	900	
Noise Figure		NF			dB
($I_C = 20$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 22$ k ohms,	2N5209		—	3.0	
f = 10 Hz to 15.7 kHz)	2N5210		—	2.0	
($I_C = 20$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ k ohms,	2N5209		—	4.0	
f = 1.0 kHz)	2N5210		—	3.0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

2N5222

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 2.0 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain(2) (I_C = 4.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	150	—
Collector-Emitter Saturation Voltage (I_C = 4.0 mAdc, I_B = 400 μAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter On Voltage (I_C = 4.0 mAdc, I_B = 400 μAdc)	$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	450	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	1.3	pF
Small-Signal Current Gain (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	20	300	—

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≈ 300 μs, Duty Cycle ≈ 2.0%.

COMMON-BASE y PARAMETERS versus FREQUENCY

(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{ib}, INPUT ADMITTANCE

FIGURE 1 – RECTANGULAR FORM

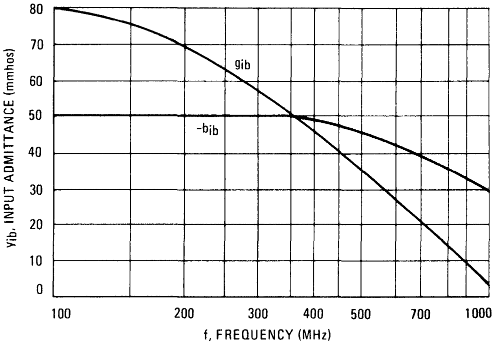
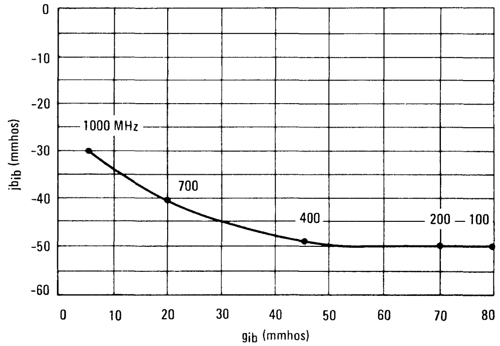


FIGURE 2 – POLAR FORM



y_{fb}, FORWARD TRANSFER ADMITTANCE

FIGURE 3 – RECTANGULAR FORM

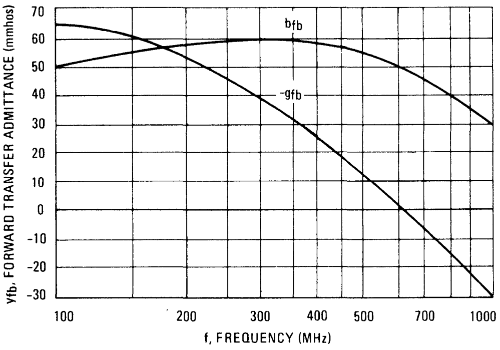
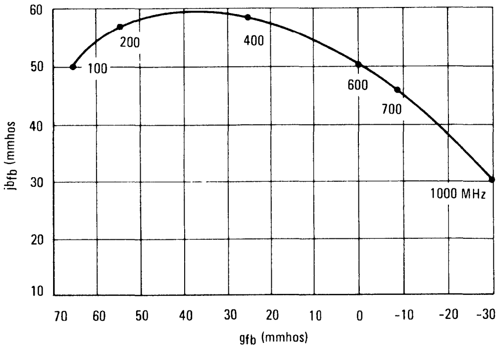


FIGURE 4 – POLAR FORM



COMMON-BASE y PARAMETERS versus FREQUENCY

(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{rb}, REVERSE TRANSFER ADMITTANCE

FIGURE 5 – RECTANGULAR FORM

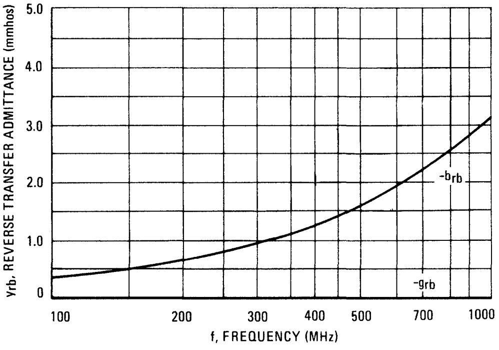
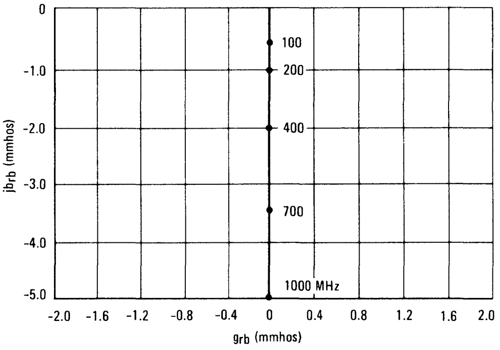


FIGURE 6 – POLAR FORM



y_{ob}, OUTPUT ADMITTANCE

FIGURE 7 — RECTANGULAR FORM

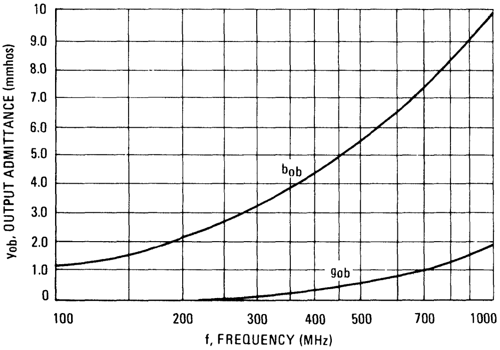
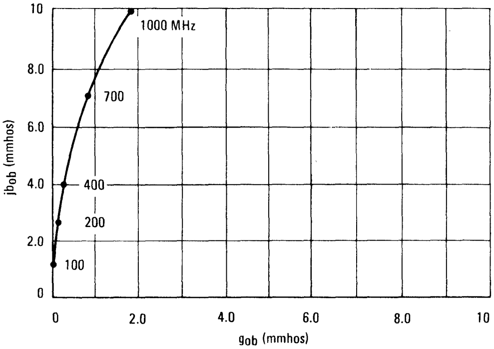
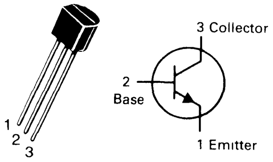


FIGURE 8 — POLAR FORM



2N5223

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3903 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

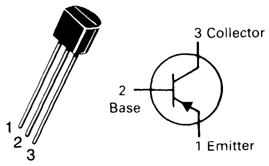
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	500	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	200	500	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.7	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	150	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	4.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	50	1600	—

2N5226

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

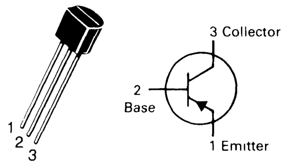
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_C = 0$)	I_{CBO}	—	300	nAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	500	nAdc
ON CHARACTERISTICS(2)				
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	 25 30	 — 600	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{CE(sat)}$	—	0.8	Vdc
Base-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	50	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	20	pF
Small-Signal Current Gain ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30	1800	—

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2N5227

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N3905 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

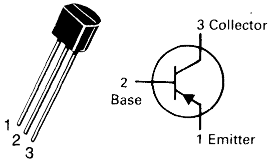
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	500	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 100\ \mu$Adc, $V_{CE} = 10$ Vdc) ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	 30 50	 — 700	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	100	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	5.0	pF
Small-Signal Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	50	1500	—

2N5400
2N5401

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N5400	2N5401	Unit
Collector-Emitter Voltage	V_{CEO}	120	150	Vdc
Collector-Base Voltage	V_{CBO}	130	160	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	 2N5400 2N5401	$V_{(BR)CEO}$	 120 150	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 2N5400 2N5401	$V_{(BR)CBO}$	 130 160	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C) (V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	 2N5400 2N5401 2N5400 2N5401	I_{CBO}	 — — — —	 100 50 100 50	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	 2N5400 2N5401	h_{FE}	 30 50	 — —	—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N5400 2N5401		40 60	180 240	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	2N5400 2N5401		40 50	— —	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	 — —	 0.20 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{BE(sat)}$	 — —	 1.0 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 Mhz)	 2N5400 2N5401	f_T	 100 100	 400 300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	6.0	pF

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

Characteristic		Symbol	Min	Max	Unit
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N5400 2N5401	h_{fe}	30 40	200 200	—
Noise Figure (I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kohm, f = 10 Hz to 15.7 kHz)		NF	—	8.0	dB

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 – DC CURRENT GAIN

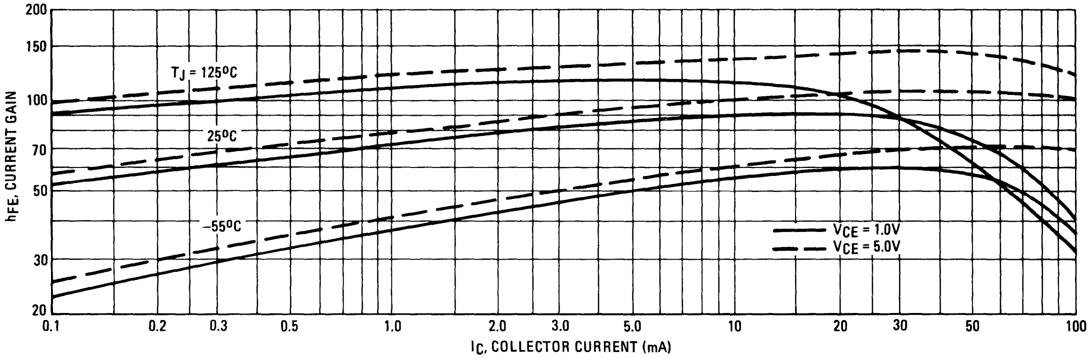


FIGURE 2 – COLLECTOR SATURATION REGION

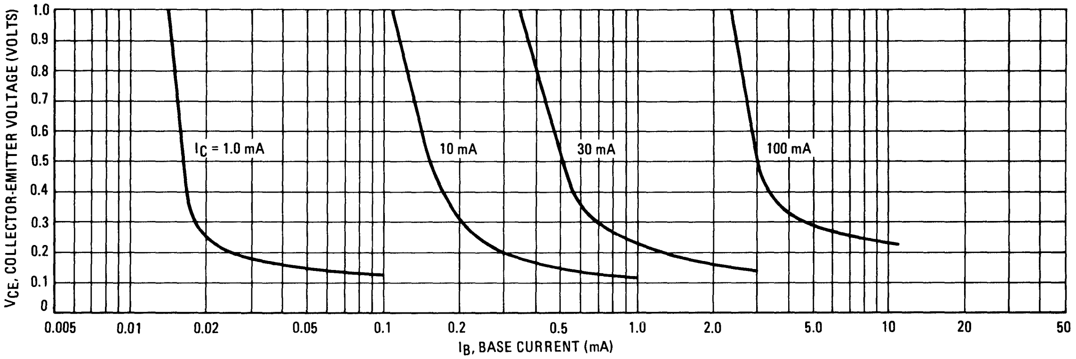


FIGURE 3 – COLLECTOR CUT-OFF REGION

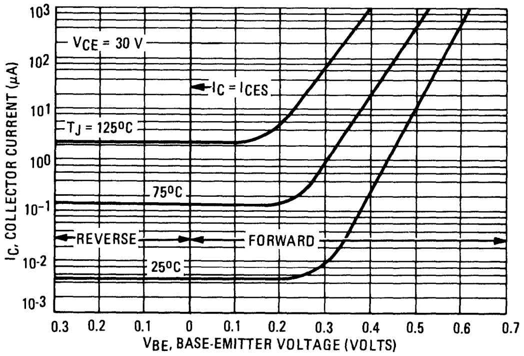


FIGURE 4 – "ON" VOLTAGES

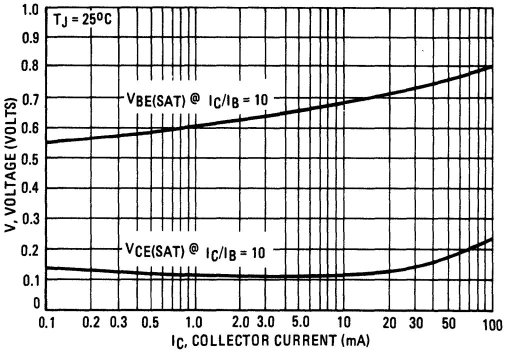


FIGURE 5 – TEMPERATURE COEFFICIENTS

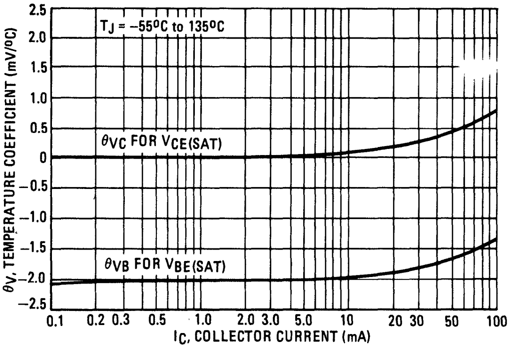
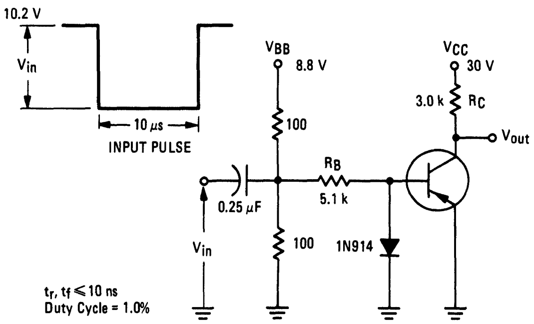


FIGURE 6 – SWITCHING TIME TEST CIRCUIT



Values Shown are for IC @ 10 mA

FIGURE 7 – CAPACITANCES

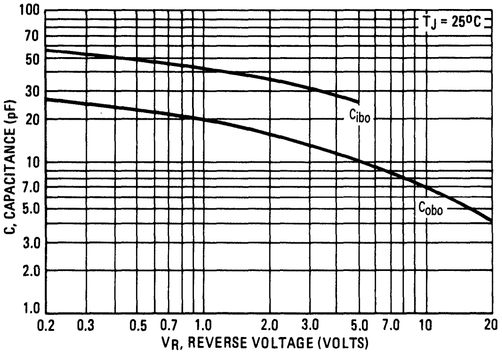


FIGURE 8 – TURN-ON TIME

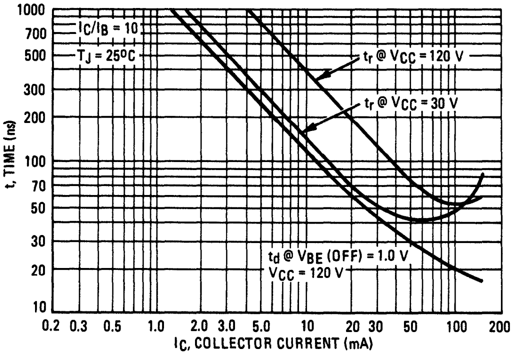
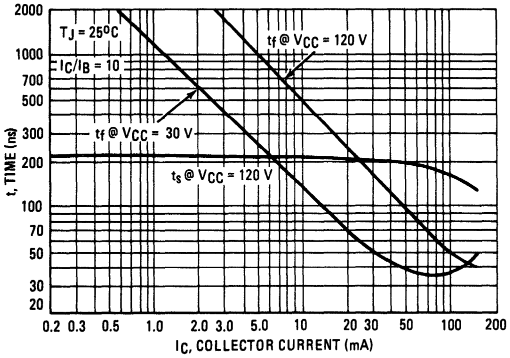
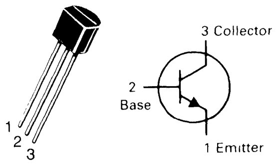


FIGURE 9 – TURN-OFF TIME



2N5550
2N5551

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N5550	2N5551	Unit
Collector-Emitter Voltage	V_{CEO}	140	160	Vdc
Collector-Base Voltage	V_{CBO}	160	180	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2)		$V_{(BR)CEO}$			Vdc
($I_C = 1.0$ mAdc, $I_B = 0$)	2N5550		140	—	
	2N5551		160	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100$ μAdc, $I_E = 0$)	2N5550		160	—	
	2N5551		180	—	
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			
($V_{CB} = 100$ Vdc, $I_E = 0$)	2N5550		—	100	nAdc
($V_{CB} = 120$ Vdc, $I_E = 0$)	2N5551		—	50	
($V_{CB} = 100$ Vdc, $I_E = 0$, $T_A = 100°C$)	2N5550		—	100	μAdc
($V_{CB} = 120$ Vdc, $I_E = 0$, $T_A = 100°C$)	2N5551		—	50	
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain		h_{FE}			—
($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	2N5550		60	—	
	2N5551		80	—	
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	2N5550		60	250	
	2N5551		80	250	
($I_C = 50$ mAdc, $V_{CE} = 5.0$ Vdc)	2N5550		20	—	
	2N5551		30	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	Both Types		—	0.15	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	2N5550		—	0.25	
	2N5551		—	0.20	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	Both Types		—	1.0	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	2N5550		—	1.2	
	2N5551		—	1.0	

(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	100	300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N5550 2N5551	C_{ibo}	— —	30 20	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	50	200	—
Noise Figure (I_C = 250 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kohm, f = 10 Hz to 15.7 kHz)	2N5550 2N5551	NF	— —	10 8.0	dB

FIGURE 1 — DC CURRENT GAIN

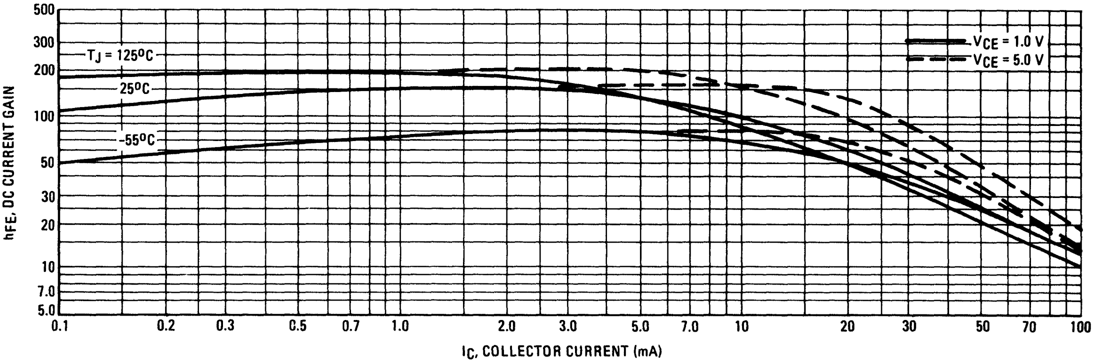


FIGURE 2 — COLLECTOR SATURATION REGION

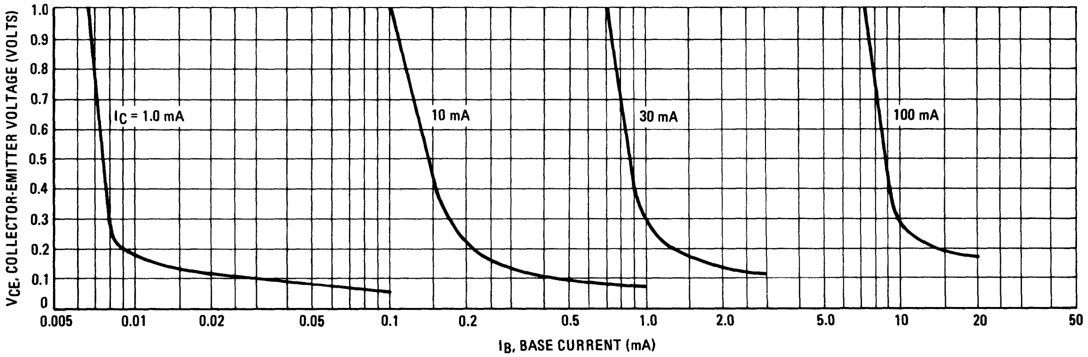


FIGURE 3 – COLLECTOR CUT-OFF REGION

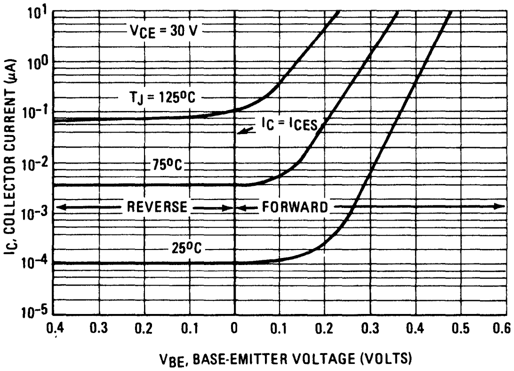


FIGURE 4 – "ON" VOLTAGES

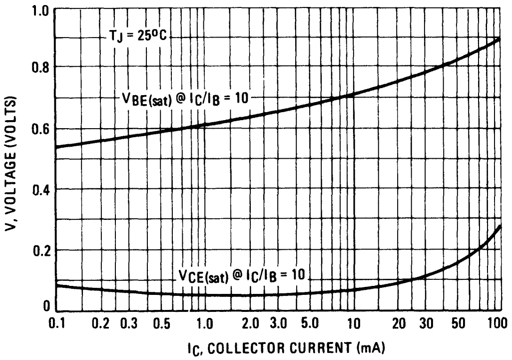


FIGURE 5 – TEMPERATURE COEFFICIENTS

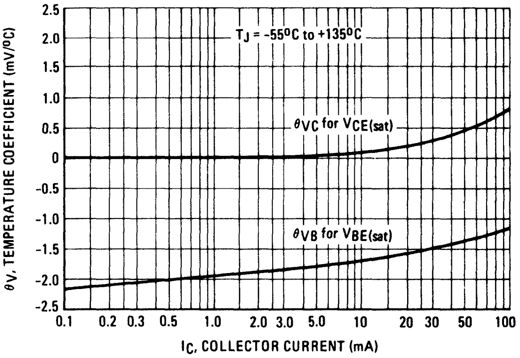


FIGURE 6 – SWITCHING TIME TEST CIRCUIT

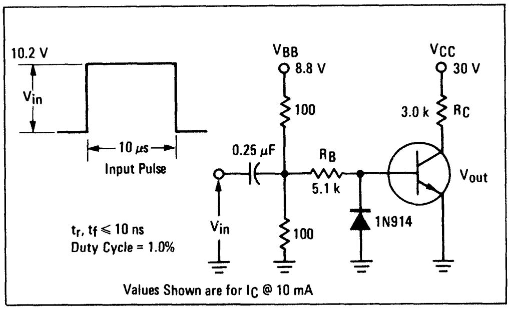


FIGURE 7 – CAPACITANCES

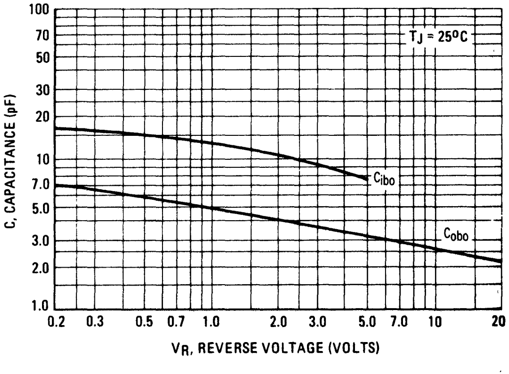


FIGURE 8 — TURN-ON TIME

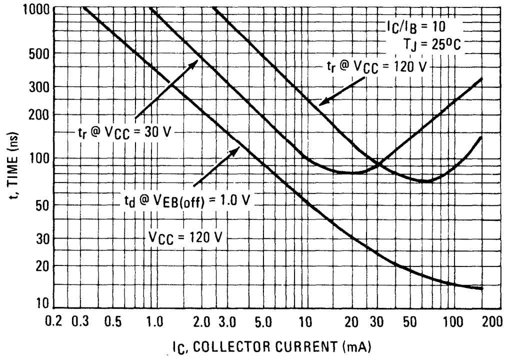
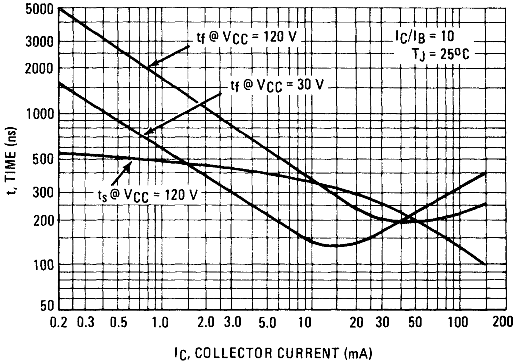
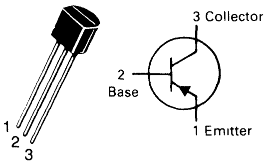


FIGURE 9 — TURN-OFF TIME



2N5771

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C
Lead Temperature	T_L	260	°C

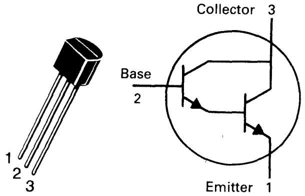
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 3.0$ mA)(1)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100$ μA)	$V_{(BR)CES}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μA)	$V_{(BR)EBO}$	4.5	—	Vdc
Collector Cutoff Current ($V_{CB} = 8.0$ Vdc)	I_{CBO}	—	10	nA
Collector Cutoff Current ($V_{CE} = 8.0$ Vdc) ($V_{CE} = 8.0$ Vdc, $T_A = 125°C$)	I_{CES}	— —	10 5.0	nA μA
Emitter Cutoff Current ($V_{BE} = 4.5$ Vdc)	I_{EBO}	—	1.0	μA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0$ mA, $V_{CE} = 0.5$ Vdc)(1) ($I_C = 10$ mA, $V_{CE} = 0.3$ Vdc)(1) ($I_C = 50$ mA, $V_{CE} = 1.0$ Vdc)(1) ($I_C = 10$ mA, $V_{CE} = 0.3$ Vdc, $T_A = -55°C$)	h_{FE}	35 50 40 20	— 120 — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 1.0$ mA, $I_B = 0.1$ mA) ($I_C = 10$ mA, $I_B = 1.0$ mA) ($I_C = 50$ mA, $I_B = 5.0$ mA)	$V_{CE(sat)}$	— — —	0.15 0.18 0.6	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 1.0$ mA, $I_B = 0.1$ mA) ($I_C = 10$ mA, $I_B = 1.0$ mA) ($I_C = 50$ mA, $I_B = 5.0$ mA)	$V_{BE(sat)}$	— 0.75 —	0.8 0.95 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, f = 140 kHz)	C_{cb}	—	3.0	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, f = 140 kHz)	C_{eb}	—	3.5	pF
Small-Signal Current Gain ($I_C = 10$ mA, $V_{CE} = 10$ Vdc, f = 100 MHz)	h_{fe}	8.5	—	—
SWITCHING CHARACTERISTICS				
Storage Time ($I_C = 10$ mA, $I_{B1} \approx I_{B2} \approx 10$ mA)	t_s	—	20	ns
Turn-On Time ($I_C = 10$ mA, $I_B = 1.0$ mA)	t_{on}	—	15	ns
Turn-Off Time ($I_C = 10$ mA, $I_{B1} = I_{B2} = 1.0$ mA)	t_{off}	—	20	ns

(1) Pulse Conditions: Pulse Length = 300 μs, Duty Cycle = 1.0%.

2N6426
2N6427

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

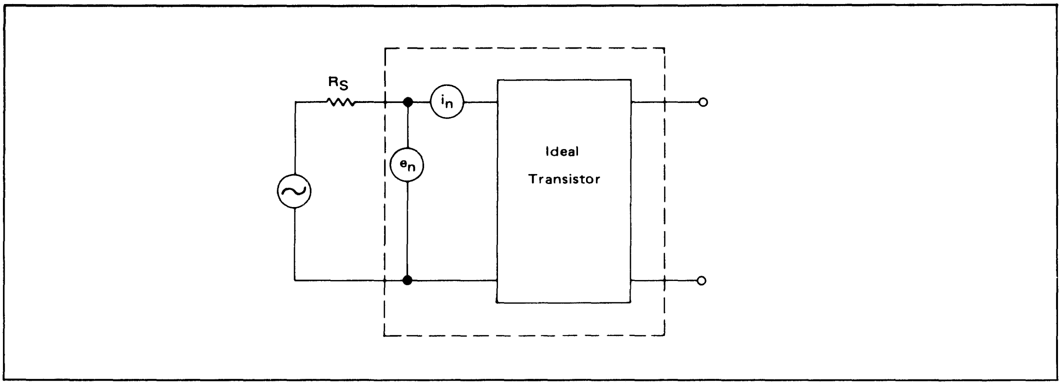
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, V_{BE} = 0)		$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, I_B = 0)		I_{CEO}	—	—	1.0	μAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain(2)		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N6426		20,000	—	200,000	
	2N6427		10,000	—	100,000	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	2N6426		30,000	—	300,000	
	2N6427		20,000	—	200,000	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	2N6426		20,000	—	200,000	
	2N6427		14,000	—	140,000	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 50 mAdc, I_B = 0.5 mAdc)			—	0.71	1.2	
(I_C = 500 mAdc, I_B = 0.5 mAdc)			—	0.9	1.5	
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 0.5 mAdc)		$V_{BE(sat)}$	—	1.52	2.0	Vdc
Base-Emitter On Voltage (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	1.24	1.75	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	5.4	7.0	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	15	pF

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

Characteristic		Symbol	Min	Typ	Max	Unit
Input Impedance (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N6426 2N6427	h_{ie}	100 50	— —	2000 1000	k Ω
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N6426 2N6427	h_{fe}	20,000 10,000	— —	— —	—
Current Gain — High Frequency (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	2N6426 2N6427	$\|h_{fe}\|$	1.5 1.3	2.4 2.4	— —	—
Output Admittance (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{oe}	—	—	1000	μmhos
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz)		NF	—	3.0	10	dB

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – TRANSISTOR NOISE MODEL



NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

FIGURE 2 – NOISE VOLTAGE

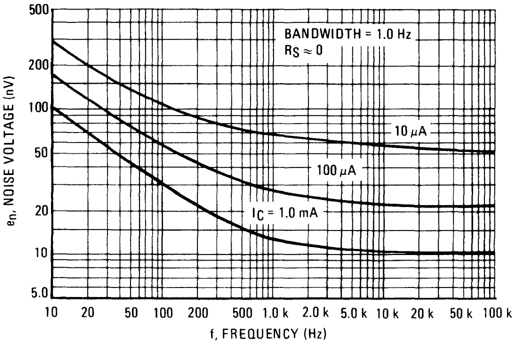


FIGURE 3 – NOISE CURRENT

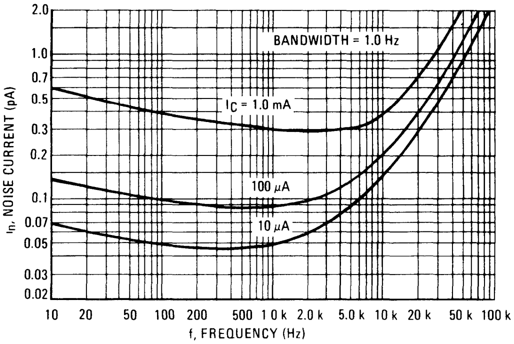


FIGURE 4 – TOTAL WIDEBAND NOISE VOLTAGE

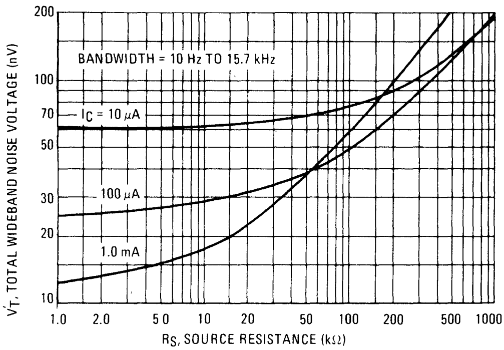
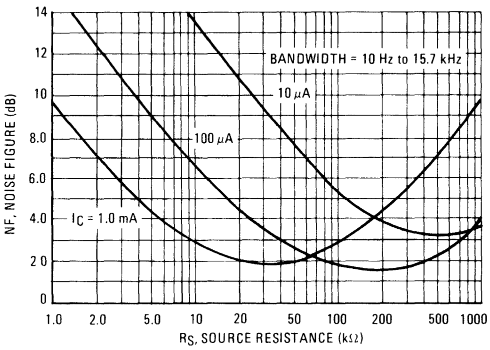


FIGURE 5 – WIDEBAND NOISE FIGURE



SMALL-SIGNAL CHARACTERISTICS

FIGURE 6 – CAPACITANCE

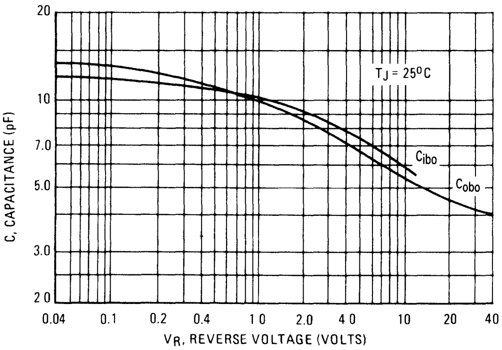


FIGURE 7 – HIGH FREQUENCY CURRENT GAIN

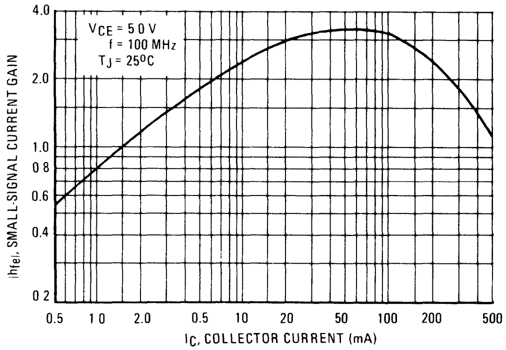


FIGURE 8 – DC CURRENT GAIN

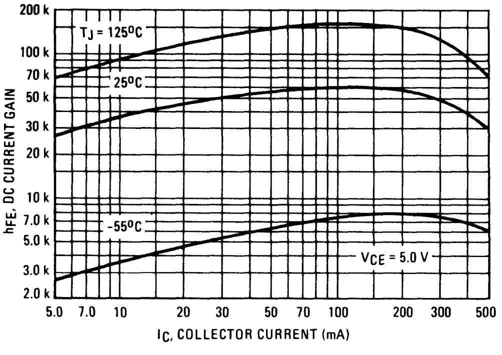


FIGURE 9 – COLLECTOR SATURATION REGION

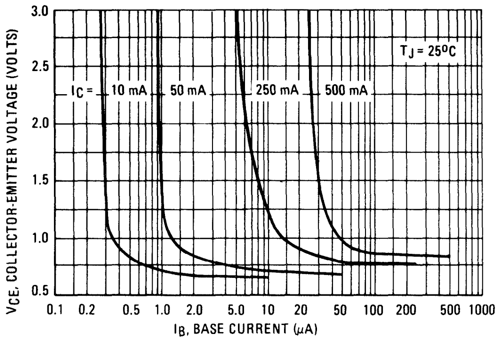


FIGURE 10 – "ON" VOLTAGES

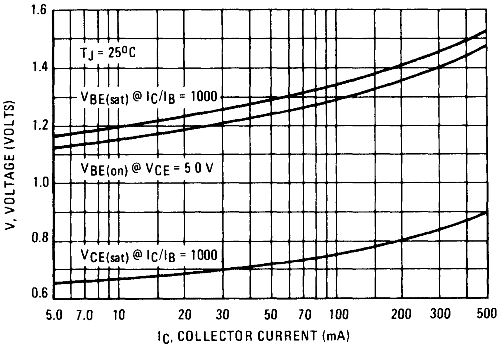


FIGURE 11 – TEMPERATURE COEFFICIENTS

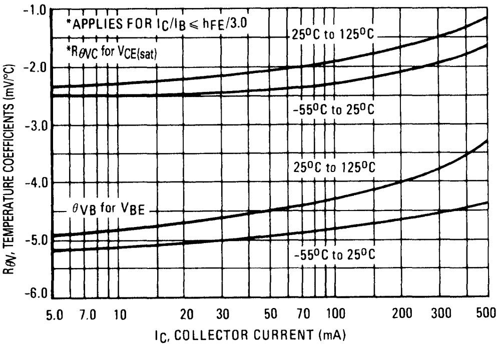


FIGURE 12 – THERMAL RESPONSE

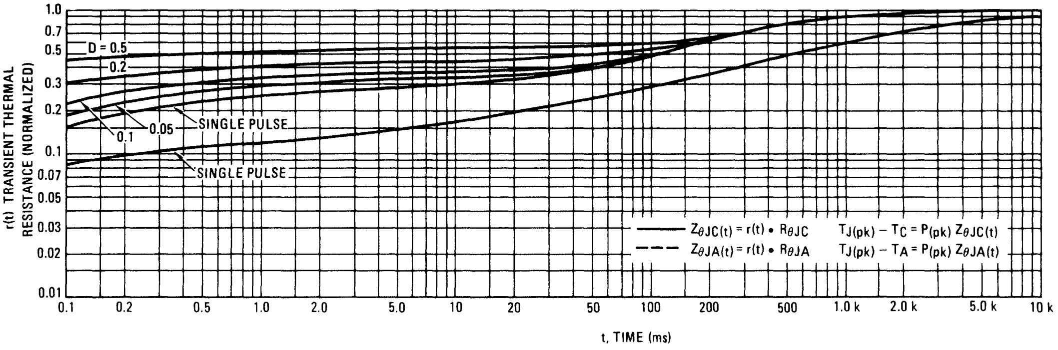
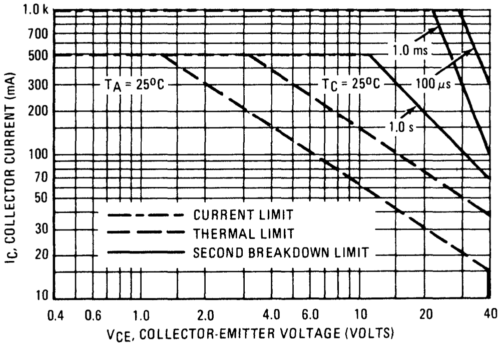
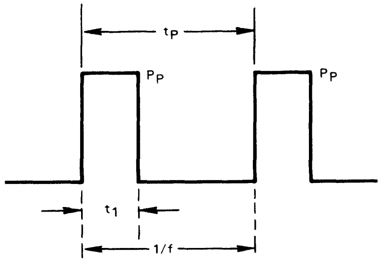


FIGURE 13 – ACTIVE REGION SAFE OPERATING AREA



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA

Figure A

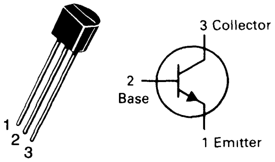


Duty Cycle = $t_1 f = \frac{t_1}{t_P}$

Peak Pulse Power = P_P

2N6428, A

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc)	I_{CEO}	—	0.025	μA
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	0.01	μA
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.01	μA
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
($V_{CE} = 5.0$ Vdc, $I_C = 0.01$ mAdc)		250	—	
($V_{CE} = 5.0$ Vdc, $I_C = 0.1$ mAdc)		250	650	
($V_{CE} = 5.0$ Vdc, $I_C = 1.0$ mAdc)		250	—	
($V_{CE} = 5.0$ Vdc, $I_C = 10$ mAdc)		250	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)		—	0.2	
($I_C = 100$ mAdc, $I_B = 5.0$ mAdc)		—	0.6	
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	$V_{BE(on)}$	0.56	0.66	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ V, f = 100 MHz)	f_T	100	700	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	3.0	pF
Input Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	8.0	pF

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

Characteristic	Symbol	Min	Max	Unit
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{ie}	3.0	30	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{re}	2.0	20	$X 10^{-4}$
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	200	800	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{oe}	5.0	50	μmhos

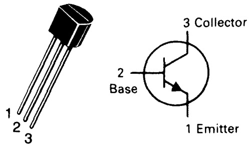
NOISE FIGURE/TOTAL NOISE VOLTAGE CHARACTERISTICS

		NF Max (1)	V_T Max (1)	NF Max (2)	V_T Max (2)	NF Max (3)	V_T Max (3)	Unit	
Noise Figure/Voltage	2N6428	3.0	18.1	6.0	5700	3.5	4.3	dB	nV
(V_{CE} = 5.0 V, I_C = 0.1 mA, T_A = 25°C)	2N6428A	2.0	16.2	4.0	4600	3.0	4.1	dB	nV

(1) R_S = 10 kΩ, BW = 1.0 Hz, f = 100 Hz
(2) R_S = 50 kΩ, BW = 15.7 kHz, f = 10 Hz–10 kHz
(3) R_S = 500 Ω, BW = 1.0 Hz, f = 10 Hz

NPN
2N6515
thru 2N6517
PNP
2N6519
2N6520

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	2N6515	2N6516 2N6519	2N6517 2N6520	Unit
Collector-Emitter Voltage	V_{CEO}	250	300	350	Vdc
Collector-Base Voltage	V_{CBO}	250	300	350	Vdc
Emitter-Base Voltage	V_{EBO}				Vdc
2N6515, 2N6516, 2N6517			6.0		
2N6519, 2N6520			5.0		
Base Current	I_B		250		mAdc
Collector Current — Continuous	I_C		500		mAdc
Total Device Dissipation @ T_A = 25°C	P_D		0.625		Watt
Derate above 25°C			5.0		mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}		−55 to +150		°C
Lead Temperature ≥1/16″ from case for 10 seconds	T_L		260		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	2N6515		250	—	
	2N6516, 2N6519		300	—	
	2N6517, 2N6520		350	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	2N6515		250	—	
	2N6516, 2N6519		300	—	
	2N6517, 2N6520		350	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	2N6515, 2N6516, 2N6517		6.0	—	
	2N6519, 2N6520		5.0	—	
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 150 Vdc, I_E = 0)	2N6515		—	50	
(V_{CB} = 200 Vdc, I_E = 0)	2N6516, 2N6519		—	50	
(V_{CB} = 250 Vdc, I_E = 0)	2N6517, 2N6520		—	50	
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{EB} = 5.0 Vdc, I_C = 0)	2N6515, 2N6516, 2N6517		—	50	
(V_{EB} = 4.0 Vdc, I_C = 0)	2N6519, 2N6520		—	50	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N6515		35	—	
	2N6516, 2N6519		30	—	
	2N6517, 2N6520		20	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N6515		50	—	
	2N6516, 2N6519		45	—	
	2N6517, 2N6520		30	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	2N6515		50	300	
	2N6516, 2N6519		45	270	
	2N6517, 2N6520		30	200	
(I_C = 50 mAdc, V_{CE} = 10 Vdc)	2N6515		45	220	
	2N6516, 2N6519		40	200	
	2N6517, 2N6520		20	200	
(I_C = 100 mAdc, V_{CE} = 10 Vdc)	2N6515		25	—	
	2N6516, 2N6519		20	—	
	2N6517, 2N6520		15	—	

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

Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.30	
(I_C = 20 mAdc, I_B = 2.0 mAdc)		—	0.35	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		—	0.50	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.75	
(I_C = 20 mAdc, I_B = 2.0 mAdc)		—	0.85	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		—	0.90	
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(1) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	40	200	MHz
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	6.0	pF
Emitter-Base Capacitance	C_{eb}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz) 2N6515 thru 2N6517		—	80	
2N6519, 2N6520		—	100	
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 100 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 50 mAdc, I_{B1} = 10 mAdc)	t_{on}	—	200	μs
Turn-Off Time (V_{CC} = 100 Vdc, I_C = 50 mAdc, I_{B1} = I_{B2} = 10 mAdc)	t_{off}	—	3.5	μs

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

NPN

PNP

FIGURE 1 — DC CURRENT GAIN

2N6515, 2N6516

2N6519

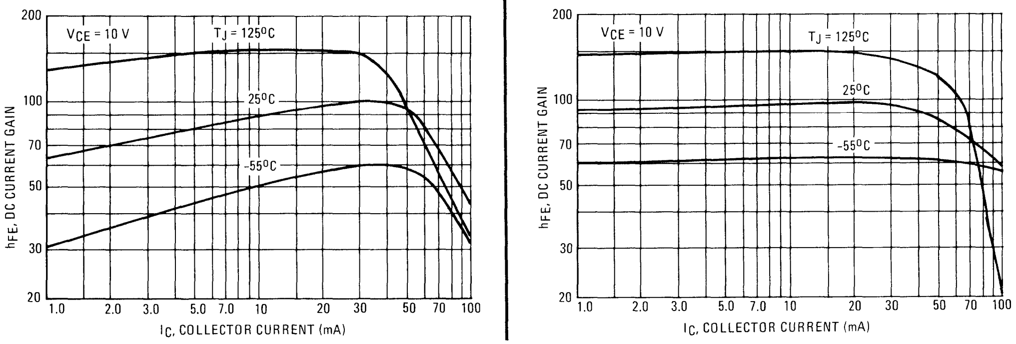
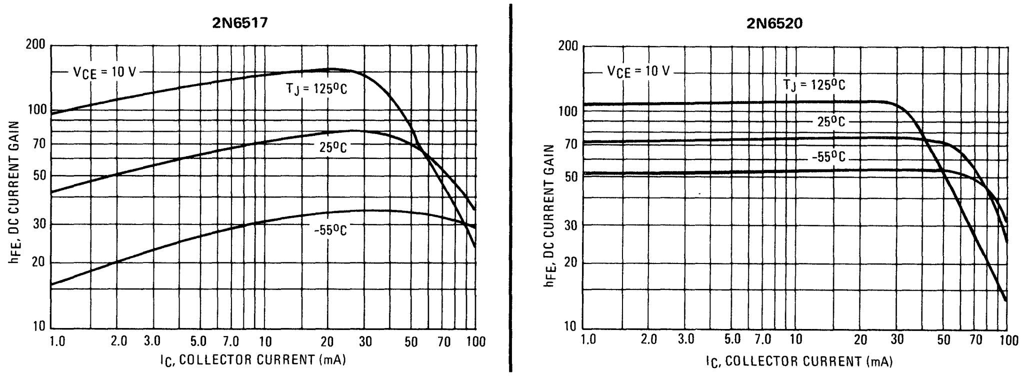
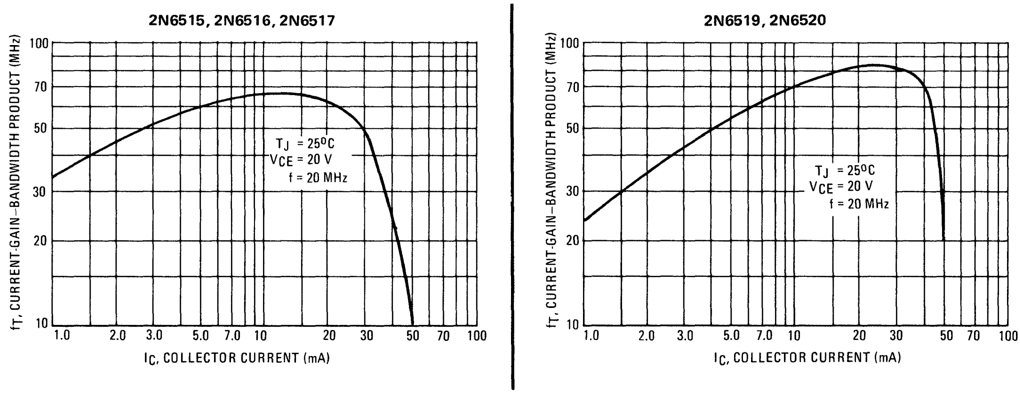


FIGURE 2 – DC CURRENT GAIN


2N6517

2N6520

FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

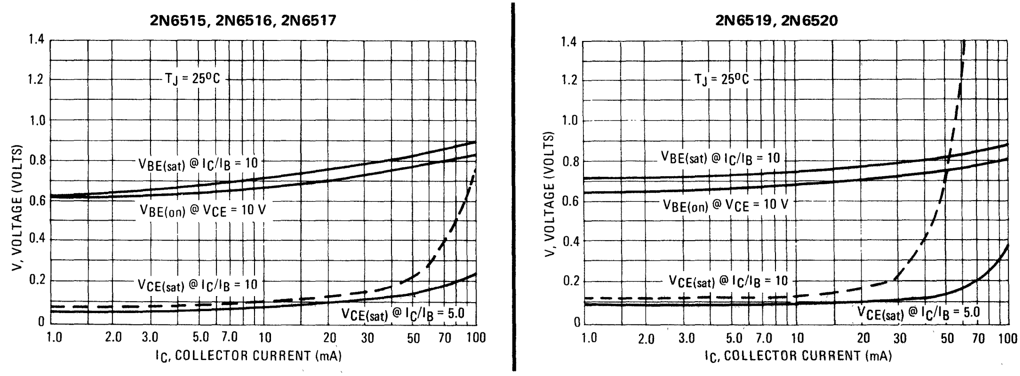

2N6515, 2N6516, 2N6517

2N6519, 2N6520

NPN

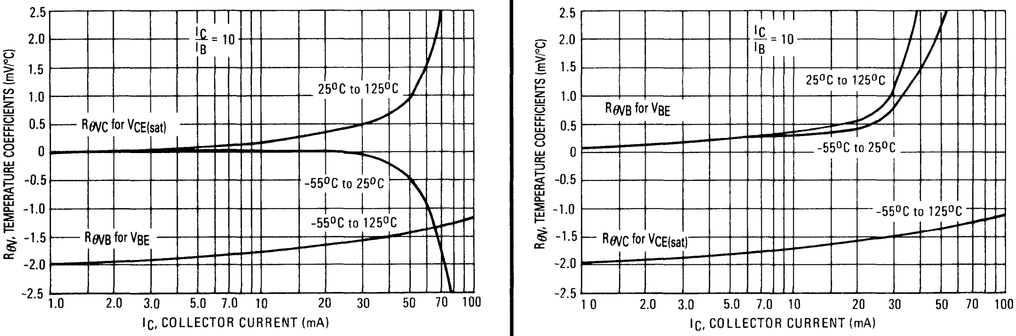
PNP

FIGURE 4 – "ON" VOLTAGES


2N6515, 2N6516, 2N6517

2N6519, 2N6520

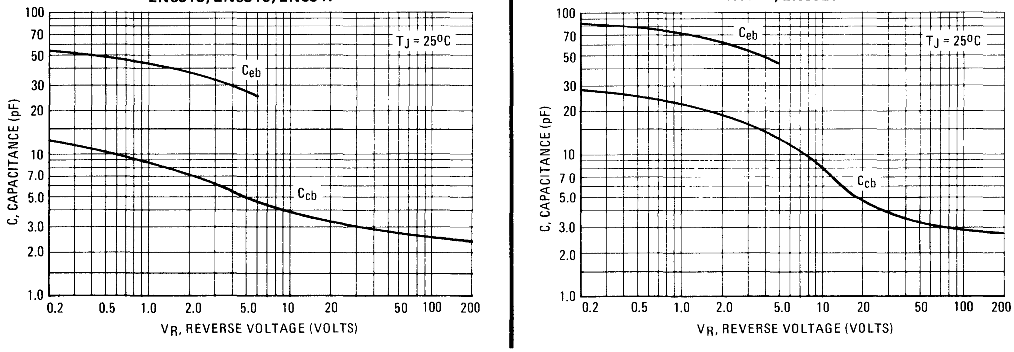
FIGURE 5 – TEMPERATURE COEFFICIENTS



2N6515, 2N6516, 2N6517

2N6519, 2N6520

FIGURE 6 – CAPACITANCE



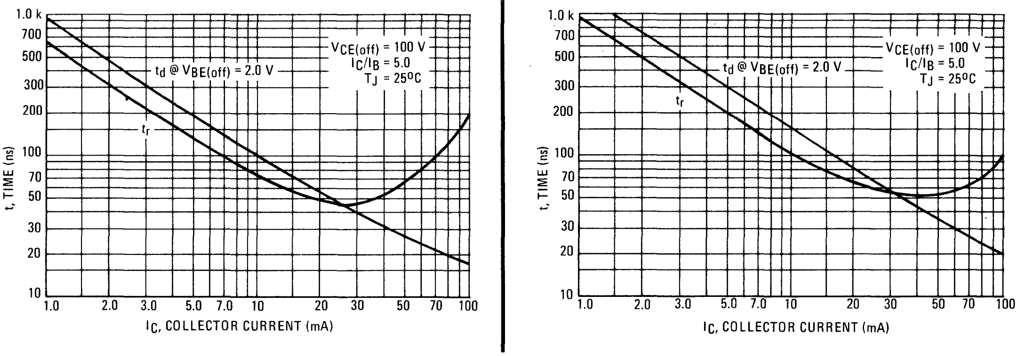
2N6515, 2N6516, 2N6517

2N6519, 2N6520

NPN

PNP

FIGURE 7 – TURN-ON TIME



2N6515, 2N6516, 2N6517

2N6519, 2N6520

FIGURE 8 — TURN-OFF TIME

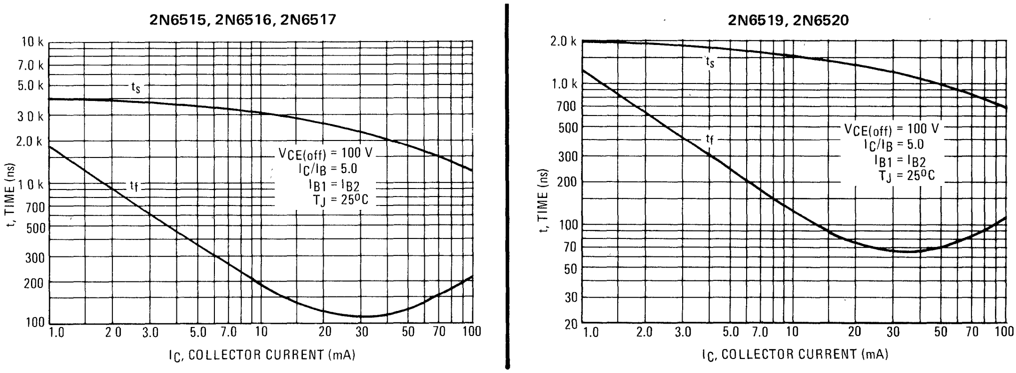
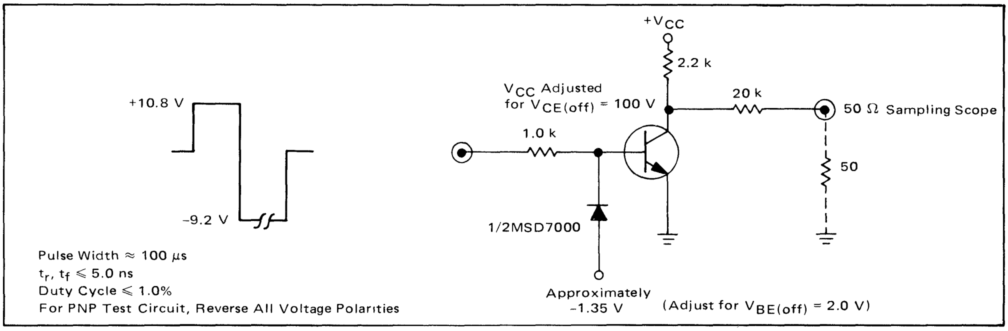


FIGURE 9 — SWITCHING TIME TEST CIRCUIT



Pulse Width ≈ 100 μs
t_r, t_f ≤ 5.0 ns
Duty Cycle ≤ 1.0%
For PNP Test Circuit, Reverse All Voltage Polarities

FIGURE 10 — THERMAL RESPONSE

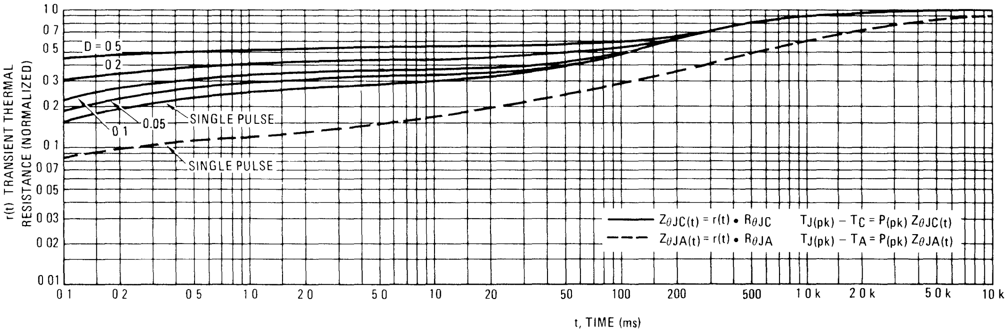
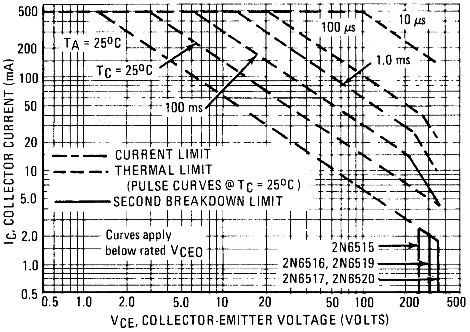
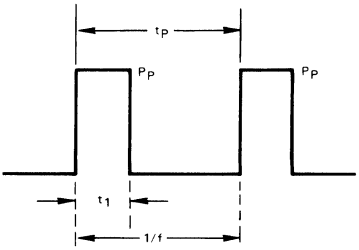


FIGURE 11 – ACTIVE REGION SAFE OPERATING AREA



DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA

Figure A

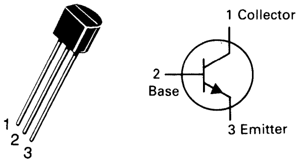


Duty Cycle = $t_1 \, f = \frac{t_1}{t_P}$

Peak Pulse Power = P_P

BC171A, B
BC172A, B, C
BC174A, B

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to BC546 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 174A,B	BC 171A,B	BC 172A,B	Unit
Collector-Emitter Voltage	V_{CEO}	65	45	25	Vdc
Collector-Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current — Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

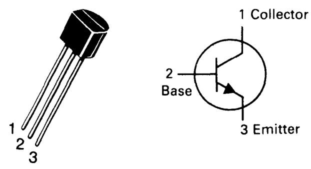
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
(I_C = 2.0 mA, I_B = 0)	BC174A,B		65	—	—	
	BC171A,B		45	—	—	
	BC172A,B		25	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				V
(I_E = 100 μA, I_C = 0)	BC171A,B		6.0	—	—	
	BC172A,B		6.0	—	—	
	BC174A,B		6.0	—	—	
Collector Cutoff Current		I_{CES}				nA
(V_{CE} = 70 V, V_{BE} = 0)	BC174A,B		—	0.2	15	
(V_{CE} = 50 V, V_{BE} = 0)	BC171A,B		—	0.2	15	
(V_{CE} = 35 V, V_{BE} = 0)	BC172A,B		—	0.2	15	
(V_{CE} = 30 V, V_{BE} = 0) T_A = 125°C			—	—	4.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 10 μA, V_{CE} = 5.0 V)	BC171A/2A/4A		—	90	—	
	BC171B/2B/4B		—	150	—	
	BC172C		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC171A/2A/4A		120	180	220	
	BC171B/2B/4B		180	290	460	
	BC172C		380	520	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC171A/2A/4A		—	120	—	
	BC171B/2B/4B		—	180	—	
	BC172C		—	300	—	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{CE(sat)}$	—	0.09	0.25	V
(I_C = 100 mA, I_B = 5.0 mA)			—	0.2	0.6	
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
Base-Emitter On Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	0.55	—	0.7	V

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

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS, SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product		f_T				MHz
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz	BC171A,B		150	300	—	
	BC172A,B		150	300	—	
	BC174A,B		150	300	—	
Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{obo}	—	1.7	4.5	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	—	pF
Small-Signal Current Gain		h_{fe}				
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC171A/2A/4A		125	220	260	
	BC171B/2B/4B		240	330	500	
	BC172C		450	600	900	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kohms,	BC171A,B		—	2.0	10	
f = 1.0 kHz, Δf = 200 Hz)	BC172A,B		—	2.0	10	
	BC174A,B		—	2.0	10	

BC182, A, B
BC183, A, B, C
BC184, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to BC237 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 182	BC 183	BC 184	Unit
Collector-Emitter Voltage	V_{CEO}	50	30	30	Vdc
Collector-Base Voltage	V_{CBO}	60	45	45	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current − Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)	BC182	$V_{(BR)CEO}$	50	—	—	V
	BC183		30	—	—	
	BC184		30	—	—	
Collector-Base Breakdown Voltage (I_C = 10 µA, I_E = 0)	BC182	$V_{(BR)CBO}$	60	—	—	V
	BC183		45	—	—	
	BC184		45	—	—	
Emitter-Base Breakdown Voltage (I_E = 100 µA, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	V
Collector Cutoff Current (V_{CB} = 50 V, V_{BE} = 0)	BC182	I_{CBO}	—	0.2	15	nA
(V_{CB} = 30 V, V_{BE} = 0)	BC183		—	0.2	15	
	BC184		—	0.2	15	
Emitter-Base Leakage Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	—	—	15	nA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 µA, V_{CE} = 5.0 V)	BC182	h_{FE}	40	—	—	
	BC183		40	—	—	
	BC184		100	—	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC182		120	—	500	
	BC183		120	—	800	
	BC184		250	—	800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC182		80	—	—	
	BC183		80	—	—	
	BC184		130	—	—	
Collector-Emitter On Voltage	(I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)*	$V_{CE(sat)}$	— —	0.07 0.2	0.25 0.6	V
Base-Emitter Saturation Voltage	(I_C = 100 mA, I_B = 5.0 mA)*	$V_{BE(sat)}$	—	—	1.2	V
Base-Emitter On Voltage	(I_C = 100 µA, V_{CE} = 5.0 V) (I_C = 2.0 mA, V_{CE} = 5.0 V) (I_C = 100 mA, V_{CE} = 5.0 V)*	$V_{BE(on)}$	— 0.55 —	0.5 0.62 0.83	— 0.7 —	V

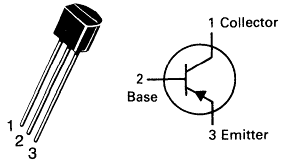
*Pulse Test: Tp 300 s, Duty Cycle 2.0%.

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

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product		f_T				MHz
(I_C = 0.5 mA, V_{CE} = 3.0 V, f = 100 MHz)	BC182		—	100	—	
	BC183		—	120	—	
	BC184		—	140	—	
(I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC182		150	200	—	
	BC183		150	240	—	
	BC184		150	280	—	
Common Base Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{ob}	—	—	5.0	pF
Common Base Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ib}	—	8.0	—	pF
Small-Signal Current Gain		h_{fe}				
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC182		125	—	500	
	BC183		125	—	900	
	BC184		240	—	900	
	BC182A, BC183A		125	—	260	
	BC182B, BC183B, BC184B		240	—	500	
	BC183C, BC184C		450	—	900	
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kohms, f = 30 Hz to 15 kHz)	BC184		—	2.0	4.0	
(I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2.0 kohms, f = 1.0 kHz, F = 200 Hz)	BC182		—	2.0	10	
	BC183		—	2.0	10	
	BC184		—	2.0	4.0	

BC212, A, B
BC213, A, B, C
BC214, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to BC307 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 212	BC 213	BC 214	Unit
Collector-Emitter Voltage	V_{CEO}	50	30	30	Vdc
Collector-Base Voltage	V_{CBO}	60	45	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	100			mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 2.0$ mAdc, $I_B = 0$)	BC212 BC213 BC214	$V_{(BR)CEO}$	50 30 30	— — —	— — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\mu A$, $I_E = 0$)	BC212 BC213 BC214	$V_{(BR)CBO}$	60 45 45	— — —	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\mu Adc$, $I_C = 0$)	BC212 BC213 BC214	$V_{(BR)EBO}$	5 5 5	— — —	— — —	Vdc
Collector-Emitter Leakage Current ($V_{CB} = 30$ V)	BC212 BC213 BC214	I_{CBO}	— — —	— — —	15 15 15	nAdc
Emitter-Base Leakage Current ($V_{EB} = 4$ V, $I_C = 0$)	BC212 BC213 BC214	I_{EBO}	— — —	— — —	15 15 15	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 10\ \mu Adc$, $V_{CE} = 5$ Vdc)	BC212 BC213 BC214	h_{FE}	40 40 100	— — —	— — —	
($I_C = 2$ mAdc, $V_{CE} = 5$ Vdc)	BC212 BC213 BC214		60 80 140	— — —	— — 600	
($I_C = 100$ mAdc, $V_{CE} = 5$ Vdc)*	BC212, BC214 BC213		— —	120 140	— —	

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{CE(sat)}$	—	0.10	—	Vdc
(I_C = 100 mAdc, I_B = 5 mAdc)*			—	0.25	0.6	
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5 mAdc)		$V_{BE(sat)}$	—	1.00	1.4	Vdc
Base-Emitter on Voltage (I_C = 2 mAdc, V_{CE} = 5 Vdc)		$V_{BE(on)}$	0.6	0.62	0.72	Vdc

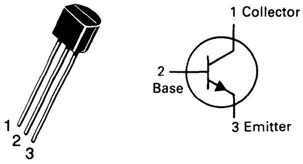
DYNAMIC CHARACTERISTICS

Characteristic	Type	Symbol	Min	Typ	Max	Unit
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 50 MHz)	BC212	f_T	—	280	—	MHz
	BC214		—	320	—	
	BC213		—	360	—	
Common-Base Output Capacitance (V_{CB} = 10 Vdc, I_C = 0, f = MHz)		C_{ob}	—	—	6.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 30 Hz to 15 KHz)	BC214	NF	—	—	2	dB
(I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 1 KHz, f = 200 Hz)	BC213		—	—	10	
	BC212		—	—	10	
Small Signal Current Gain (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 KHz)	BC212	h_{fe}	60	—	—	
	BC213		80	—	—	
	BC214		140	—	—	
	BC212A, BC213A		100	—	300	
	BC212B, BC213B,		200	—	400	
	BC214B		200	—	400	
	BC213C, BC214C		350	—	600	

*Pulse-test: Tp 300 s, Duty-cycle 2%.

BC237, A, B, C
BC238, A, B, C
BC239, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 237	BC 238	BC 239	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	25	Vdc
Collector-Emitter Voltage	V_{CES}	50	30	30	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	5.0	5.0	Vdc
Collector Current – Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Type	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 2.0 mA, I_B = 0)	BC237 BC238 BC239	$V_{(BR)CEO}$	45 25 25			V
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	BC237 BC238 BC239	$V_{(BR)EBO}$	6 5 5			V
Collector Cutoff Current						
(V_{CE} = 30 V, V_{BE} = 0)	BC238 BC239	I_{CES}		0.20 0.20	15 15	nA
(V_{CE} = 50 V, V_{BE} = 0)	BC237			0.20	15	
(V_{CE} = 30 V, V_{BE} = 0) T_A = 125°C	BC238 BC239			0.20 0.20	4 4	μA
(V_{CE} = 50 V, V_{BE} = 0) T_A = 125°C	BC237			0.20	4	
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5 V)		h_{FE}				
	BC237A/238A			90		
	BC237B/238B/239B			150		
	BC237C/238C/239C			270		
(I_C = 2 mA, V_{CE} = 5 V)	BC237		120		800	
	BC238		120		800	
	BC239		120		800	
	BC237A/238A		120	170	220	
	BC237B/238B/239B		200	290	460	
	BC237C/238C/239C		380	500	800	
(I_C = 100 mA, V_{CE} = 5 V)	BC237A/238A			120		
	BC237B/238B/239B			180		
	BC237C/238C/239C			300		
Collector-Emitter On Voltage (I_C = 10 mA, I_B = 0.5 mA)	BC237/BC238/BC239	$V_{CE(sat)}$		0.07	0.20	V
(I_C = 100 mA, I_B = 5 mA)	BC237/BC239			0.20	0.60	
	BC238				0.8	
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$		0.60	0.83	V
(I_C = 100 mA, I_B = 5 mA)					1.05	
Base-Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 100 μA, V_{CE} = 5 V)				0.50		
(I_C = 2 mA, V_{CE} = 5 V)			0.55	0.62	0.70	
(I_C = 100 mA, V_{CE} = 5 V)				0.83		

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

Characteristic	Type	Symbol	Min.	Typ.	Max.	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product		f_T				MHz
(I_C = 0.5 mA, V_{CE} = 3 V, f = 100 MHz)	BC237			100		
	BC238			120		
	BC239			140		
(I_C = 10 mA, V_{CE} = 5 V, f = 100 MHz)	BC237		150	200		
	BC238		150	240		
	BC239		150	280		
Collector-Base Capacitance (V_{CB} = 10 V, I_C = 0, f = 1 MHz)		C_{obo}			4.50	pF
Emitter-Base Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1 MHz)		C_{ibo}		8.0		pF
Noise Figure		NF				dB
(I_C = 0.2 mA, V_{CE} = 5 V, R_S = 2 Kohms, f = 30 Hz to 15 KHz)	BC239			2	4	
(I_C = 0.2 mA, V_{CE} = 5 V, R_S = 2 Kohms, f = 1 KHz, Δf = 200 Hz)	BC237			2	10	
	BC238			2	10	
	BC239			2	4	

FIGURE 1 – NORMALIZED DC CURRENT GAIN

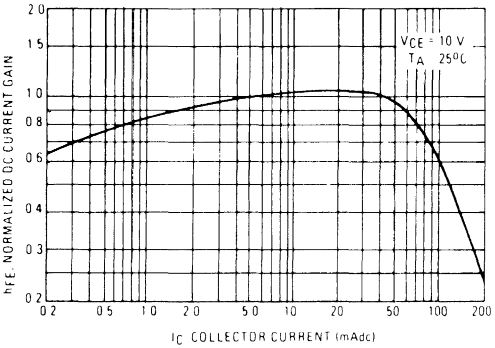


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

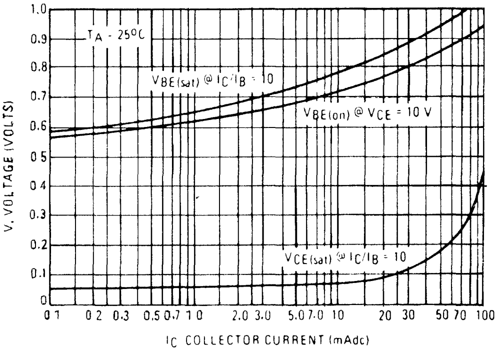


FIGURE 3 – CURRENT GAIN-BANDWIDTH PRODUCT

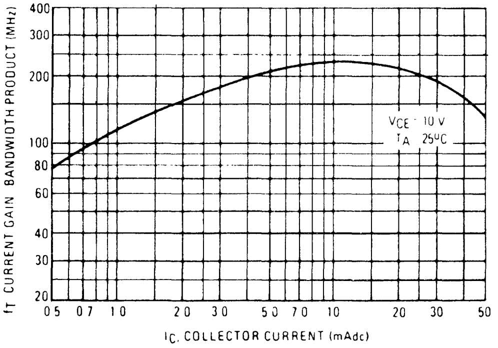


FIGURE 4 – CAPACITANCES

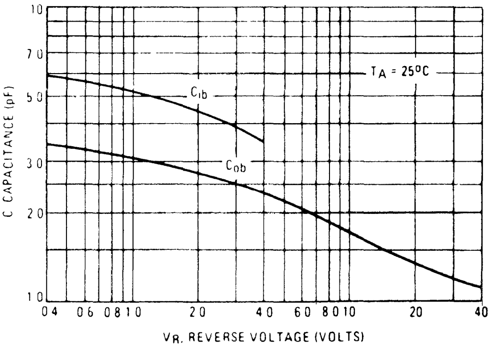
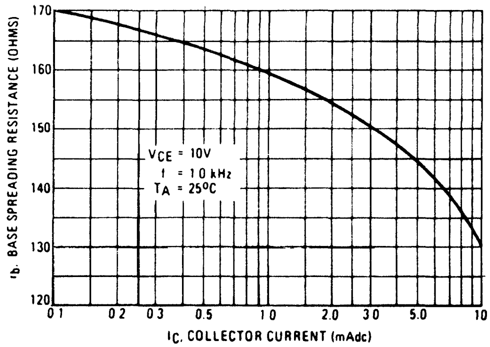
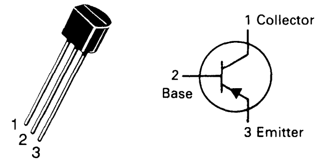


FIGURE 5 – BASE SPREADING RESISTANCE



BC307, A, B, C
thru
BC309, A, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 307	BC 308	BC 309	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Type	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	BC307	$V_{(BR)CEO}$	45	—	—	Vdc
	BC308		25	—	—	
	BC309		25	—	—	
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0)	BC307	$V_{(BR)EBO}$	5	—	—	Vdc
	BC308		5	—	—	Vdc
	BC309		5	—	—	
Collector-Emitter Leakage Current		I_{CES}				nA
(V_{CES} = 50 V, V_{BE} = 0)	BC307			0.2	15	
(V_{CES} = 30 V, V_{BE} = 0)	BC308			0.2	15	
	BC309			0.2	15	
(V_{CES} = 50 V, V_{BE} = 0) T_A = 125°C	BC307			0.2	4.0	µA
(V_{CES} = 30 V, V_{BE} = 0) T_A = 125°C	BC308			0.2	4.0	
	BC309			0.2	4.0	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 10 µAdc, V_{CE} = 5 Vdc)	BC307A/308A/309A		—	90	—	
	BC307B/308B/309B		—	150	—	
	BC307C/308C/309C		—	270	—	
(I_C = 2 mAdc, V_{CE} = 5 Vdc)	BC307		120	—	800	
	BC308		120	—	800	
	BC309		120	—	800	
	BC307A/308A/309A		120	170	220	
	BC307B/308B/309B		200	290	460	
	BC307C/308C/309C		420	500	800	
(I_C = 100 mAdc, V_{CE} = 5 Vdc)	BC307A/308A/309A		—	120	—	
	BC307B/308B/309B		—	180	—	
	BC307C/308C/309C		—	300	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0,5 mAdc)			—	0.10	0.30	
(I_C = 10 mAdc, I_B = see Note 1)			—	0.30	0.60	
(I_C = 100 mAdc, I_B = 5 mAdc)			—	0.25	—	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)			—	0.70	—	
(I_C = 100 mAdc, I_B = 5 mAdc)			—	1.00	—	
Base-Emitter on Voltage (I_C = 2 mAdc, V_{CE} = 5 Vdc)		$V_{BE(on)}$	0.55	0.62	0.70	Vdc

Note 1: I_C = 10 mAdc on the constant base current characteristic, which yields the point I_C = 11 mAdc, V_{CE} = 1 V

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

Characteristic	Type	Symbol	Min.	Typ.	Max.	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 50 MHz)	BC307 BC308 BC309	f_T	— — —	280 320 360	— — —	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_C = 0, f = 1 MHz)		C_{cbo}	—	—	6.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 30 Hz to 15 KHz)	BC309	NF	—	2	4	dB
(I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 1 KHz, f = 200 Hz)	BC307 BC308 BC309		— — —	2 2 2	10 10 4	

FIGURE 1 – NORMALIZED DC CURRENT GAIN

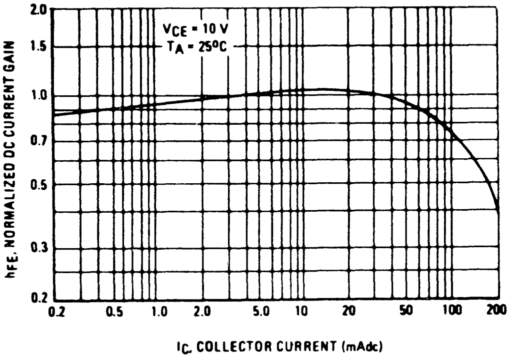


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

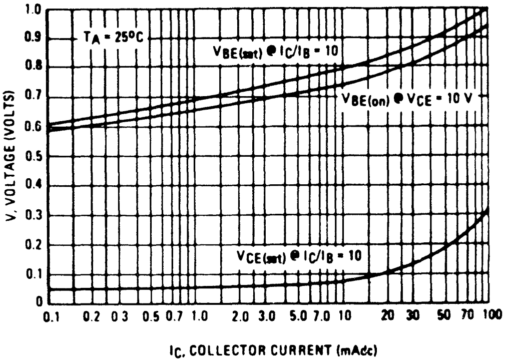


FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

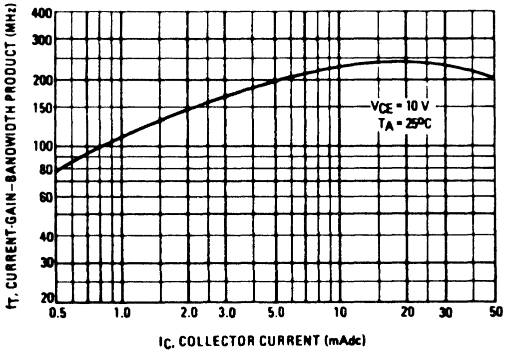


FIGURE 4 – CAPACITANCES

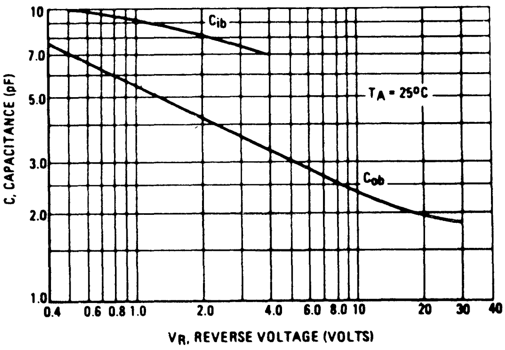


FIGURE 5 – OUTPUT ADMITTANCE

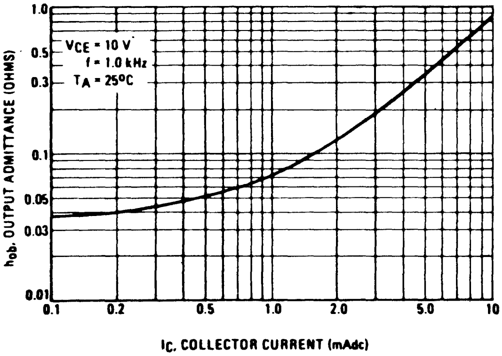
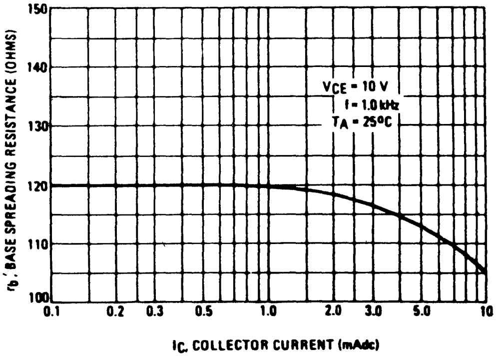
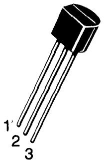


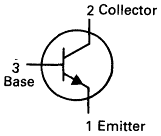
FIGURE 6 – BASE SPREADING RESISTANCE



BC317, A, B

CASE 29-04, STYLE 14
TO-92 (TO-226AA)





AMPLIFIER TRANSISTORS

NPN SILICON

Refer to BC549 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

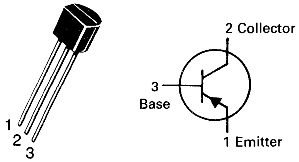
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)		$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μA, V_{BE} = 0)		$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)		$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)		I_{CBO}	—	—	30	nAdc
ON CHARACTERISTICS						
Base-Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.57	0.63	0.72	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	—	0.14	0.6	Vdc
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mA, I_B = 0.5 mA)			—	0.7	—	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.85	—	
DC Current Gain		h_{FE}				
(I_C = 10 μA, V_{CE} = 5.0 V)	BC317A		—	90	—	
	BC317B		40	150	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC317A		110	180	450	
	BC317B		200	290	450	

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

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Spot Noise Figure (I_C = 200 μA, V_{CE} = 5.0 V, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	2.0	6.0	dB
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.5	4.0	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)	C_{ib}	—	11.5	—	pF
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V)	f_T	—	280	—	MHz
Voltage Feedback Ratio (I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	h_{re}	—	2.0	—	$X10^{-4}$
Input Impedance (I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	h_{ie}	—	5.0	—	Kohms
Output Admittance (I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	h_{oe}	—	20	—	μmhos
Small-Signal Current Gain	h_{fe}				
(I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz) BC317A		125	220	260	
BC317B		240	330	500	

BC320, A, B

CASE 29-04, STYLE 14
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to BC559 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

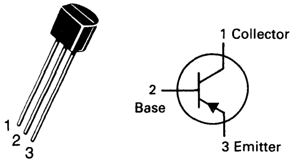
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mA, $I_B = 0$)		$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100$ μA, $V_{BE} = 0$)		$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA, $I_E = 0$)		$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μA, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ V, $I_E = 0$)		I_{CBO}	—	—	30	nAdc
ON CHARACTERISTICS						
Base-Emitter On Voltage		$V_{BE(on)}$				Vdc
($I_C = 2.0$ mA, $V_{CE} = 5.0$ V)			0.57	0.68	0.72	
($I_C = 10$ mA, $V_{CE} = 5.0$ V)			—	—	0.77	
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_B = 5.0$ mA)		$V_{CE(sat)}$	—	0.35	0.5	Vdc
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
($I_C = 10$ mA, $I_B = 0.5$ mA)			—	0.77	—	
($I_C = 100$ mA, $I_B = 5.0$ mA)			—	0.99	—	
DC Current Gain		h_{FE}				
($I_C = 10$ μA, $V_{CE} = 5.0$ V)	BC320A		—	50	—	
	BC320B		40	100	—	
($I_C = 2.0$ mA, $V_{CE} = 5.0$ V)	BC320		110	—	450	
	BC320A		110	—	220	
	BC320B		200	—	450	

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

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Spot Noise Figure (I_C = 200 μA, V_{CE} = 5.0 V, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	BC320	NF	—	2.0	6.0	dB
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	—	3.0	4.0	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ib}	—	16	—	pF
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V)		f_T	—	250	—	MHz
Small-Signal Current Gain (I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC320	h_{fe}	125	—	500	
	BC320A		125	—	260	
	BC320B		240	—	500	

BC327, -16, -25, -40
BC328, -16, -25, -40

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC327	BC328	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	800		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	BC327 BC328	$V_{(BR)CEO}$	45 25	— —	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μA, I_E = 0)	BC327 BC328	$V_{(BR)CES}$	50 30	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 20 V, I_E = 0)	BC327 BC328	I_{CBO}	— —	— —	100 100	nAdc
Collector Cutoff Current (V_{CE} = 45 V, V_{BE} = 0) (V_{CE} = 25 V, V_{BE} = 0)	BC327 BC328	I_{CES}	— —	— —	100 100	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 100 mA, V_{CE} = 1.0 V)	BC327/BC328	h_{FE}	100	—	630	—
	BC327-16/BC328-16		100	—	250	
	BC327-25/BC328-25		160	—	400	
	BC327-40/BC328-40		250	—	630	
(I_C = 300 mA, V_{CE} = 1.0 V)			40	—	—	
Base-Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	—	—	1.2	Vdc
Collector-Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	—	—	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	—	11	—	pF
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V)		f_T	—	260	—	MHz

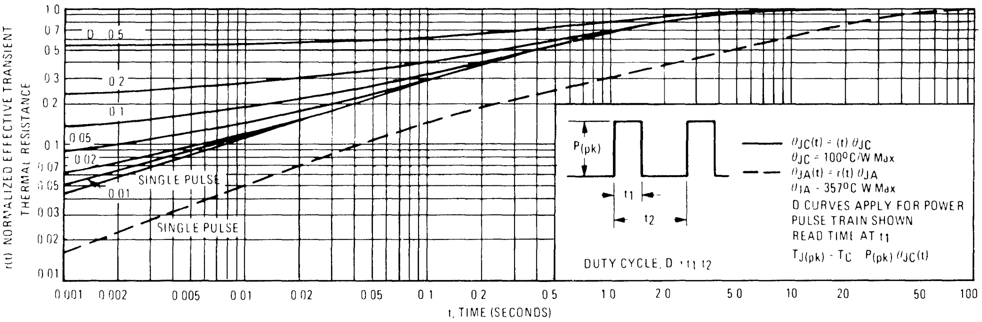


FIGURE 1 – THERMAL RESPONSE

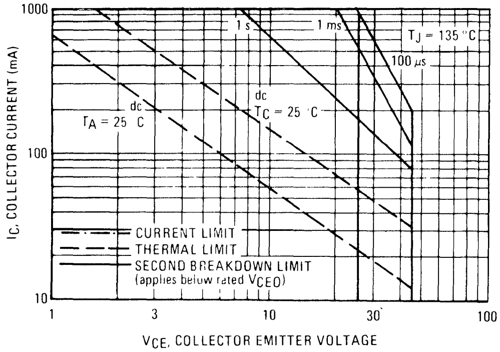


FIGURE 2 – ACTIVE REGION SAFE OPERATING AREA

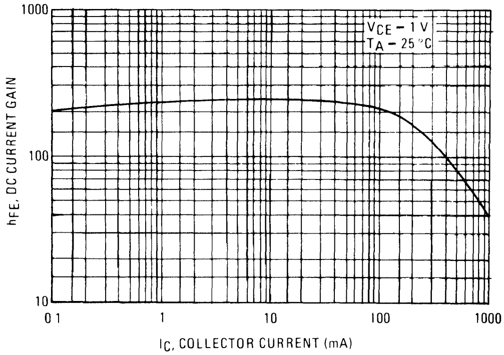


FIGURE 3 – DC CURRENT GAIN

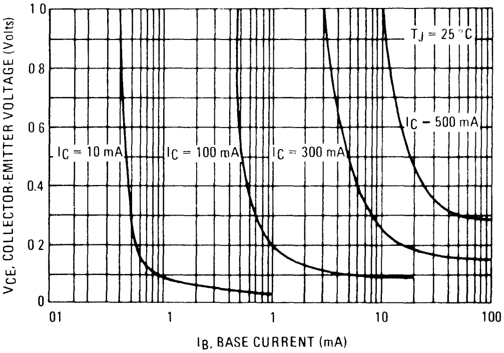


FIGURE 4 – SATURATION REGION

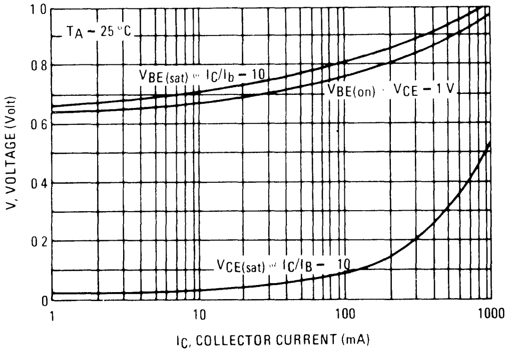


FIGURE 5 – "ON" VOLTAGES

FIGURE 6 – TEMPERATURE COEFFICIENTS

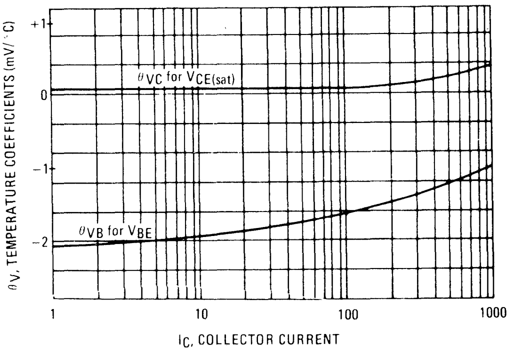
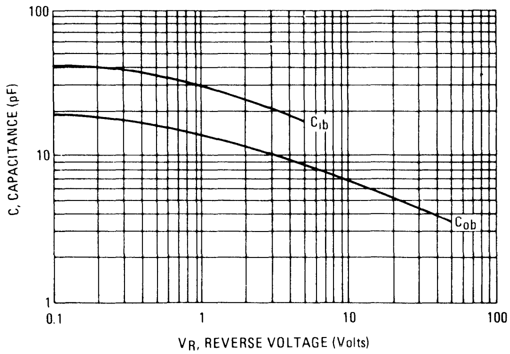
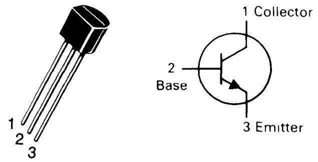


FIGURE 7 – CAPACITANCES



BC337, -16, -25, -40
BC338, -16, -25, -40

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC337	BC338	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	800		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	 BC337 BC338	$V_{(BR)CEO}$	 45 25	 — —	 — —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μA, I_E = 0)	 BC337 BC338	$V_{(BR)CES}$	 50 30	 — —	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 20 V, I_E = 0)	 BC337 BC338	I_{CBO}	 — —	 — —	 100 100	nAdc
Collector Cutoff Current (V_{CE} = 45 V, V_{BE} = 0) (V_{CE} = 25 V, V_{BE} = 0)	 BC337 BC338	I_{CES}	 — —	 — —	 100 100	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 100 mA, V_{CE} = 1.0 V) (I_C = 300 mA, V_{CE} = 1.0 V)	 BC337/BC338 BC337-16/BC338-16 BC337-25/BC338-25 BC337-40/BC338-40	h_{FE}	 100 100 160 250 60	 — — — — —	 630 250 400 630 —	—
Base-Emitter On Voltage (I_C = 300 mA, V_{CE} = 1.0 V)		$V_{BE(on)}$	—	—	1.2	Vdc
Collector-Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	—	—	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	—	15	—	pF
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V)		f_T	—	210	—	MHz

FIGURE 1 — THERMAL RESPONSE

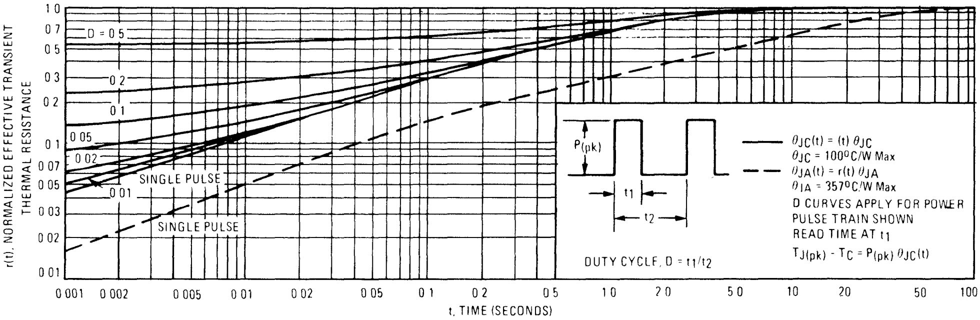


FIGURE 2 — ACTIVE REGION SAFE OPERATING AREA

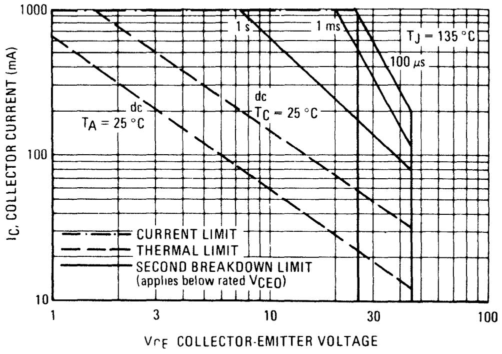


FIGURE 3 — DC CURRENT GAIN

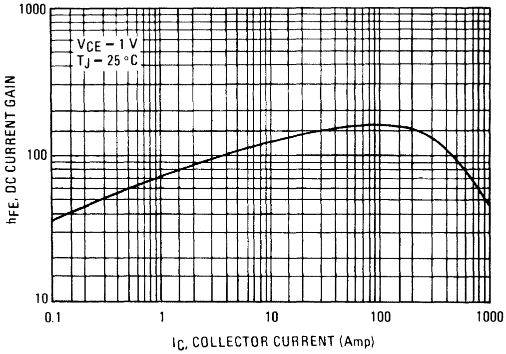


FIGURE 4 — SATURATION REGION

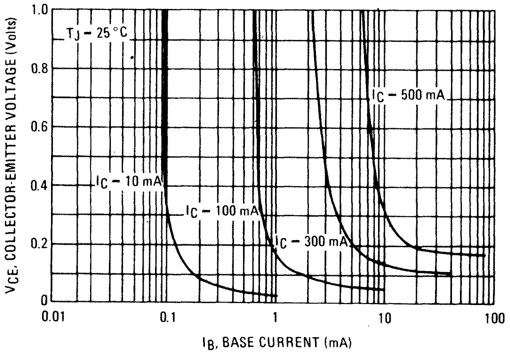


FIGURE 5 — "ON" VOLTAGES

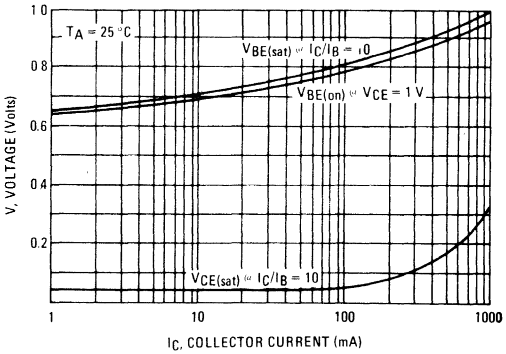


FIGURE 6 – TEMPERATURE COEFFICIENTS

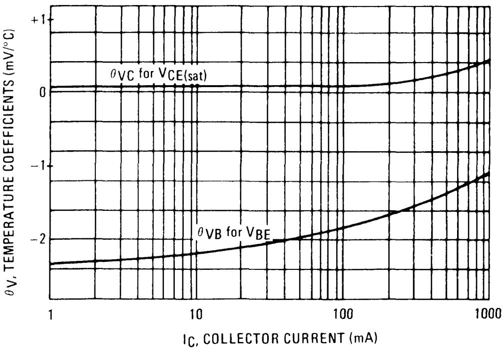
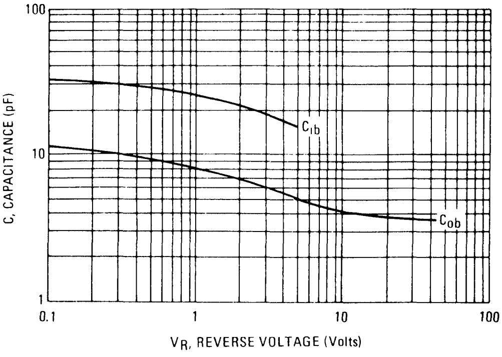
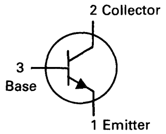


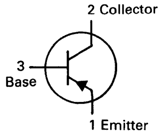
FIGURE 7 – CAPACITANCES

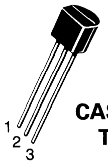


NPN
BC368



PNP
BC369





CASE 29-04, STYLE 14
TO-92 (TO-226AA)

AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Emitter Voltage	V_{CES}	25	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	800 6.4	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.75 22	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	156	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μA, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0) (V_{CB} = 25 V, I_E = 0, T_J = 150°C)	I_{CBO}	 — —	 — —	 10 1.0	 μAdc mAdc
Emitter Cutoff Current (V_{EB} = 5.0 V, I_C = 0)	I_{EBO}	—	—	10	μAdc
ON CHARACTERISTICS					
DC Current Gain (V_{CE} = 10 V, I_C = 5.0 mA) (V_{CE} = 1.0 V, I_C = 0.5 A) (V_{CE} = 1.0 V, I_C = 1.0 A)	h_{FE}	 50 85 60	 — — —	 — 375 —	—
Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V, f = 20 MHz)	f_T	65	—	—	MHz
Collector-Emitter Saturation Voltage (I_C = 1.0 A, I_B = 100 mA)	$V_{CE(sat)}$	—	—	0.5	V
Base-Emitter On Voltage (I_C = 1.0 A, V_{CE} = 1.0 V)	$V_{BE(on)}$	—	—	1.0	V

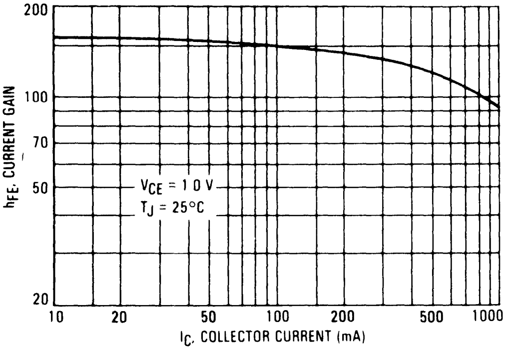


FIGURE 1 — DC CURRENT GAIN

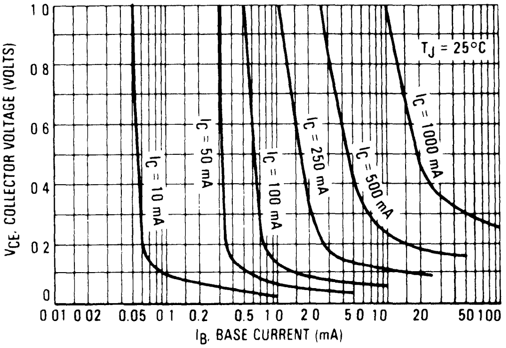


FIGURE 2 — COLLECTOR SATURATION REGION

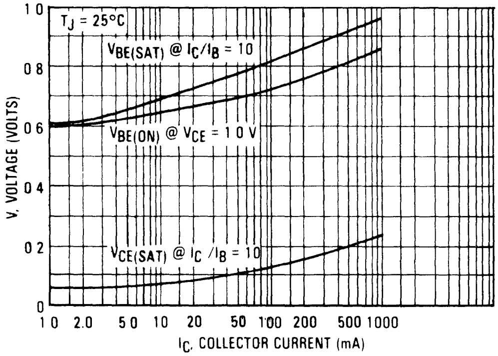


FIGURE 3 — ON VOLTAGES

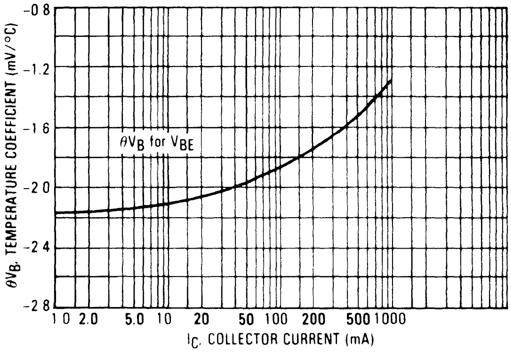


FIGURE 4 — TEMPERATURE COEFFICIENT

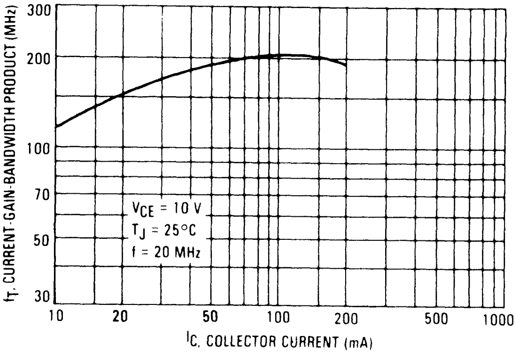


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT

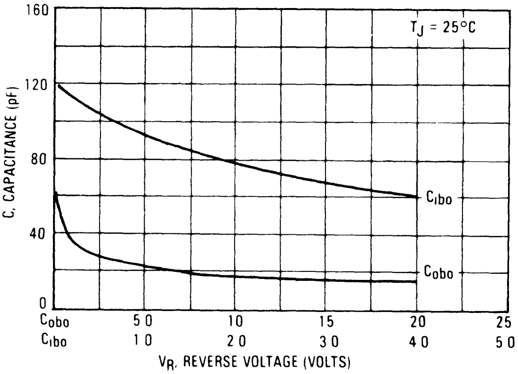
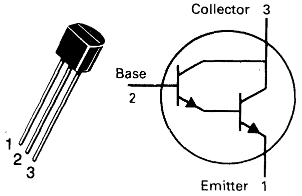


FIGURE 6 — CAPACITANCE

BC372, -16, -25, -40
BC373, -16, -25

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE DARLINGTON TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 372	BC 373	Unit
Collector-Emitter Voltage	V_{CEO}	100	80	Vdc
Collector-Base Voltage	V_{CBO}	100	80	Vdc
Emitter-Base Voltage	V_{EBO}	12		Vdc
Collector Current − Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage*		$V_{(BR)CES}$				Vdc
(I_C = 100 µAdc, I_B = 0)	BC372		100	—	—	
	BC373		80	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 µAdc, I_E = 0)	BC372		100	—	—	
	BC373		80	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 80 Vdc, I_E = 0)	BC372		—	—	100	
(V_{CB} = 60 Vdc, I_E = 0)	BC373		—	—	100	
Emitter Cutoff Current (V_{BE} = 10 V, I_C = 0)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				K
(I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	plain range		8.0	—	—	
	BC372, BC373-16		8.0	—	—	
	BC372, BC373-25		20	—	—	
	BC372		40	—	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	plain range		10	—	160	
	BC372, BC373-16		10	—	60	
	BC372, BC373-25		25	—	160	
	BC372		60	—	600	
Collector-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 0.25 mAdc)		$V_{CE(sat)}$	—	1.0	1.1	Vdc
Base-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 0.25 mAdc)		$V_{BE(sat)}$	—	1.4	2.0	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	100	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	10	25	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_g = 100 kohm, F = 1.0 kHz)		NF	—	2.0	—	dB

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

FIGURE 1 – DC CURRENT GAIN

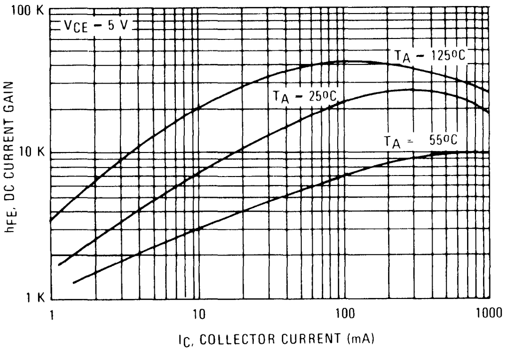


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

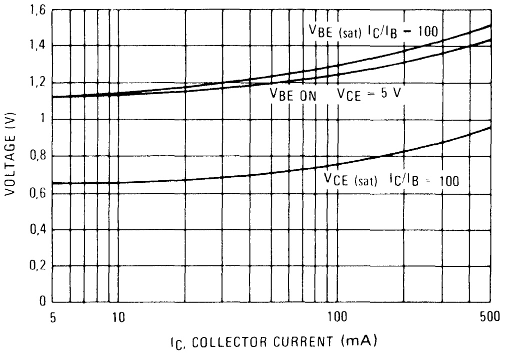


FIGURE 3 – CURRENT GAIN BANDWIDTH PRODUCT

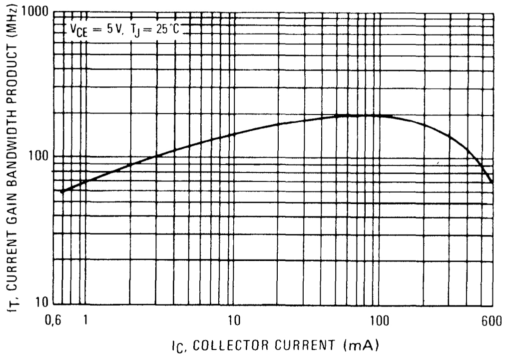
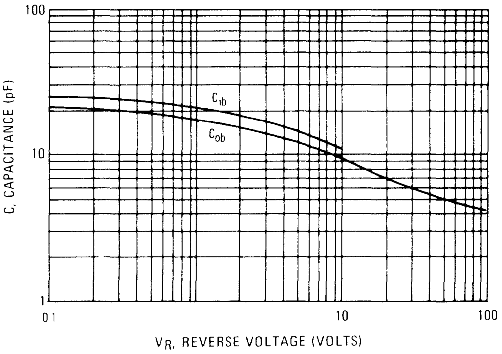
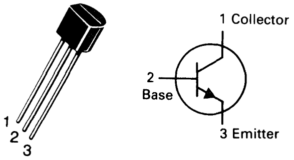


FIGURE 4 – CAPACITANCES



BC413, B, C
BC414, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

NPN SILICON

Refer to BC549 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 413	BC 414	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Base Voltage	V_{CBO}	45	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current − Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

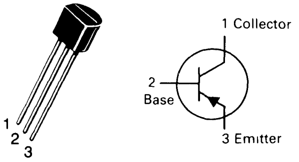
Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0) BC413		30			
BC414		45			
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 10 µAdc, I_E = 0) BC413		45			
BC414		50			
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	5			Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 30 Vdc, I_E = 0)				15	nAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = +125°C)				5	µAdc
Emitter Cutoff Current (V_{EB} = 4 Vdc, I_C = 0)	I_{EBO}			15	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				
(I_C = 10 µAdc, V_{CE} = 5 Vdc) BC413B/BC414B		100	150		
BC413C/BC414C		100	270		
(I_C = 2 mAdc, V_{CE} = 5 Vdc) BC413B/BC414B		180	290	460	
BC413C/BC414C		380	500	800	
BC413/BC414		180	350	800	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)			0.075	0.25	
(I_C = 10 mAdc, I_B = see note 1)			0.3	0.6	
(I_C = 100 mAdc, I_B = 5 mAdc, see note 2)			0.25	0.6	
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5 mAdc)	$V_{BE(sat)}$		1.1		Vdc
Base-Emitter On Voltage	$V_{BE(on)}$				Vdc
(I_C = 10 µAdc, V_{CE} = 5 Vdc)			0.52		
(I_C = 100 µAdc, V_{CE} = 5 Vdc)			0.55		
(I_C = 2 mAdc, V_{CE} = 5 Vdc)		0.55	0.62	0.75	
SMALL SIGNAL CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 100 MHz)	f_T		250		MHz
Collector-Base Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cbo}		2.5		pF
Noise Figure (I_C = 200 µAdc, V_{CE} = 5 Vdc, R_S = 2 KΩ, f = 30 Hz − 15 KHz)	NF		0.6	2.5	dB

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1 V

Note 2: Pulse test = 300 µs − Duty cycle = 2%

BC415, B, C
BC416, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 415	BC 416	Unit
Collector-Emitter Voltage	V_{CEO}	35	45	Vdc
Collector-Base Voltage	V_{CBO}	45	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

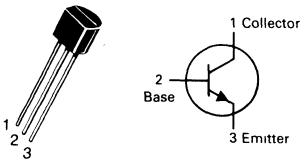
Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0) BC415 BC416	$V_{(BR)CEO}$	 35 45			Vdc
Collector-Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0) BC415 BC416	$V_{(BR)CBO}$	 45 50			Vdc
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	 5			Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = +125°C)	I_{CBO}			 15 5	 nAdc µAdc
Emitter Cutoff Current (V_{EB} = 4 Vdc, I_C = 0)	I_{EBO}			 15	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 µAdc, V_{CE} = 5 Vdc) BC415B/BC416B BC415C/BC416C (I_C = 2 mAdc, V_{CE} = 5 Vdc) BC415B/BC416B BC415C/BC416C BC415/BC416	h_{FE}	 100 100 180 380 120	 150 270 290 500 350	 460 800 800	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 10 mAdc, I_B = see note 1) (I_C = 100 mAdc, I_B = 5 mAdc, see note 2)	$V_{CE(sat)}$		 0.075 0.3 0.25	 0.25 0.6	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5 mAdc)	$V_{BE(sat)}$		 1.1		Vdc
Base-Emitter On Voltage (I_C = 10 µAdc, V_{CE} = 5 Vdc) (I_C = 100 µAdc, V_{CE} = 5 Vdc) (I_C = 2 mAdc, V_{CE} = 5 Vdc)	$V_{BE(on)}$	 0.55	 0.52 0.55 0.62	 0.75	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 100 MHz)	f_T		 250		MHz
Collector-Base Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cbo}		 2.5		pF
Noise Figure (I_C = 200 µAdc, V_{CE} = 5 Vdc, R_S = 2 KΩ, f = 30 Hz – 15 KHz)	NF		 0.5	 2.0	dB

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1 V

Note 2: Pulse test = 300 µs – Duty cycle = 2%

BC445, A
BC447, A, B
BC449, A, B

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPS8098 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 445	BC 447	BC 449	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	300			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

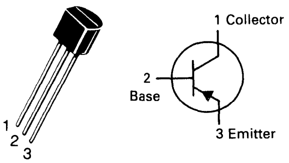
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage*		$V_{(BR)CEO}$				Vdc
(I_C = 1.0 mAdc, I_B = 0)	BC445		60	—	—	
	BC447		80	—	—	
	BC449		100	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μA, I_E = 0)	BC445		60	—	—	
	BC447		80	—	—	
	BC449		100	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BC445		—	—	100	
(V_{CB} = 60 Vdc, I_E = 0)	BC447		—	—	100	
(V_{CB} = 80 Vdc, I_E = 0)	BC449		—	—	100	
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				—
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC445/447/449		50	—	460	
	BC445A/447A/449A		120	—	220	
	BC447B/449B		180	—	460	
(I_C = 10 mA, V_{CE} = 5.0 V)	BC445/447/449		50	—	—	
	BC445A/447A/449A		100	—	—	
	BC447B/449B		160	—	—	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC445/447/449		50	—	—	
	BC445A/447A/449A		60	—	—	
	BC447B/449B		90	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.1	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{BE(sat)}$	—	0.85	—	Vdc
Base-Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 100 mA, V_{CE} = 5.0 V)*			—	0.8	1.2	
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	250	—	MHz

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

BC446, A, B
BC448, A, B
BC450, A, B

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPS8598 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 446	BC 448	BC 450	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current – Continuous	I_C	300			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

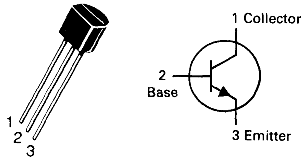
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage*		$V_{(BR)CEO}$				Vdc
(I_C = 1.0 mAdc, I_B = 0)	BC446		60	—	—	
	BC448		80	—	—	
	BC450		100	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μA, I_E = 0)	BC446		60	—	—	
	BC448		80	—	—	
	BC450		100	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 40 Vdc, I_E = 0)	BC446		—	—	100	
(V_{CB} = 60 Vdc, I_E = 0)	BC448		—	—	100	
(V_{CB} = 80 Vdc, I_E = 0)	BC450		—	—	100	
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC446/448/450		50	—	460	
	BC446A/448A/450A		120	—	220	
	BC446B/448B/450B		180	—	460	
(I_C = 10 mA, V_{CE} = 5.0 V)	BC446/448/450		50	—	—	
	BC446A/448A/450A		100	—	—	
	BC446B/448B/450B		160	—	—	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC446/448/450		50	—	—	
	BC446A/448A/450A		60	—	—	
	BC446B/448B/450B		90	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.125	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{BE(sat)}$	—	0.85	—	Vdc
Base-Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 100 mA, V_{CE} = 5.0 V)*			—	0.76	1.2	
DYNAMIC CHARACTERISTICS						
Current-Gain-Bandwidth Product (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	200	—	MHz

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

BC485, A, B, L
BC487, A, B, L
BC489, A, B, L

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

NPN SILICON

Refer to MPSA05 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 485	BC 487	BC 489	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	0.5			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

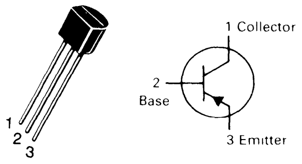
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage*	$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0) BC485		45	—	—	
BC487		60	—	—	
BC489		80	—	—	
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0) BC485		45	—	—	
BC487		60	—	—	
BC489		80	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				nAdc
V_{CB} = 30 Vdc − I_E = 0 BC485		—	—	100	
V_{CB} = 40 Vdc − I_E = 0 BC487		—	—	100	
V_{CB} = 60 Vdc − I_E = 0 BC489		—	—	100	
ON CHARACTERISTICS*					
DC Current Gain	h_{FE}				
(I_C = 10 mAdc − V_{CE} = 2.0 Vdc)		40			
(I_C = 100 mAdc − V_{CE} = 2.0 Vdc)					
BC485/487/489		60		400	
BC485L/487L/489L		60	120	150	
BC485A/487A/489A		100	160	250	
BC485B/487B/489B		160	260	400	
(I_C = 1 Adc − V_{CE} = 5.0 Vdc)*		15			
Collector Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 500 mAdc − I_B = 50 mAdc)		—	0.2	0.50	
(I_C = 1 Adc − I_B = 100 mAdc)		—	0.3	—	
Base Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.85	1.20	
(I_C = 1 Adc − I_B = 100 mAdc)*			0.90		
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)	f_T	—	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	7	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	50	—	pF

*Pulse test - Pulse width = 300 μs - Duty Cycle 2%.

BC486, A, B, L
BC488, A, B, L
BC490, A, B, L

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 486	BC 488	BC 490	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0			Vdc
Collector Current – Continuous	I_C	0.5			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

Refer to MPSA55 for graphs.

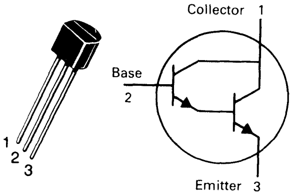
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage*	$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0) BC486		45	—	—	
BC488		60	—	—	
BC490		80	—	—	
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0) BC486		45	—	—	
BC488		60	—	—	
BC490		80	—	—	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$				Vdc
(I_E = 10 μAdc, I_C = 0)		4.0	—	—	
Collector Cutoff Current	I_{CBO}				nAdc
V_{CB} = 30 Vdc – I_E = 0 BC486		—	—	100	
V_{CB} = 40 Vdc – I_E = 0 BC488		—	—	100	
V_{CB} = 60 Vdc – I_E = 0 BC490		—	—	100	
ON CHARACTERISTICS*					
DC Current Gain	h_{FE}				
(I_C = 10 mAdc – V_{CE} = 2.0 Vdc)		40			
(I_C = 100 mAdc – V_{CE} = 2.0 Vdc)					
BC486/488/490		60	—	400	
BC486L/488L/490L		60	100	150	
BC486A/488A/490A		100	140	250	
BC486B/488B/490B		160	260	400	
(I_C = 1 Adc — V_{CE} = 5.0 Vdc)		15			
Collector Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 500 mAdc – I_B = 50 mAdc)		—	0.25	0.50	
(I_C = 1 Adc – I_B = 100 mAdc)		—	0.50	—	
Base Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.90	1.20	
(I_C = 1 Adc – I_B = 100 mAdc)			1.00		
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)	f_T	—	150	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	9	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	—	110	—	pF

* Pulse test - Pulse width = 300 μs - Duty Cycle 2%.

BC517, S

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC517	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	10	Vdc
Collector Current − Continuous	I_C	1.0	Adc
Total Power Dissipation $T_A = 25°C$ Derate above 25°C	P_D	625 12	mW mW/°C
Total Power Dissipation $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JA}$	83.3	°C/W

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

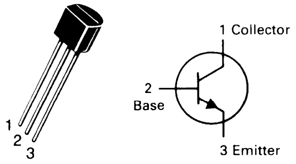
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 2.0$ mAdc, $V_{BE} = 0$)		$V_{(BR)CES}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ nAdc, $I_C = 0$)		$V_{(BR)EBO}$	10	—	—	Vdc
Collector Cutoff Current		I_{CES}				nA
($V_{CE} = 30$ V)	BC517		—	—	500	
($V_{CE} = 20$ V)	BC517S		—	—	5.0	
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)		I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 10$ Vdc, $I_C = 0$)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS (1)						
DC Current Gain		h_{FE}				—
($I_C = 20$ mAdc, $V_{CE} = 2.0$ V)			30,000	—	—	
($I_C = 180$ mAdc, $V_{CE} = 1.2$ V)	BC517S		33,000	—	—	
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 0.1$ mAdc)		$V_{CE(sat)}$	—	—	1.0	Vdc
Base-Emitter On Voltage ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	—	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain-Bandwidth Product (2) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	—	200	—	MHz

(1) Pulse Test Pulse Width ≤ 2.0%.

(2) $f_T = |h_{fe}| \bullet f_{test}$

BC546, A, B
BC547, A, B, C
BC548, A, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 546	BC 547	BC 548	Unit
Collector-Emitter Voltage	V_{CEO}	65	45	30	Vdc
Collector-Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current − Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	BC546 BC547 BC548	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector-Base Breakdown Voltage (I_C = 100 μAdc)	BC546 BC547 BC548	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	BC546 BC547 BC548	$V_{(BR)EBO}$	6.0 6.0 6.0	— — —	— — —	V
Collector Cutoff Current		I_{CES}				
(V_{CE} = 70 V, V_{BE} = 0)	BC546		—	0.2	15	nA
(V_{CE} = 50 V, V_{BE} = 0)	BC547		—	0.2	15	
(V_{CE} = 35 V, V_{BE} = 0)	BC548		—	0.2	15	
(V_{CE} = 30 V, T_A = 125°C)	BC546/547/548		—	—	4.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC546A/547A/548A BC546B/547B/548B BC548C		— — —	90 150 270	— — —	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC546 BC547 BC548 BC546A/547A/548A BC546B/547B/548B BC547C/BC548C		110 110 110 110 200 420	— — — 180 290 520	450 800 800 220 450 800	
(I_C = 100 mA, V_{CE} = 5.0 V)	BC546A/547A/548A BC546B/547B/548B BC548C		— — —	120 180 300	— — —	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.09	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.2	0.6	
(I_C = 10 mA, I_B = See Note 1)			—	0.3	0.6	
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
Base-Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.55	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	

NOTE 1: I_B is value for which I_C = 11 mA at V_{CE} = 1.0 V.

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

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	BC546	f_T	150	300	—	MHz
	BC547		150	300	—	
	BC548		150	300	—	
Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{obo}	—	1.7	4.5	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	10	—	pF
Small-Signal Current Gain (I_C = 2.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	BC546	h_{fe}	125	—	500	—
	BC547/548		125	—	900	
	BC546A/547A/548A		125	220	260	
	BC546B/547B/548B		240	330	500	
	BC547C/548C		450	600	900	
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 V, R_S = 2 kohms, f = 1.0 kHz, Δf = 200 Hz)	BC546	NF	—	2.0	10	dB
	BC547		—	2.0	10	
	BC548		—	2.0	10	

FIGURE 1 – NORMALIZED DC CURRENT GAIN

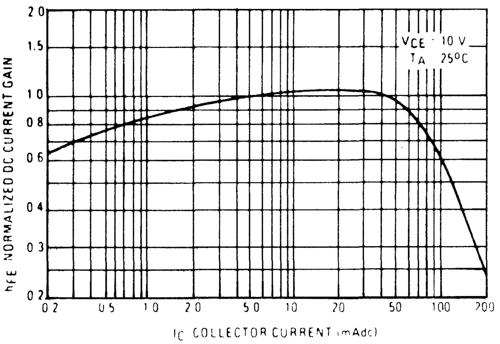


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

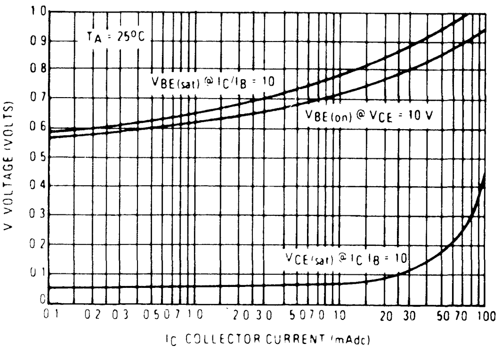


FIGURE 3 – COLLECTOR SATURATION REGION

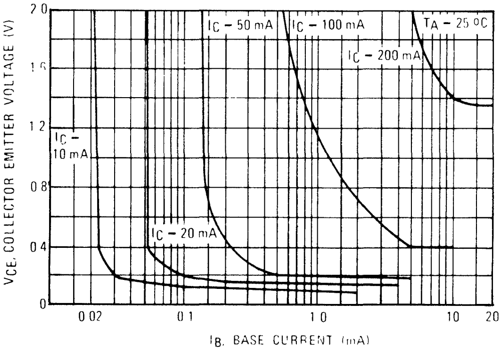
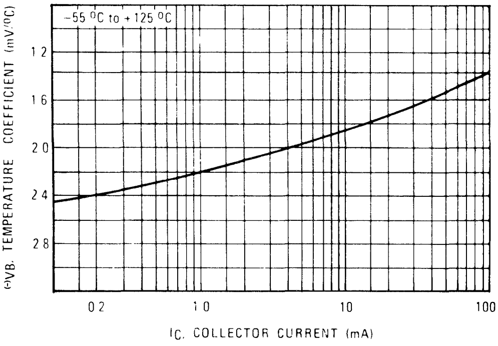


FIGURE 4 – BASE EMITTER TEMPERATURE COEFFICIENT



BC547/BC548

FIGURE 5 — CAPACITANCES

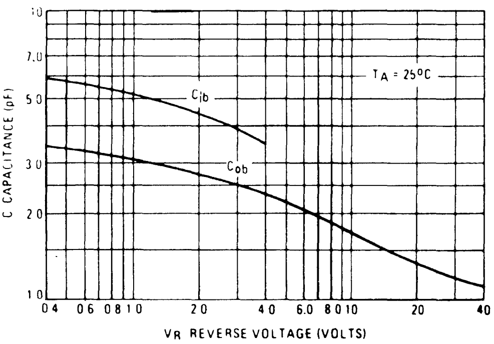


FIGURE 6 — CURRENT GAIN—BANDWIDTH PRODUCT

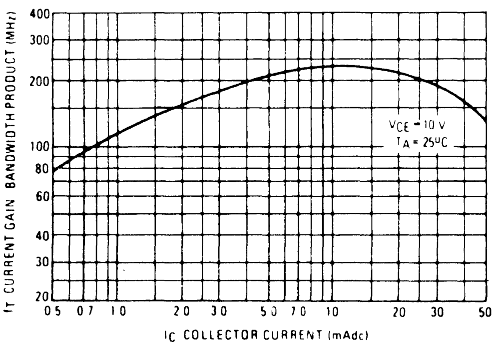


FIGURE 7 — DC CURRENT GAIN

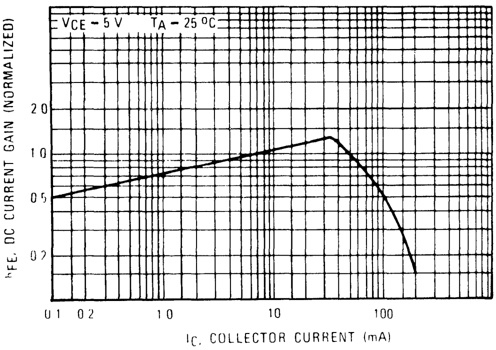


FIGURE 8 — "ON" VOLTAGE

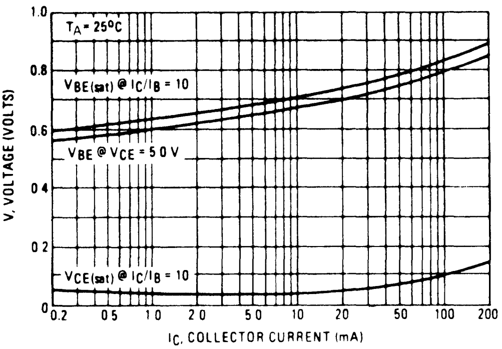


FIGURE 9 — COLLECTOR SATURATION REGION

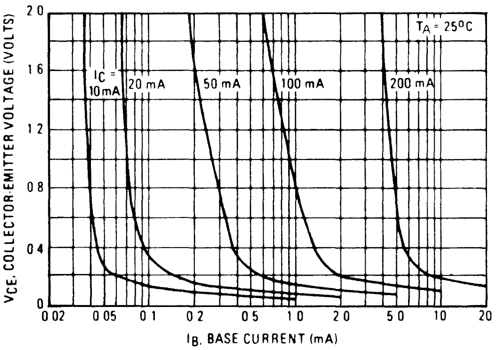
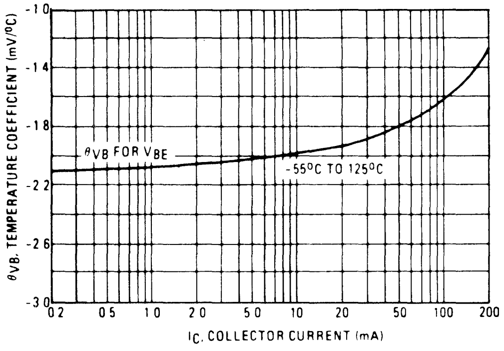


FIGURE 10 — BASE EMITTER TEMPERATURE COEFFICIENT



BC546

FIGURE 11 — CAPACITANCE

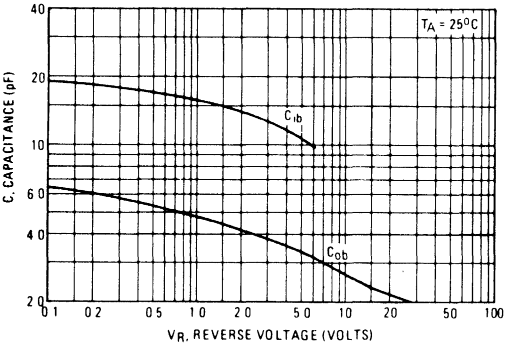
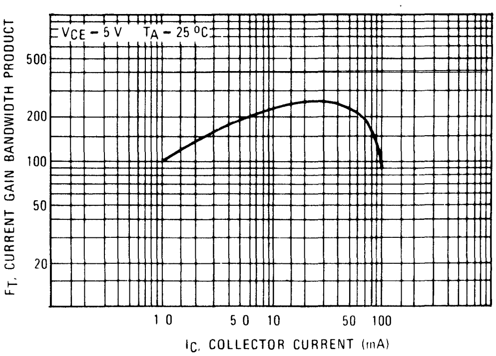
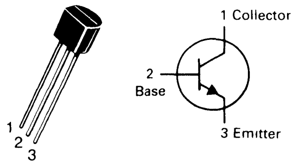


FIGURE 12 — CURRENT GAIN–BANDWIDTH PRODUCT



BC549, A, B, C
BC550, A, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 549	BC 550	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Base Voltage	V_{CBO}	30	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0) BC549 BC550	$V_{(BR)CEO}$	 30 45			Vdc
Collector-Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0) BC549 BC550	$V_{(BR)CBO}$	 30 50			Vdc
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	5			Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = +125°C)	I_{CBO}			 15 5	 nAdc µAdc
Emitter Cutoff Current (V_{EB} = 4 Vdc, I_C = 0)	I_{EBO}			 15	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 µAdc, V_{CE} = 5 Vdc) BC549B/550B BC549C/550C (I_C = 2 mAdc, V_{CE} = 5 Vdc) BC549A/550A BC549B/550B BC549C/550C BC549/550	h_{FE}	 100 100 110 200 420 110	 150 270 290 500 	 220 450 800 800	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 10 mAdc, I_B = see note 1) (I_C = 100 mAdc, I_B = 5 mAdc, see note 2)	$V_{CE(sat)}$		 0.075 0.3 0.25	 0.25 0.6 0.6	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5 mAdc)	$V_{BE(sat)}$		 1.1		Vdc
Base-Emitter On Voltage (I_C = 10 µAdc, V_{CE} = 5 Vdc) (I_C = 100 µAdc, V_{CE} = 5 Vdc) (I_C = 2 mAdc, V_{CE} = 5 Vdc)	$V_{BE(on)}$	 0.55	 0.52 0.55 0.62	 0.7	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 100 MHz)	f_T		 250		MHz
Collector-Base Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cbo}		 2.5		pF

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1 V

Note 2: Pulse test = 300 µs – Duty cycle = 2%

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

Characteristic		Symbol	Min	Typ	Max	Unit
Small-Signal Current Gain		h_{fe}				—
(I_C = 2.0 mAdc, V_{CE} = 5.0 V, f = 1.0 kHz)	BC549/BC550		125	—	900	
	BC549B/BC550B		240	330	500	
	BC549C/BC550C		450	600	900	
Noise Figure						dB
(I_C = 200 μAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 30 Hz–15 kHz)		NF_1	—	0.6	2.5	
(I_C = 200 μAdc, V_{CE} = 5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz)		NF_2	—	—	10	

FIGURE 1 – TRANSISTOR NOISE MODEL

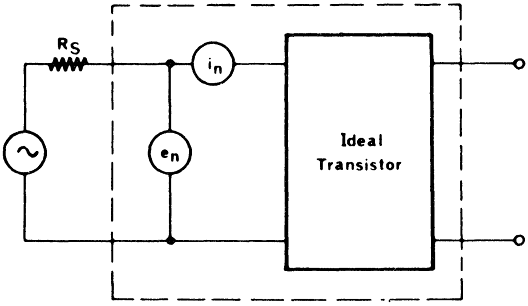


FIGURE 2 — NORMALIZED DC CURRENT GAIN

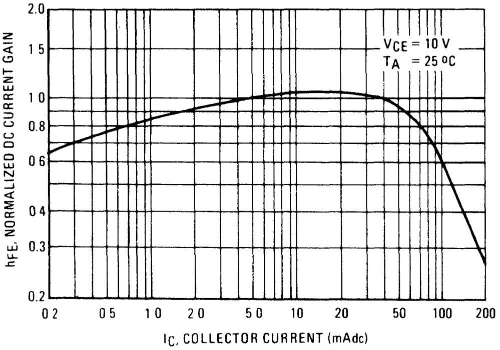


FIGURE 3 — "SATURATION" AND "ON" VOLTAGES

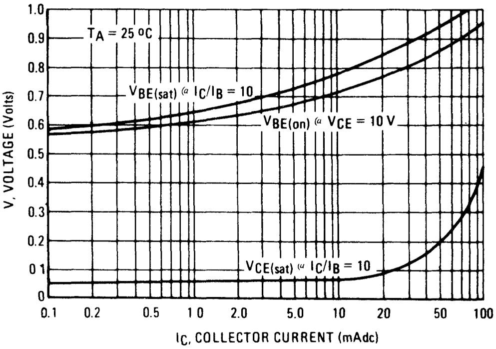


FIGURE 4 — CURRENT-GAIN BANDWIDTH PRODUCT

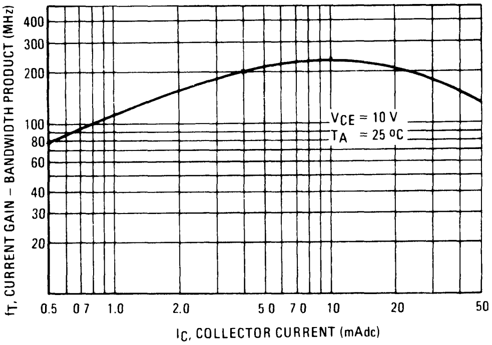


FIGURE 5 — CAPACITANCE

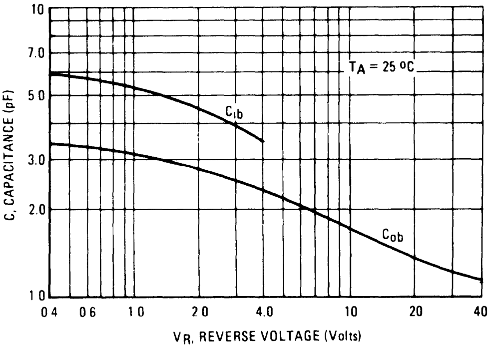
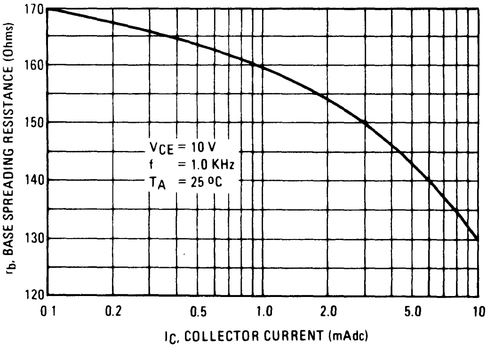
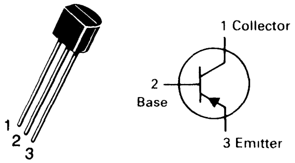


FIGURE 6 — BASE SPREADING RESISTANCE



BC556, A, B
BC557, A, B, C
BC558, A, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 556	BC 557	BC 558	Unit
Collector-Emitter Voltage	V_{CEO}	65	45	30	Vdc
Collector-Base Voltage	V_{CBO}	80	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	100			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
(I_C = 2.0 mAdc, I_B = 0)	BC556		65	—	—	
	BC557		45	—	—	
	BC558		30	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				V
(I_C = 100 μAdc)	BC556		80	—	—	
	BC557		50	—	—	
	BC558		30	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				V
(I_E = 100 μAdc, I_C = 0)	BC556		5.0	—	—	
	BC557		5.0	—	—	
	BC558		5.0	—	—	
Collector-Emitter Leakage Current		I_{CES}				nA
(V_{CES} = 40 V)	BC556		—	2.0	100	
(V_{CES} = 20 V)	BC557		—	2.0	100	
	BC558		—	2.0	100	
(V_{CES} = 20 V, T_A = 125°C)	BC556		—	—	4.0	
	BC557		—	—	4.0	μA
	BC558		—	—	4.0	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 V)	BC556A/557A/558A		—	90	—	
	BC556B/557B/558B		—	150	—	
	BC557C/558C		—	270	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 V)	BC556		120	—	500	
	BC557		120	—	800	
	BC558		120	—	800	
	BC556A/557A/558A		120	170	220	
	BC556B/557B/558B		180	290	460	
	BC557C/558C		420	500	800	
(I_C = 100 mAdc, V_{CE} = 5.0 V)	BC556A/557A/558A		—	120	—	
	BC556B/557B/558B		—	180	—	
	BC557C/558C		—	300	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mAdc, I_B = 0.5 mAdc)			—	0.075	0.3	
(I_C = 10 mAdc, I_B = see Note 1)			—	0.3	0.6	
(I_C = 100 mAdc, I_B = 5.0 mAdc)			—	0.25	0.65	

NOTE 1: I_C = 10 mAdc on the constant base current characteristics, which yields the point I_C = 11 mAdc, V_{CE} = 1.0 V.

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

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (continued)						
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 10 mAdc, I_B = 0.5 mAdc)			—	0.7	—	
(I_C = 100 mAdc, I_B = 5.0 mAdc)			—	1.0	—	
Base-Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)			0.55	0.62	0.7	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)			—	0.7	0.82	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product		f_T				MHz
(I_C = 10 mA, V_{CE} = 5.0 V, f = 50 MHz)	BC556		—	280	—	
	BC557		—	320	—	
	BC558		—	360	—	
Output Capacitance (V_{CB} = 10 V, I_C = 0, f = 1.0 MHz)		C_{ob}	—	3.0	6.0	pF
Noise Figure		NF				dB
(I_C = 0.2 mAdc, V_{CE} = 5.0 V, R_S = 2 kohms,	BC556		—	2.0	10	
f = 1.0 kHz, Δf = 200 Hz)	BC557		—	2.0	10	
	BC558		—	2.0	10	
Small-Signal Current Gain		h_{fe}				—
(I_C = 2.0 mAdc, V_{CE} = 5.0 V, f = 1.0 kHz)	BC556		125	—	500	
	BC557/558		125	—	900	
	BC556A/557A/558A		125	220	260	
	BC556B/557B/558B		240	330	500	
	BC557C/558C		450	600	900	

BC557/BC558

FIGURE 1 – NORMALIZED DC CURRENT GAIN

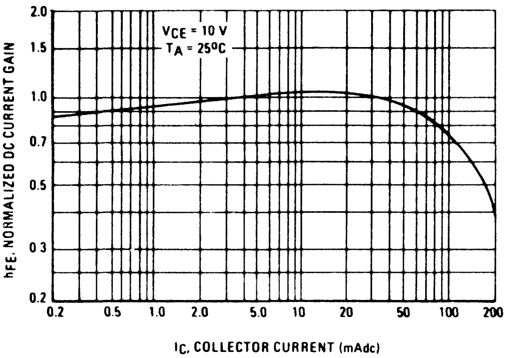


FIGURE 2 – "SATURATION" AND "ON" VOLTAGES

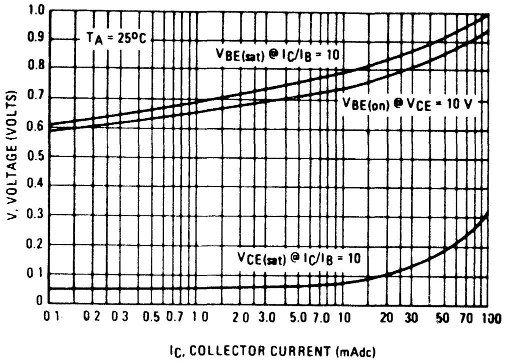


FIGURE 3 – COLLECTOR SATURATION REGION

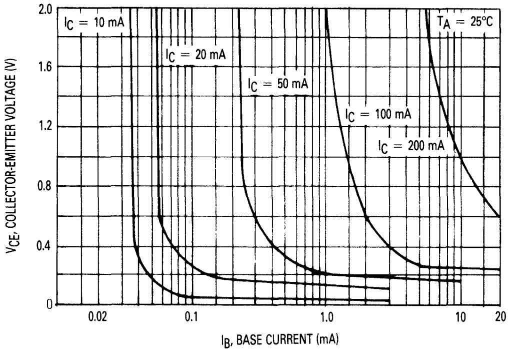


FIGURE 4 – BASE EMITTER TEMPERATURE COEFFICIENT

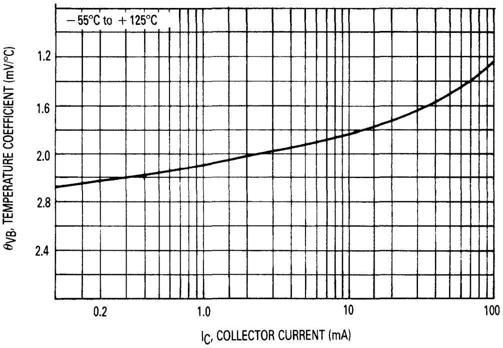


FIGURE 5 – CAPACITANCES

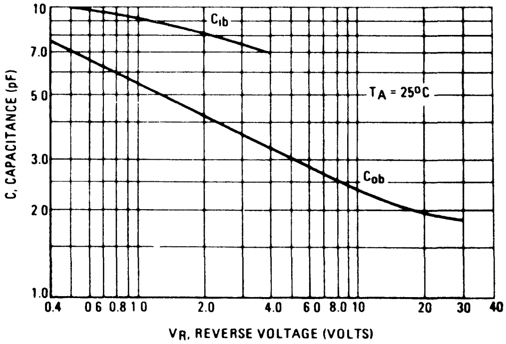
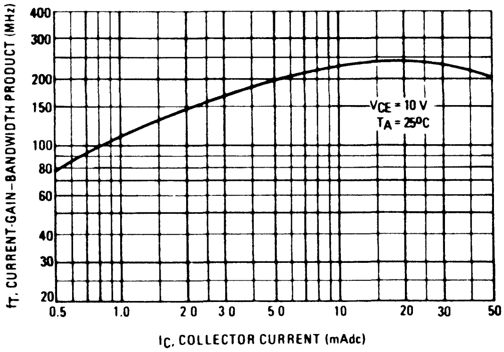


FIGURE 6 – CURRENT GAIN–BANDWIDTH PRODUCT



BC556

FIGURE 7 – DC CURRENT GAIN

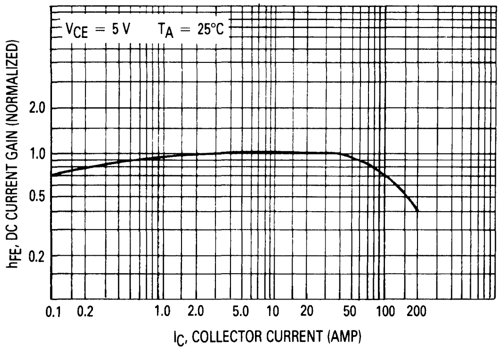


FIGURE 8 – "ON" VOLTAGE

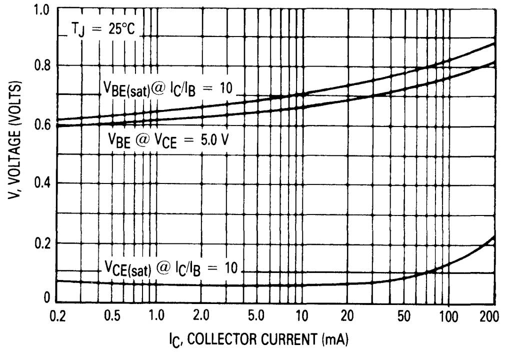


FIGURE 9 – COLLECTOR SATURATION REGION

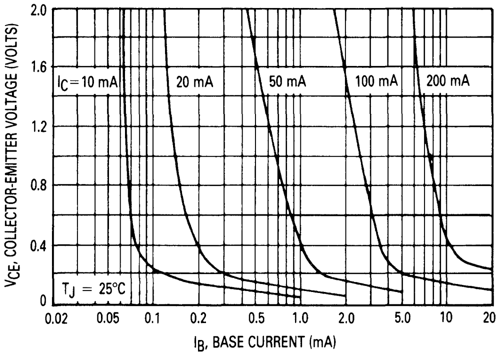


FIGURE 10 – BASE EMITTER TEMPERATURE COEFFICIENT

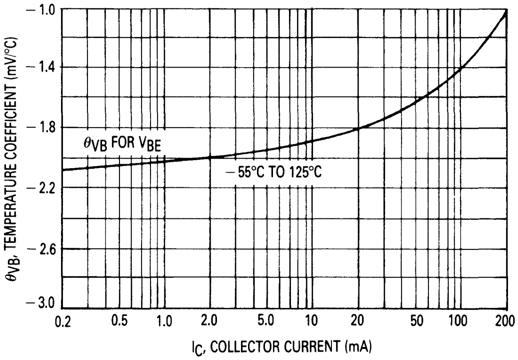


FIGURE 11 – CAPACITANCE

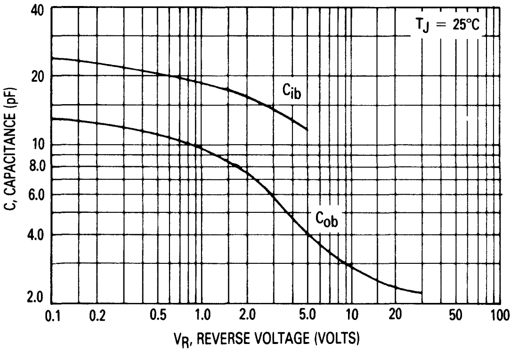


FIGURE 12 – CURRENT GAIN–BANDWIDTH PRODUCT

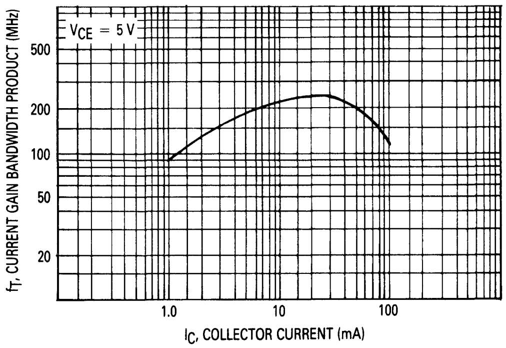


FIGURE 13 – THERMAL RESPONSE

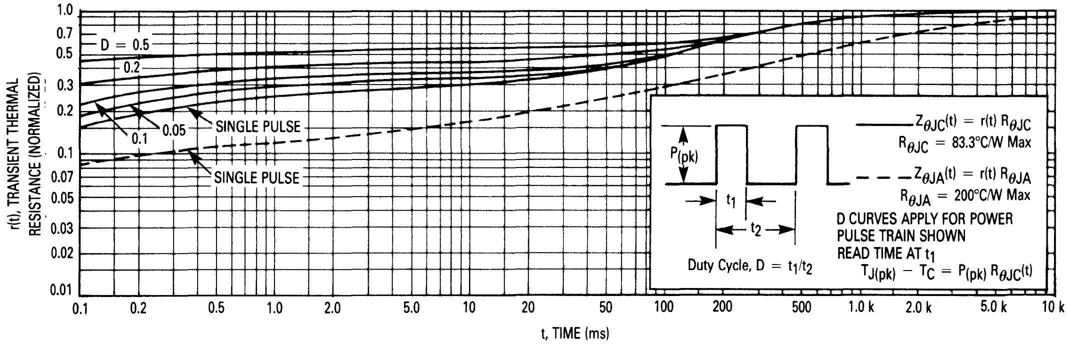
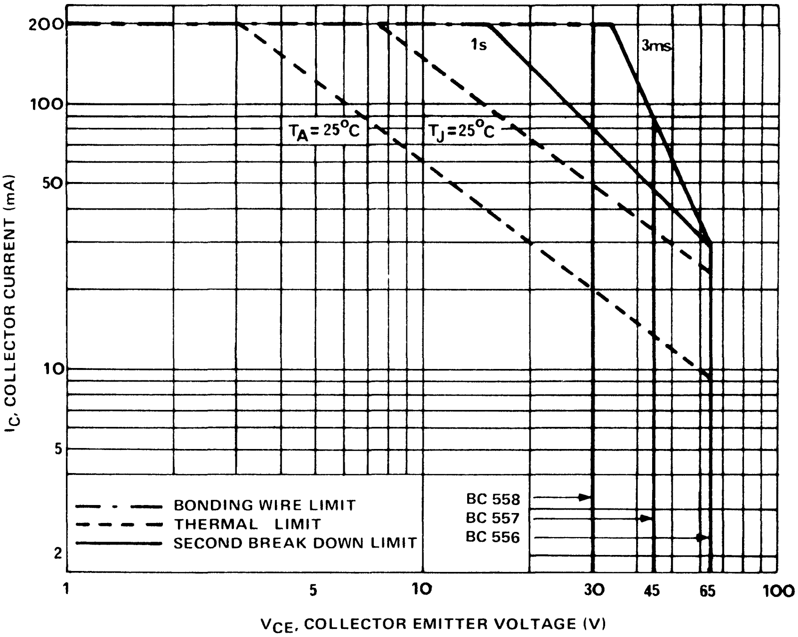


FIGURE 14 – ACTIVE REGION SAFE OPERATING AREA

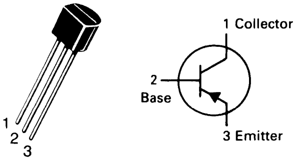


The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 14 is based upon $T_{J(pk)}$=150°C; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150°C$. $T_{J(pk)}$ may be calculated from the data of Figure 13. At high case or ambient temperatures thermal limitations will reduce the power that can be handled to values less than the limitations imposed by the secondary breakdown. (see AN 415).

BC559, B, C
BC560, B, C

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



LOW NOISE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 559	BC 560	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Base Voltage	V_{CBO}	30	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0) BC559		30			
BC560		45			
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 10 µAdc, I_E = 0) BC559		30			
BC560		50			
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$				Vdc
(I_E = 10 µAdc, I_C = 0)		5			
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 30 Vdc, I_E = 0)				15	nAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = +125°C)				5	µAdc
Emitter Cutoff Current	I_{EBO}				nAdc
(V_{EB} = 4 Vdc, I_C = 0)				15	
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				
(I_C = 10 µAdc, V_{CE} = 5 Vdc) BC559B/560B		100	150		
BC559C/560C		100	270		
(I_C = 2 mAdc, V_{CE} = 5 Vdc) BC559B/560B		180	290	460	
BC559C/560C		380	500	800	
BC559/560		120		800	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.5 mAdc)			0.075	0.25	
(I_C = 10 mAdc, I_B = see note 1)			0.3	0.6	
(I_C = 100 mAdc, I_B = 5 mAdc, see note 2)			0.25		
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 100 mAdc, I_B = 5 mAdc)			1.1		
Base-Emitter On Voltage	$V_{BE(on)}$				Vdc
(I_C = 10 µAdc, V_{CE} = 5 Vdc)			0.52		
(I_C = 100 µAdc, V_{CE} = 5 Vdc)			0.55		
(I_C = 2 mAdc, V_{CE} = 5 Vdc)		0.55	0.62	0.7	
SMALL SIGNAL CHARACTERISTICS					
Current-Gain-Bandwidth Product	f_T				MHz
(I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 100 MHz)			250		
Collector-Base Capacitance	C_{cbo}				pF
(V_{CE} = 10 Vdc, I_E = 0, f = 1 MHz)			2.5		
Small-Signal Current Gain	h_{fe}				—
(I_C = 2.0 mAdc, V_{CE} = 5.0 V, f = 1.0 kHz) BC559B/BC560B		240	330	500	
BC559C/BC560C		450	600	900	
Noise Figure					dB
(I_C = 200 µAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 30 Hz–15 kHz)	NF_1	—	0.5	2.0	
(I_C = 200 µA, V_{CE} = 5.0 V, R_S = 100 kΩ, f = 1.0 kHz, Δf = 200 Hz)	NF_2	—	—	10	

Note 1: I_B is value for which I_C = 11 mA at V_{CE} = 1 V

Note 2: Pulse test = 300 µs – Duty cycle = 2%

FIGURE 1 — NORMALIZED DC CURRENT GAIN

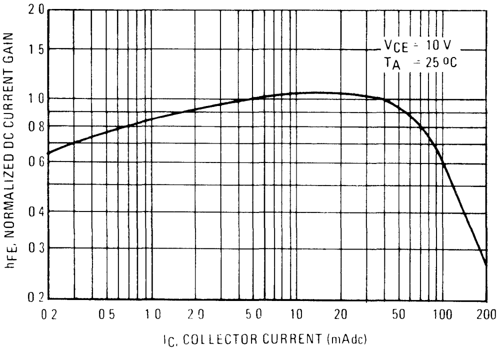


FIGURE 2 — "SATURATION" AND "ON" VOLTAGES

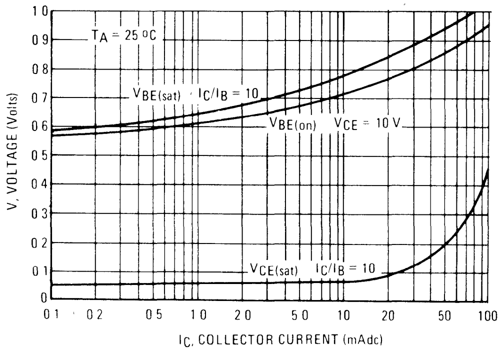


FIGURE 3 — CURRENT-GAIN BANDWIDTH PRODUCT

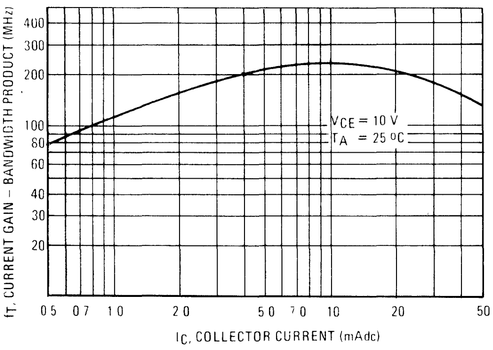


FIGURE 4 — CAPACITANCE

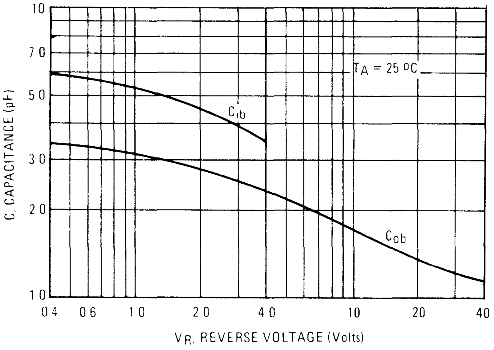
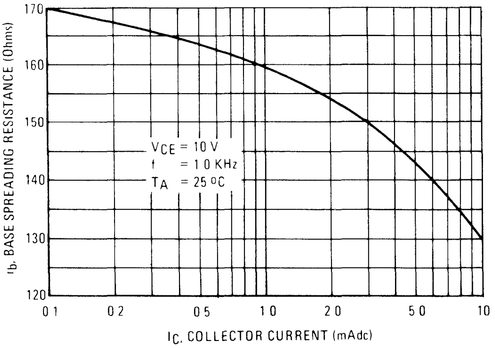
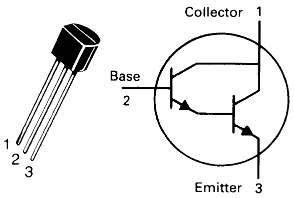


FIGURE 5 — BASE SPREADING RESISTANCE



BC617
BC618

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 617	BC 618	Unit
Collector-Emitter Voltage	V_{CEO}	40	55	Vdc
Collector-Base Voltage	V_{CBO}	50	80	Vdc
Emitter-Base Voltage	V_{EBO}	12		Vdc
Collector Current – Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

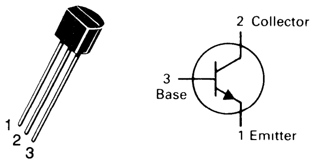
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	 BC617 BC618	$V_{(BR)CEO}$	 40 55	 — —	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 BC617 BC618	$V_{(BR)CBO}$	 50 80	 — —	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	 Both Types	$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current (V_{CE} = 40 Vdc, V_{BE} = 0) (V_{CE} = 60 Vdc, V_{BE} = 0)	 BC617 BC618	I_{CES}	 — —	 — —	 50 50	nAdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0)	 BC617 BC618	I_{CBO}	 — —	 — —	 50 50	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)	 Both Types	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
Collector-Emitter Saturation Voltage (I_C = 200 mA, I_B = 0.2 mA)	 Both Types	$V_{CE(sat)}$	—	—	1.1	Vdc
Base-Emitter Saturation Voltage (I_C = 200 mA, I_B = 0.2 mA)	 Both Types	$V_{BE(sat)}$	—	—	1.6	Vdc
Current Gain (I_C = 100 μA, V_{CE} = 5.0 V) (I_C = 10 mA, V_{CE} = 5.0 V) (I_C = 200 mA, V_{CE} = 5.0 V) (I_C = 1.0 A, V_{CE} = 5.0 V) 	 BC617 BC618 BC617 BC618 BC617 BC618 BC617 BC618	h_{FE}	 4000 2000 10000 4000 20000 10000 10000 4000	 — — — — — — — —	 — — — — 70000 50000 — —	—
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 500 mA, V_{CE} = 5.0 V, P = 100 MHz)	 Both Types	f_T	150	—	—	MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{ob}	—	4.5	7.0	pF
Input Capacitance (V_{EB} = 5.0 V, I_E = 0, f = 1.0 MHz)		C_{ib}	—	5.0	9.0	pF

BC635
BC637
BC639

CASE 29-04, STYLE 14
TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 635	BC 637	BC 639	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	0.5			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	800 6.4			mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.75 22			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	156	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage*		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	BC635		45	—	—	
	BC637		60	—	—	
	BC639		80	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BC635		45	—	—	
	BC637		60	—	—	
	BC639		80	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				
(V_{CB} = 30 Vdc, I_E = 0,			—	—	100	nAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = 125°C)			—	—	10	μAdc
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				—
(I_C = 5.0 mAdc, V_{CE} = 2.0 Vdc)			25	—	—	
(I_C = 150 mAdc, V_{CE} = 2.0 Vdc)	BC635		40	—	250	
	BC637		40	—	160	
	BC639		40	—	160	
(I_C = 500 mA, V_{CE} = 2.0 V)			25	—	—	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	—	—	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 Vdc, f = 100 MHz)		f_T	—	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	7.0	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ib}	—	50	—	pF

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

FIG. 1 — ACTIVE REGION SAFE OPERATING AREA

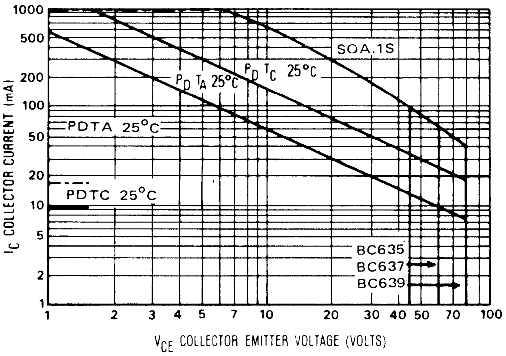


FIG. 2 — DC CURRENT GAIN

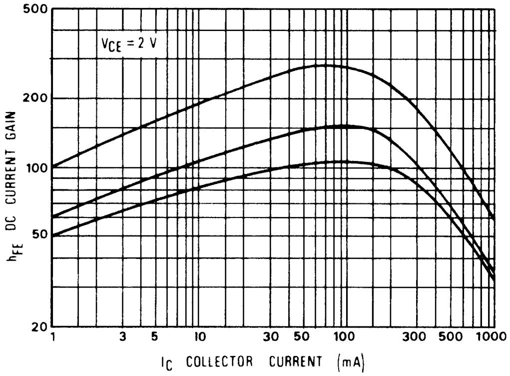


FIG. 3 — CURRENT GAIN BANDWIDTH PRODUCT

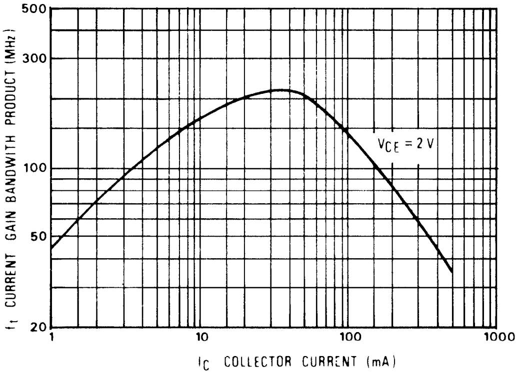


FIG. 4 — "SATURATION" AND "ON" VOLTAGES

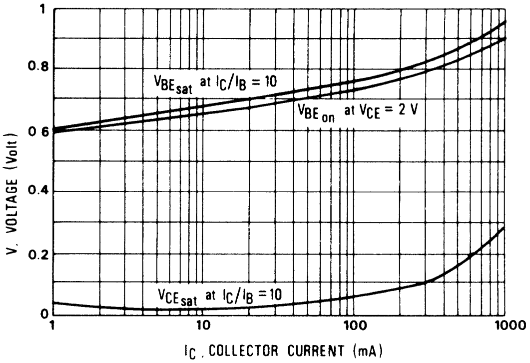
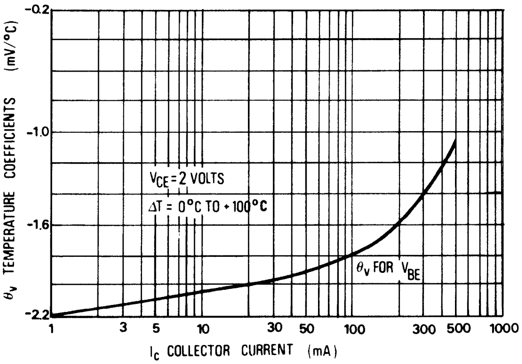
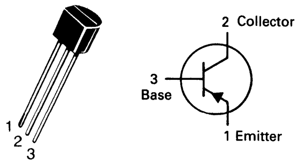


FIG. 5 — TEMPERATURE COEFFICIENTS



BC636
BC638
BC640

CASE 29-04, STYLE 14
TO-92 (TO-226AA)



HIGH CURRENT TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 636	BC 638	BC 640	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current – Continuous	I_C	0.5			Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	800 6.4			mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.75 22			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	156	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage*		$V_{(BR)CEO}$				Vdc
($I_C = 10$ mAdc, $I_B = 0$)	BC636		45	—	—	
	BC638		60	—	—	
	BC640		80	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
($I_C = 100$ μAdc, $I_E = 0$)	BC636		45	—	—	
	BC638		60	—	—	
	BC640		80	—	—	
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				
($V_{CB} = 30$ Vdc, $I_E = 0$,			—	—	100	nAdc
($V_{CB} = 30$ Vdc, $I_E = 0$, $T_A = 125°C$)			—	—	10	μAdc
ON CHARACTERISTICS*						
DC Current Gain		h_{FE}				—
($I_C = 5.0$ mAdc, $V_{CE} = 2.0$ Vdc)			25	—	—	
($I_C = 150$ mAdc, $V_{CE} = 2.0$ Vdc)	BC636		40	—	250	
	BC638		40	—	160	
	BC640		40	—	160	
($I_C = 500$ mA, $V_{CE} = 2.0$ V)			25	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
($I_C = 500$ mAdc, $I_B = 50$ mAdc)			—	0.25	0.5	
			—	0.5	—	
Base-Emitter On Voltage ($I_C = 500$ mAdc, $V_{CE} = 2.0$ Vdc)		$V_{BE(on)}$	—	—	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 2.0$ Vdc, f = 100 MHz)		f_T	—	150	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{ob}	—	9.0	—	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)		C_{ib}	—	110	—	pF

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

FIG. 1 — ACTIVE REGION SAFE OPERATING AREA

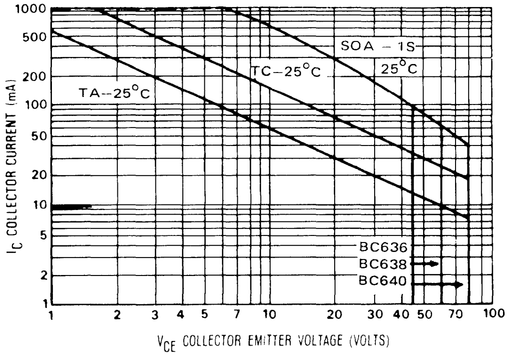


FIG. 2 — DC CURRENT GAIN

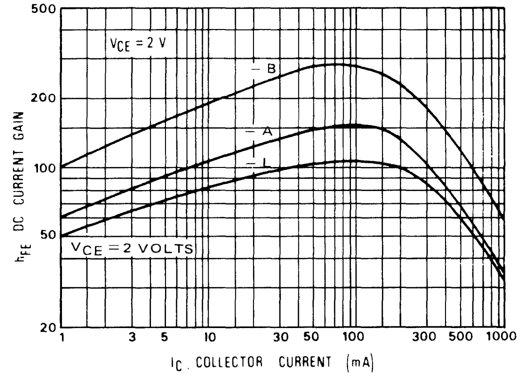


FIG. 3 — CURRENT GAIN BANDWIDTH PRODUCT

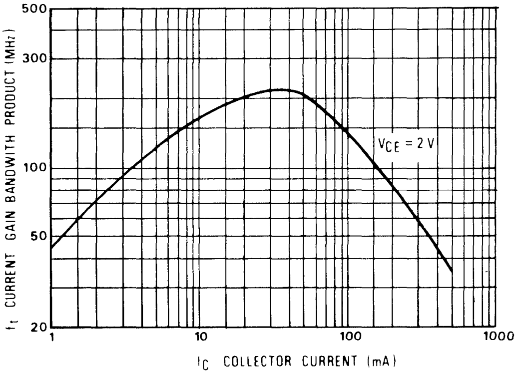


FIG. 4 — "SATURATION" AND "ON" VOLTAGES

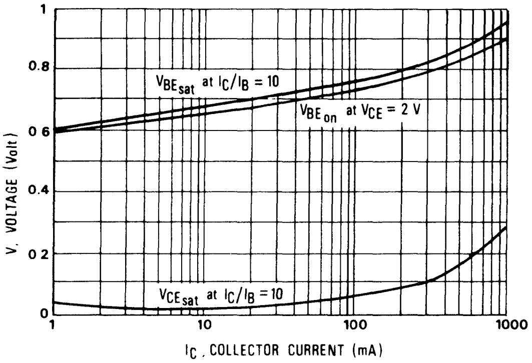
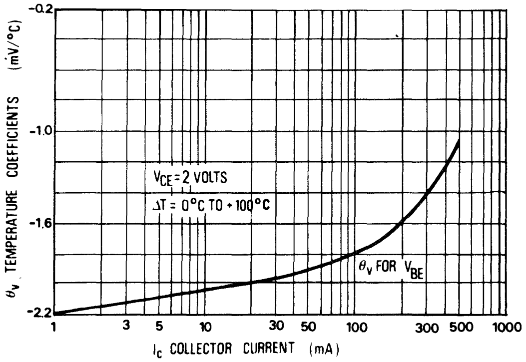
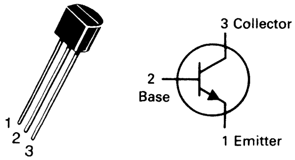


FIG. 5 — TEMPERATURE COEFFICIENTS



BC650, C, CS, S
BC651, C, CS, S

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



LOW NOISE AUDIO TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC650 Series	BC651 Series	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Base Voltage	V_{CBO}	30	45	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	BC650 BC651	$V_{(BR)CEO}$	30 45	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	BC650 BC651	$V_{(BR)CBO}$	30 45	— —	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	0.015	μA
Collector-Emitter Leakage Current (V_{CE} = 60 V)		I_{CES}	—	0.025	μA
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)		I_{EBO}	—	0.015	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BC650, S/BC651, S BC650, C, CS/BC651, C, CS	h_{FE}	380 380	1400 820	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 100 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	— —	0.2 0.6	Vdc
Base Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.55	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}	380	1600	—
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	3.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ib}	—	8.0	pF
Current-Gain Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 V, f = 100 MHz)		f_T	100	700	MHz
Noise Figure (V_{CE} = 5.0 V, I_C = 0.2 mA, R_S = 2.0 kΩ, f = 1.0 kHz, T_A = 25°C)	BC650, C, BC651, C BC650S, CS, BC651S, CS	NF	— —	2.8 2.0	dB

MAXIMUM RATINGS

Rating	Symbol	BC807	BC808	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	V
Collector-Base Voltage	V_{CBO}	50	30	V
Emitter-Base Voltage	V_{EBO}	5.0	5.0	V
Collector Current — Continuous	I_C	500	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

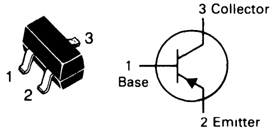
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BC807-16L = 5A; BC807-25L = 5B; BC807-40L = 5C; BC808-16L = 5E; BC808-25L = 5F; BC808-40L = 5G

BC807-16L, -25L, -40L
BC808-16L, -25L, -40L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

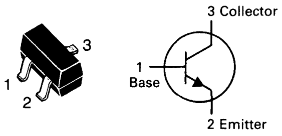
PNP SILICON

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
	BC807 Series		45	—	—	
	BC808 Series		25	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				V
(V_{EB} = 0)	BC807 Series		50	—	—	
	BC808 Series		30	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				V
	BC807 Series		5.0	—	—	
	BC808 Series		5.0	—	—	
Collector Cutoff Current		I_{CBO}				
(V_{CB} = 20 V)			—	—	100	nA
(V_{CB} = 20 V, T_J = 150°C)			—	—	5.0	µA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 100 mA, V_{CE} = 1.0 V)	BC807-16L					
	BC808-16L		100	—	250	
	BC807-25L					
	BC808-25L		160	—	400	
	BC807-40L					
	BC808-40L		250	—	600	
(I_C = 500 mA, V_{CE} = 1.0 V)			40	—	—	
Collector-Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	—	—	0.7	V
Base-Emitter On Voltage (I_C = 500 mA, I_B = 1.0 V)		$V_{BE(on)}$	—	—	1.2	V
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 35 MHz)		f_T	200	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	10	—	pF

BC817-16L, -25L, -40L
BC818-16L, -25L, -40L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BC817	BC818	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	V
Collector-Base Voltage	V_{CBO}	50	30	V
Emitter-Base Voltage	V_{EBO}	5.0	5.0	V
Collector Current — Continuous	I_C	500	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BC817-16L = 6A; BC817-25L = 6B; BC817-40L = 6C; BC818-16L = 6E;
BC818-25L = 6F; BC818-40L = 6G

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$				V
BC817 Series		45	—	—	
BC818 Series		25	—	—	
Collector-Emitter Breakdown Voltage (V_{EB} = 0)	$V_{(BR)CES}$				V
BC817 Series		50	—	—	
BC818 Series		30	—	—	
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$				V
BC817 Series		5.0	—	—	
BC818 Series		5.0	—	—	
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 20 V)		—	—	100	nA
(V_{CB} = 20 V, T_A = 150°C)		—	—	5.0	μA
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				
(I_C = 100 mA, V_{CE} = 1.0 V) BC817-16L BC818-16L		100	—	250	
BC817-25L BC818-25L		160	—	400	
BC817-40L BC818-40L		250	—	600	
(I_C = 500 mA, V_{CE} = 1.0 V)		40	—	—	
Collector-Emitter Saturation Voltage (I_C = 500 mA, I_B = 50 mA)	$V_{CE(sat)}$	—	—	0.7	V
Base-Emitter On Voltage (I_C = 500 mA, V_{CE} = 1.0 V)	$V_{BE(on)}$	—	—	1.2	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 35 MHz)	f_T	200	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)	C_{obo}	—	10	—	pF

MAXIMUM RATINGS

Rating	Symbol	BC846	BC847	BC848	Unit
Collector-Emitter Voltage	V_{CEO}	65	45	30	V
Collector-Base Voltage	V_{CBO}	80	50	30	V
Emitter-Base Voltage	V_{EBO}	6.0	6.0	5.0	V
Collector Current — Continuous	I_C	100	100	100	mAdc

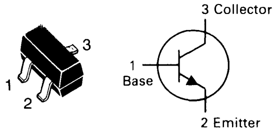
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

BC846AL, BL
BC847AL, BL, CL
BC848AL, BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to BC546 for graphs.

DEVICE MARKING

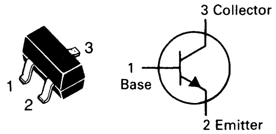
BC846AL = 1A; BC846BL = 1B; BC847AL = 1E; BC847BL = 1F; BC847CL = 1G; BC848AL = 1J; BC848BL = 1K; BC848CL = 1L

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	BC846AL,BL	$V_{(BR)CEO}$	65	—	—	V
	BC847AL,BL,CL		45	—	—	
	BC848AL,BL,CL		30	—	—	
Collector-Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC846AL,BL	$V_{(BR)CES}$	80	—	—	V
	BC847AL,BL,CL		50	—	—	
	BC848AL,BL,CL		30	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μA)	BC846AL,BL	$V_{(BR)CBO}$	80	—	—	V
	BC847AL,BL,CL		50	—	—	
	BC848AL,BL,CL		30	—	—	
Emitter-Base Breakdown Voltage (I_E = 1.0 μA)	BC846AL,BL	$V_{(BR)EBO}$	6.0	—	—	V
	BC847AL,BL,CL		6.0	—	—	
	BC848AL,BL,CL		5.0	—	—	
Collector Cutoff Current (V_{CB} = 30 V)		I_{CBO}	—	—	15	nA
(V_{CB} = 30 V, T_A = 150°C)			—	—	5.0	μA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC846AL, BC847AL, BC848AL	h_{FE}	—	90	—	—
	BC846BL, BC847BL, BC848BL		—	150	—	
	BC847CL, BC848CL		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC846AL, BC847AL, BC848AL		110	180	220	
	BC846BL, BC847BL, BC848BL		200	290	450	
	BC847CL, BC848CL		420	520	800	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{CE(sat)}$	—	—	0.25	V
(I_C = 100 mA, I_B = 5.0 mA)			—	—	0.6	
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA)		$V_{BE(sat)}$	—	0.7	—	V
(I_C = 100 mA, I_B = 5.0 mA)			—	0.9	—	
Base-Emitter Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	580	660	700	mV
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	770	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		N_F	—	—	10	dB

BC849BL, CL
BC850BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



LOW NOISE TRANSISTORS

NPN SILICON

Refer to BC549 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC850	BC849	Unit
Collector-Emitter Voltage	V_{CEO}	45	30	V
Collector-Base Voltage	V_{CBO}	50	30	V
Emitter-Base Voltage	V_{EBO}	6.0	5.0	V
Collector Current — Continuous	I_C	100	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

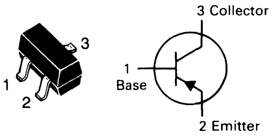
BC849BL = 2B; BC849CL = 2C; BC850BL = 2F; BC850CL = 2G

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
	BC850BL,CL		45	—	—	
	BC849BL,CL		30	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				V
(V_{EB} = 0)	BC850BL,CL		50	—	—	
	BC849BL,CL		30	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	5.0	—	—	V
Collector Cutoff Current		I_{CBO}				
(V_{CB} = 30 V, I_E = 0)			—	—	15	nA
(V_{CB} = 30 V, T_A = 150°C)			—	—	5.0	μA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μA, V_{CE} = 5.0 V)	BC849BL, BC850BL		—	150	—	
	BC849CL, BC850CL		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC849BL, BC850BL		200	290	450	
	BC849CL, BC850CL		420	520	800	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	—	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	—	0.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.7	—	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.9	—	
Base-Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.58	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 35 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		N_F	—	—	4	dB

BC856AL, BL
BC857AL, BL, CL
BC858AL, BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to BC556 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC856	BC857	BC858	Unit
Collector-Emitter Voltage	V_{CEO}	65	45	30	V
Collector-Base Voltage	V_{CBO}	80	50	30	V
Emitter-Base Voltage	V_{EBO}	5.0	5.0	5.0	V
Collector Current — Continuous	I_C	100	100	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in. **Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

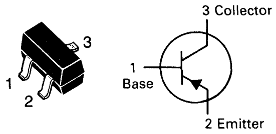
BC856AL = 3A; BC856BL = 3B; BC857AL = 3E; BC857BL = 3F; BC857CL = 3G; BC858AL = 3J; BC858BL = 3K; BC858CL = 3L

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)CEO}$	65 45 30	— — —	— — —	V
Collector-Emitter Breakdown Voltage (I_C = 10 μA, V_{EB} = 0)	BC856 Series BC857 Series BC858 Series	$V_{(BR)CES}$	80 50 30	— — —	— — —	V
Collector-Base Breakdown Voltage (I_C = 10 μA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)CBO}$	80 50 30	— — —	— — —	V
Emitter-Base Breakdown Voltage (I_E = 1.0 μA)	BC856 Series BC857 Series BC858 Series	$V_{(BR)EBO}$	5.0 5.0 5.0	— — —	— — —	V
Collector Cutoff Current (V_{CB} = 30 V) (V_{CB} = 30 V, T_A = 150°C)		I_{CBO}	— —	— —	15 4.0	nA μA
ON CHARACTERISTICS						
DC Current Gain (I_C = 10 μA, V_{CE} = 5.0 V)	BC856AL, BC857AL, BC858AL BC856BL, BC857BL, BC858BL BC857CL, BC858CL	h_{FE}	— — —	90 150 270	— — —	—
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC856AL, BC857AL, BC858AL BC856BL, BC857BL, BC858BL BC857CL, BC858CL		125 220 420	180 290 520	250 475 800	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	— —	— —	0.3 0.65	V
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	— —	0.7 0.9	— —	V
Base-Emitter On Voltage (I_C = 2.0 mA, V_{CE} = 5.0 V) (I_C = 10 mA, V_{CE} = 5.0 V)		$V_{BE(on)}$	0.6 —	— —	0.75 0.82	V
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mA, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		N_F	—	—	10	dB

BC859AL, BL, CL
BC860AL, BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



LOW NOISE TRANSISTORS

PNP SILICON

Refer to BC559 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC860	BC859	Unit
Collector-Emitter Voltage	V_{CEO}	45	30	V
Collector-Base Voltage	V_{CBO}	50	30	V
Emitter-Base Voltage	V_{EBO}	6.0	5.0	V
Collector Current — Continuous	I_C	100	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BC859AL = 4A; BC859BL = 4B; BC859CL = 4C; BC860AL = 4E;
BC860BL = 4F; BC860CL = 4G

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
	BC860 Series		45	—	—	
	BC859 Series		30	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				V
(V_{EB} = 0)	BC860 Series		50	—	—	
	BC859 Series		30	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	5.0	—	—	V
Collector Cutoff Current		I_{CBO}				
(V_{CB} = 30 V, I_E = 0)			—	—	15	nA
(V_{CB} = 30 V, T_A = 150°C)			—	—	5.0	µA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 µA, V_{CE} = 5.0 V)	BC859AL, BC860AL		—	90	—	
	BC859BL, BC860BL		—	150	—	
	BC859CL, BC860CL		—	270	—	
(I_C = 2.0 mA, V_{CE} = 5.0 V)	BC859AL, BC860AL		110	180	220	
	BC859BL, BC860BL		200	290	450	
	BC859CL, BC860CL		420	520	800	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	—	0.25	
(I_C = 100 mA, I_B = 5.0 mA)			—	—	0.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)			—	0.7	—	
(I_C = 100 mA, I_B = 5.0 mA)			—	0.9	—	
Base-Emitter On Voltage		$V_{BE(on)}$				V
(I_C = 2.0 mA, V_{CE} = 5.0 V)			0.58	—	0.7	
(I_C = 10 mA, V_{CE} = 5.0 V)			—	—	0.77	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5.0 Vdc, f = 35 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		N_F	—	—	4.0	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	Vdc
Collector-Base Voltage	V_{CBO}	32	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

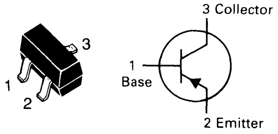
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BCW29L = C1; BCW30L = C2

BCW29L
BCW30L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

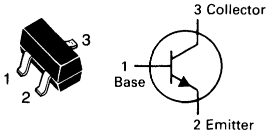
Refer to 2N5086 for graphs.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_E = 0)	$V_{(BR)CEO}$	32	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{EB} = 0)	$V_{(BR)CES}$	32	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_C = 0)	$V_{(BR)CBO}$	32	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 32 Vdc, I_E = 0) (V_{CB} = 32 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 100 10	 nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCW29L BCW30L	h_{FE}	 120 215	 260 500	 — —
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.6	0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (I_E = 0, V_{CE} = 10 Vdc, f = 1.0 MHz)	C_{obo}	—	7.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	10	dB

BCW31L
BCW33L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

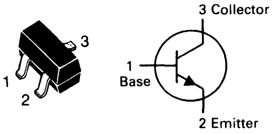
BCW31L = D1; BCW33L = D3

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	20	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_B = 0)		$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BCW31L BCW33L	h_{FE}	110 420	220 800	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.55	0.70	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (I_E = 0, V_{CB} = 10 Vdc, f = 1.0 MHz)		C_{obo}	—	4.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	10	dB

BCW60AL, BL, CL, DL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	V
Collector-Base Voltage	V_{CBO}	32	V
Emitter-Base Voltage	V_{EBO}	5.0	V
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BCW60AL = AA; BCW60BL = AB; BCW60CL = AC; BCW60DL = AD

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_E = 0)	$V_{(BR)CEO}$	32	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current	I_{CES}			
(V_{CE} = 32 Vdc)		—	20	nAdc
(V_{CE} = 32 Vdc, T_A = 150°C)		—	20	µAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	20	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 10 µAdc, V_{CE} = 5.0 Vdc) BCW60AL		20	—	
BCW60BL		30	—	
BCW60CL		40	—	
BCW60DL		100	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCW60AL		120	220	
BCW60BL		175	310	
BCW60CL		250	460	
BCW60DL		380	630	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) BCW60AL		60	—	
BCW60BL		70	—	
BCW60CL		90	—	
BCW60DL		100	—	
AC Current Gain	h_{fe}			—
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) BCW60AL		125	250	
BCW60BL		175	350	
BCW60CL		250	500	
BCW60DL		350	700	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)		—	0.55	
(I_C = 10 mAdc, I_B = 0.25 mAdc)		—	0.35	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)		0.7	1.05	
(I_C = 50 mAdc, I_B = 0.25 mAdc)		0.6	0.85	
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.6	0.75	Vdc

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

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 MHz)	f_T	125	—	MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)	C_{obo}	—	4.5	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	6.0	dB
SWITCHING CHARACTERISTICS				
Turn-On Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	150	ns
Turn-Off Time (I_{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R_1 = R_2 = 5.0 kΩ, R_L = 990 Ω)	t_{off}	—	800	ns

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	V
Collector-Base Voltage	V_{CBO}	32	V
Emitter-Base Voltage	V_{EBO}	5.0	V
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

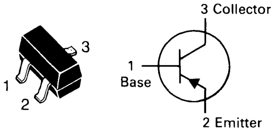
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BCW61AL = BA; BCW61BL = BB; BCW61CL = BC; BCW61DL = BD

BCW61AL, BL, CL, DL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

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

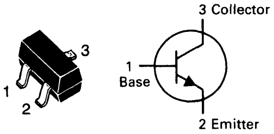
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	32	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CES}			
(V_{CE} = 32 Vdc)			—	20	nAdc
(V_{CE} = 32 Vdc, T_A = 150°C)			—	20	μAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	BCW61AL		20	—	
	BCW61BL		30	—	
	BCW61CL		40	—	
	BCW61DL		100	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BCW61AL		120	220	
	BCW61BL		140	310	
	BCW61CL		250	460	
	BCW61DL		380	630	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	BCW61AL		60	—	
	BCW61BL		80	—	
	BCW61CL		100	—	
	BCW61DL		100	—	
AC Current Gain		h_{fe}			—
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	BCW61AL		125	250	
	BCW61BL		175	350	
	BCW61CL		250	500	
	BCW61DL		350	700	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)			—	0.55	
(I_C = 10 mAdc, I_B = 0.25 mAdc)			—	0.25	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 1.25 mAdc)			0.68	1.05	
(I_C = 10 mAdc, I_B = 0.25 mAdc)			0.6	0.85	
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.6	0.75	Vdc

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

Characteristic	Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	6.0	dB
SWITCHING CHARACTERISTICS				
Turn-On Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	150	ns
Turn-Off Time (I_{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R_1 = R_2 = 5.0 kΩ, R_L = 990 Ω)	t_{off}	—	800	ns

BCW65AL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	800	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

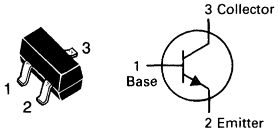
BCW65AL = EA

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	32	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{EB} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 32 Vdc, I_E = 0) (V_{CE} = 32 Vdc, I_E = 0, T_A = 150°C)	I_{CES}	 — —	 — —	 20 20	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 μAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	 35 75 100 35	 — — — —	 — 220 250 —	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	 — —	 0.7 0.3	 — —	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	—	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	—	12	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	—	80	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	—	10	dB
SWITCHING CHARACTERISTICS					
Turn-On Time (I_{B1} = I_{B2} = 15 mAdc)	t_{on}	—	—	100	ns
Turn-Off Time (I_C = 150 mAdc, R_L = 150 Ω)	t_{off}	—	—	400	ns

BCW66HL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	800	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

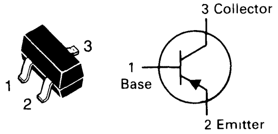
BCW66HL = EF

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{EB} = 0)	$V_{(BR)CES}$	75	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CES}				
(V_{CE} = 45 Vdc, I_C = 0)		—	—	20	nAdc
(V_{CE} = 45 Vdc, I_C = 0, T_A = 150°C)		—	—	20	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 100 μAdc, V_{CE} = 10 V)		35	—	—	
(I_C = 10 mAdc, V_{CE} = 10 V)		75	—	—	
(I_C = 100 mAdc, V_{CE} = 10 V)		100	—	250	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)		35	—	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.7	—	
(I_C = 100 mAdc, I_B = 10 mAdc)		—	0.3	—	
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	—	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	—	12	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	—	80	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	—	10	dB
SWITCHING CHARACTERISTICS					
Turn-On Time (I_{B1} = I_{B2} = 15 mAdc)	t_{on}	—	—	100	ns
Turn-Off Time (I_C = 150 mAdc, R_L = 150 Ω)	t_{off}	—	—	400	ns

BCW67L, AL, BL, CL
BCW68L, FL, GL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BCW67	BCW68	Unit
Collector-Emitter Voltage	V_{CEO}	32	45	Vdc
Collector-Base Voltage	V_{CBO}	45	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	800		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

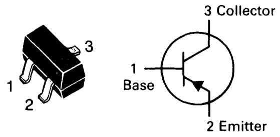
BCW67L = DD; BCW68L = DP; BCW67AL = DA; BCW67BL = DB;
BCW67CL = DC; BCW68FL = DF; BCW68GL = DH

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	BCW67 Series		32	—	—	
	BCW68 Series		45	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 μAdc, V_{EB} = 0)	BCW67 Series		45	—	—	
	BCW68 Series		60	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CES}				
(V_{CE} = 32 Vdc, I_E = 0)	BCW67 Series		—	—	20	nAdc
(V_{CE} = 45 Vdc, I_E = 0)	BCW68 Series		—	—	20	
(V_{CE} = 32 Vdc, I_B = 0, T_A = 150°C)	BCW67 Series		—	—	10	μAdc
(V_{CE} = 45 Vdc, I_B = 0, T_A = 150°C)	BCW68 Series		—	—	10	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	BCW67L,AL,68L,FL		75	—	—	
	BCW67BL,68GL		120	—	—	
	BCW67CL		180	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	BCW67L,AL,68L,FL		100	—	250	
	BCW67BL,68GL		160	—	400	
	BCW67CL		250	—	630	
(I_C = 300 mAdc, V_{CE} = 1.0 Vdc)	BCW67L,AL,68L,FL		35	—	—	
	BCW67BL,68GL		60	—	—	
	BCW67CL		100	—	—	
Collector-Emitter Saturation Voltage (I_C = 300 mAdc, I_B = 30 mAdc)		$V_{CE(sat)}$	—	—	1.5	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$	—	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	100	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	—	18	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	—	105	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	—	10	dB

BCW69L
BCW70L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

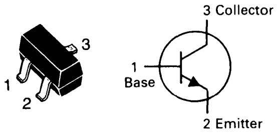
BCW69L = H1; BCW70L = H2

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{EB} = 0)	$V_{(BR)CES}$	50	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 100 10	 nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCW69L BCW70L	h_{FE}	 120 215	 260 500	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.6	0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (I_E = 0, V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{obo}	—	7.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	10	dB

BCW71L
BCW72L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

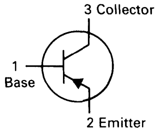
DEVICE MARKING

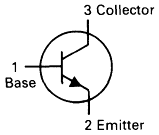
BCW71L = K1; BCW72L = AH

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

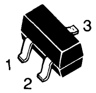
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, V_{EB} = 0)	$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, V_{EB} = 0)	$V_{(BR)CES}$	45	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 — —	 100 10	 nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCW71L BCW72L	h_{FE}	 110 200	 — —	 220 450	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 50 mAdc, I_B = 2.5 mAdc)	$V_{CE(sat)}$	 — —	 — 0.21	 0.25 —	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 2.5 mAdc)	$V_{BE(sat)}$	—	0.85	—	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.6	—	0.75	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 35 MHz)	f_T	—	300	—	MHz
Output Capacitance (I_E = 0, V_{CE} = 10 Vdc, f = 1.0 MHz)	C_{obo}	—	—	4.0	pF
Input Capacitance (I_C = 0, V_{EB} = 0.5 Vdc, f = 1.0 MHz)	C_{ibo}	—	9.0	—	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	—	10	dB

PNP	NPN
BCX17L	**BCX19L**
BCX18L	**BCX20L**





CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE
TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value BCX17L BCX19L	Value BCX18L BCX20L	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

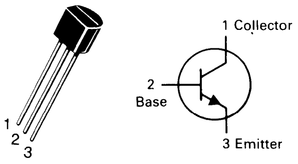
BCX17L = T1; BCX18L = T2; BCX19L = U1; BCX20L = U2

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	BCX17L,19L BCX18L,20L	$V_{(BR)CEO}$	45 25	— —	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 µAdc, I_C = 0)	BCX17L,19L BCX18L,20L	$V_{(BR)CES}$	50 30	— —	— —	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 150°C)		I_{CBO}	— —	— —	100 5.0	nAdc µAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	—	10	µAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 300 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	100 70 40	— — —	600 — —	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	—	—	0.62	Vdc
Base-Emitter On Voltage (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	—	1.2	Vdc

BCX58-7, -8, -9, -10
BCX59-7, -8, -9, -10

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BCX 58	BCX 59	Unit
Collector-Emitter Voltage	V_{CEO}	32	45	Vdc
Collector-Base Voltage	V_{CBO}	32	45	Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Collector Current − Continuous	I_C	100		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	BCX58 Series		32	—	—	
	BCX59 Series		45	—	—	
Emitter-Base Breakdown Voltage (I_E = 1.0 μAdc, I_C = 0)	All	$V_{(BR)EBO}$	7.0	8.7	—	Vdc
Collector Cutoff Current						
(V_{CE} = 32 V)	BCX58 Series	I_{CES}	—	—	10	nAdc
(V_{CE} = 45 V)	BCX59 Series	I_{CES}	—	—	10	
(V_{CE} = 32 V, T_A = 100°C, V_{BE} = 0.2 V)	BCX58 Series	I_{CEX}	—	—	20	μAdc
(V_{CE} = 45 V, T_A = 100°C, V_{BE} = 0.2 V)	BCX59 Series	I_{CEX}	—	—	20	
(V_{CE} = 32 V, T_A = 125°C)	BCX58 Series	I_{CES}	—	—	2.5	
(V_{CE} = 45 V, T_A = 125°C)	BCX59 Series	I_{CES}	—	—	2.5	
Emitter-Cutoff Current (V_{EBO} = 4.0 V, I_C = 0)		I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	BCX58-7, BCX59-7		20	80	—	
	BCX58-8, BCX59-8		40	145	—	
	BCX58-9, BCX59-9		75	220	—	
	BCX58-10, BCX59-10		100	300	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BCX58-7, BCX59-7		120	170	220	
	BCX58-8, BCX59-8		180	250	310	
	BCX58-9, BCX59-9		250	350	460	
	BCX58-10, BCX59-10		380	500	630	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	BCX58-7, BCX59-7		80	190	—	
	BCX58-8, BCX59-8		120	260	400	
	BCX58-9, BCX59-9		160	380	630	
	BCX58-10, BCX59-10		240	550	1000	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	BCX58-7, BCX59-7		40	—	—	
	BCX58-8, BCX59-8		45	—	—	
	BCX58-9, BCX59-9		60	—	—	
	BCX58-10, BCX59-10		60	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 2.5 mAdc)		$V_{BE(sat)}$	—	—	1.0	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.55	—	0.7	Vdc

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

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 V, f = 100 MHz)	f_T	125	250	—	MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)	C_{ob}	—	1.8	4.5	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz)	C_{ib}	—	5.2	15	pF
Small-Signal Current Gain	h_{fe}				—
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) BCX58-7, BCX59-7		125	—	250	
BCX58-8, BCX59-8		175	—	350	
BCX58-9, BCX59-9		250	—	500	
BCX58-10, BCX59-10		350	—	700	
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kohms, f = 1.0 kHz)	NF	—	1.0	6.0	dB
(I_C = 10 mA, I_{B1} = 1.0 mA, I_{B2} = 1.0 mA)	T_d	—	16	—	ns
(V_{BB} = 3.6 V, R_1 = R_2 = 5.0 kΩ)	T_r	—	29	—	
(R_L = 999 ohms)	T_{on}	—	45	150	
*See test circuit	T_s	—	475	—	
	T_f	—	40	—	
	T_{off}	—	515	800	
(I_C = 100 mA, I_{B1} = 10 mA, I_{B2} = 10 mA)	t_d	—	5.0	—	ns
(V_{BB} = 5.0 V, R_1 = 500 Ω, R_2 = 700 Ω)	t_r	—	40	—	
(R_L = 98 ohms)	t_{on}	—	45	150	
*See test circuit	t_s	—	135	—	
	t_f	—	80	—	
	t_{off}	—	215	800	

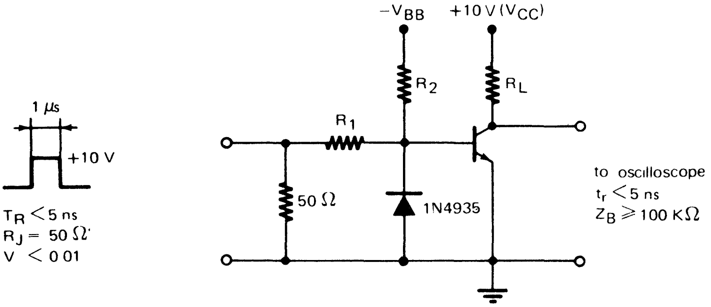


FIGURE 1 — NORMALIZED DC CURRENT GAIN

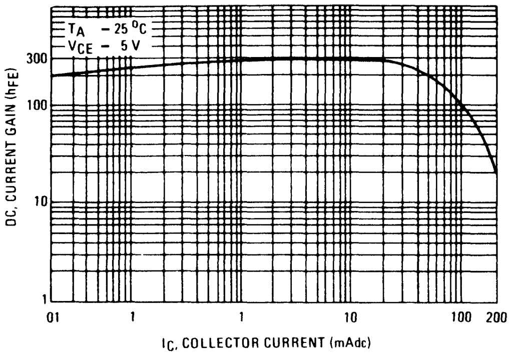


FIGURE 2 — "SATURATION" AND "ON" VOLTAGES

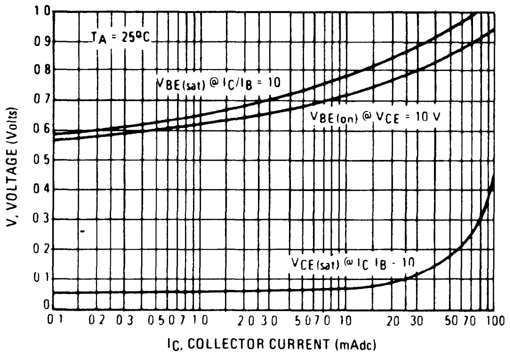


FIGURE 3 — COLLECTOR SATURATION REGION

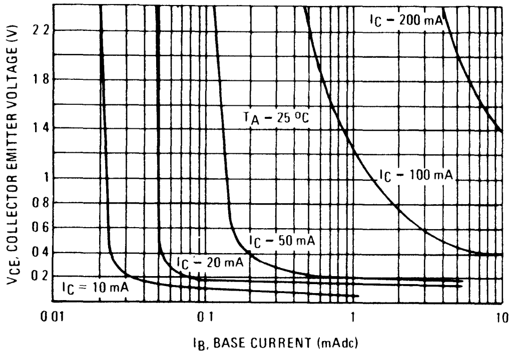


FIGURE 4 — BASE-EMITTER TEMPERATURE COEFFICIENT

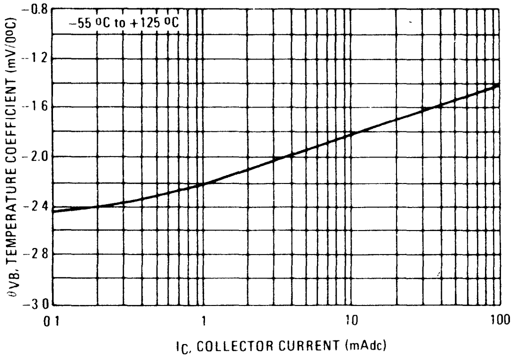


FIGURE 5 — CAPACITANCES

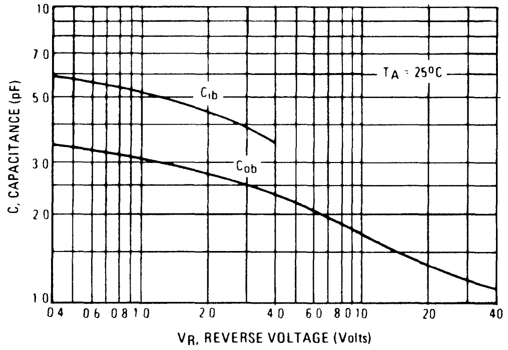
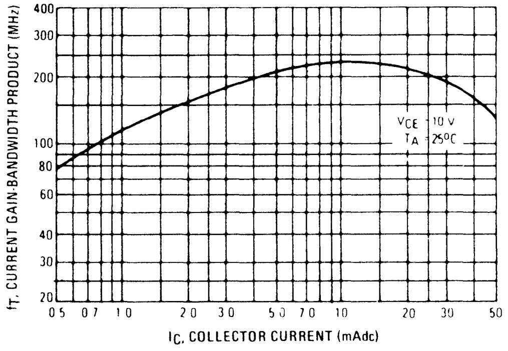
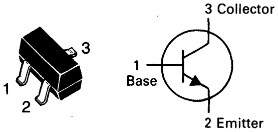


FIGURE 6 — CURRENT-GAIN-BANDWIDTH PRODUCT



BCX70GL, HL, JL, KL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BCX70GL = AG; BCX70HL = AH; BCX70JL = AJ; BCX70KL = AK

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_E = 0)	$V_{(BR)CEO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 32 Vdc) (V_{CE} = 32 Vdc, T_A = 150°C)	I_{CES}	 — —	 20 20	 nAdc µAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	20	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 10 µAdc, V_{CE} = 5.0 Vdc) BCX70GL		—	—	
BCX70HL		20	—	
BCX70JL		40	—	
BCX70KL		100	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCX70GL		120	220	
BCX70HL		180	310	
BCX70JL		250	460	
BCX70KL		380	630	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) BCX70GL		60	—	
BCX70HL		70	—	
BCX70JL		90	—	
BCX70KL		100	—	
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 1.25 mAdc) (I_C = 10 mAdc, I_B = 0.25 mAdc)	$V_{CE(sat)}$	 — —	 0.55 0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 1.25 mAdc) (I_C = 50 mAdc, I_B = 0.25 mAdc)	$V_{BE(sat)}$	 0.7 0.6	 1.05 0.85	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.55	0.75	Vdc

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)		C_{obo}	—	4.5	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}			—
	BCX70GL		125	250	
	BCX70HL		175	350	
	BCX70JL		250	500	
	BCX70KL		350	700	
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)		NF	—	6.0	dB
SWITCHING CHARACTERISTICS					
Turn-On Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_{on}	—	150	ns
Turn-Off Time (I_{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R1 = R2 = 5.0 kΩ, R_L = 990 Ω)		t_{off}	—	800	ns

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	V
Collector-Base Voltage	V_{CBO}	45	V
Emitter-Base Voltage	V_{EBO}	5.0	V
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

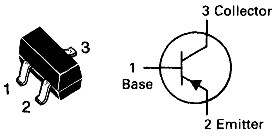
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BCX71GL = BG; BCX71JL = BJ; BCX71KL = BK

BCX71GL, JL, KL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

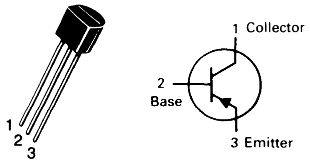
PNP SILICON

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 32 Vdc) (V_{CE} = 32 Vdc, T_A = 150°C)	I_{CES}	— —	20 20	nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc) BCX71GL		—	—	
BCX71JL		40	—	
BCX71KL		100	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc) BCX71GL		120	220	
BCX71JL		250	460	
BCX71KL		380	630	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) BCX71GL		60	—	
BCX71JL		100	—	
BCX71KL		110	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) BCX71GL		125	250	
BCX71JL		250	500	
BCX71KL		350	700	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.25 mAdc) (I_C = 50 mAdc, I_B = 1.25 mAdc)	$V_{CE(sat)}$	— —	0.25 0.55	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.25 mAdc) (I_C = 50 mAdc, I_B = 1.25 mAdc)	$V_{BE(sat)}$	0.6 0.68	0.85 1.05	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.6	0.75	Vdc
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_S = 2.0 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	6.0	dB
SWITCHING CHARACTERISTICS				
Turn-On Time (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	150	ns
Turn-Off Time (I_{B2} = 1.0 mAdc, V_{BB} = 3.6 Vdc, R1 = R2 = 5.0 kΩ, R_L = 990 Ω)	t_{off}	—	800	ns

BCX78-7L,-8L,-9L,-10L
BCX79-7L,-8L,-9L,-10L

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BCX 78	BCX 79	Unit
Collector-Emitter Voltage	V_{CEO}	32	45	Vdc
Collector-Base Voltage	V_{CBO}	32	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

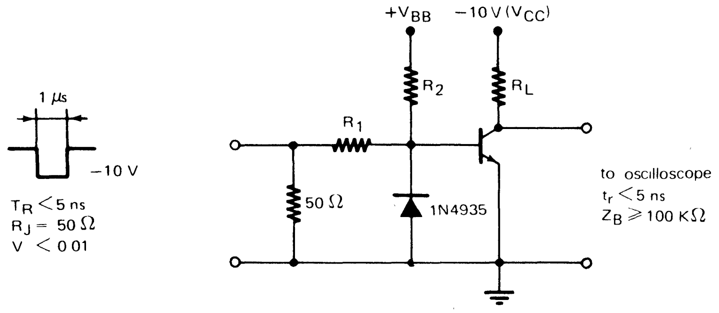
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	BCX78 Series		32	—	—	
	BCX79 Series		45	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	All	$V_{(BR)EBO}$	5.0	6.8	—	Vdc
Collector Cutoff Current						
(V_{CE} = 32 V)	BCX78 Series	I_{CES}	—	—	10	nAdc
(V_{CE} = 45 V)	BCX79 Series	I_{CES}	—	—	10	
(V_{CE} = 32 V, T_A = 100°C, V_{BE} = 0.2 V)	BCX78 Series	I_{CEX}	—	—	20	μAdc
(V_{CE} = 45 V, T_A = 100°C, V_{BE} = 0.2 V)	BCX79 Series	I_{CEX}	—	—	20	
(V_{CE} = 32 V, T_A = 125°C)	BCX78 Series	I_{CES}	—	—	2.5	
(V_{CE} = 45 V, T_A = 125°C)	BCX79 Series	I_{CES}	—	—	2.5	
Emitter-Cutoff Current (V_{EBO} = 4.0 V, I_C = 0)		I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	BCX78-7L, BCX79-7L		20	140	—	
	BCX78-8L, BCX79-8L		40	200	—	
	BCX78-9L, BCX79-9L		75	270	—	
	BCX78-10L, BCX79-10L		100	340	—	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)	BCX78-7L, BCX79-7L		120	170	220	
	BCX78-8L, BCX79-8L		180	250	310	
	BCX78-9L, BCX79-9L		250	350	460	
	BCX78-10L, BCX79-10L		380	500	630	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	BCX78-7L, BCX79-7L		80	180	—	
	BCX78-8L, BCX79-8L		120	260	400	
	BCX78-9L, BCX79-9L		160	360	630	
	BCX78-10L, BCX79-10L		240	500	1000	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	BCX78-7L, BCX79-7L		40	—	—	
	BCX78-8L, BCX79-8L		45	—	—	
	BCX78-9L, BCX79-9L		60	—	—	
	BCX78-10L, BCX79-10L		60	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	—	—	0.6	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 5.0 mAdc)		$V_{BE(sat)}$	—	—	1.0	Vdc
Base-Emitter On Voltage (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.55	—	0.7	Vdc

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

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 V, f = 100 MHz)		f_T	—	200	—	MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1.0 MHz)		C_{ob}	—	2.6	4.5	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ib}	—	8.5	15	pF
Small-Signal Current Gain		h_{fe}				—
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	BCX78-7L, BCX79-7L		125	200	250	
	BCX78-8L, BCX79-8L		175	260	350	
	BCX78-9L, BCX79-9L		250	330	500	
	BCX78-10L, BCX79-10L		350	520	700	
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5.0 Vdc, R_g = 2.0 kohms, f = 1.0 kHz)		NF	—	1.0	6.0	dB
(I_C = 10 mA, I_{B1} = 1.0 mA, I_{B2} = 1.0 mA)		T_d	—	17	—	nS
(V_{BB} = 3.6 V, R_1 = R_2 = 5.0 kΩ)		T_r	—	27	—	
(R_L = 999 ohms)		T_{on}	—	44	150	
*See test circuit		T_s	—	400	—	
		T_f	—	60	—	
		T_{off}	—	460	800	
(I_C = 100 mA, I_{B1} = 10 mA, I_{B2} = 10 mA)		t_d	—	5.0	—	ns
(V_{BB} = 5.0 V, R_1 = 500 Ω, R_2 = 700 Ω)		t_r	—	20	—	
(R_L = 98 ohms)		t_{on}	—	25	150	
*See test circuit		t_s	—	130	—	
		t_f	—	40	—	
		t_{off}	—	170	800	

TEST CIRCUIT



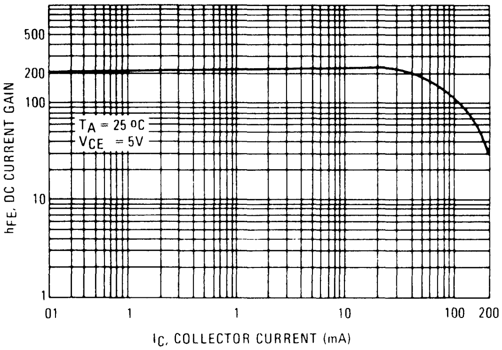


FIGURE 1 — NORMALIZED DC CURRENT GAIN

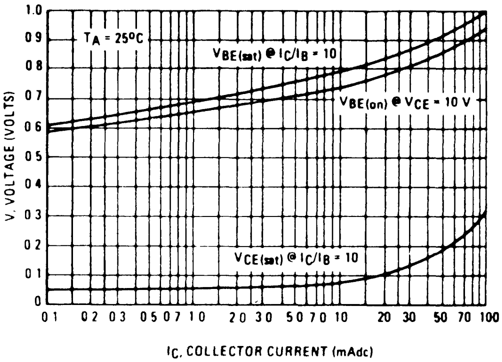


FIGURE 2 — "SATURATION" AND "ON" VOLTAGES

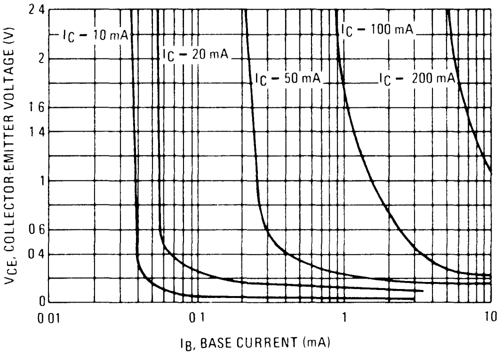


FIGURE 3 — COLLECTOR SATURATION REGION

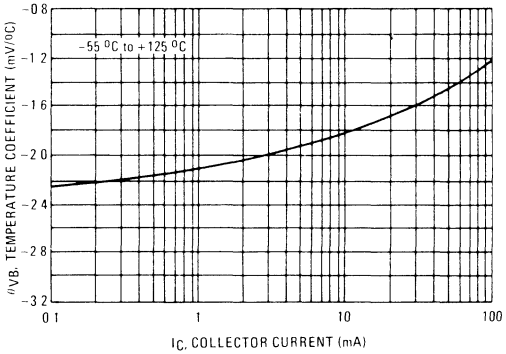


FIGURE 4 — BASE EMITTER TEMPERATURE COEFFICIENT

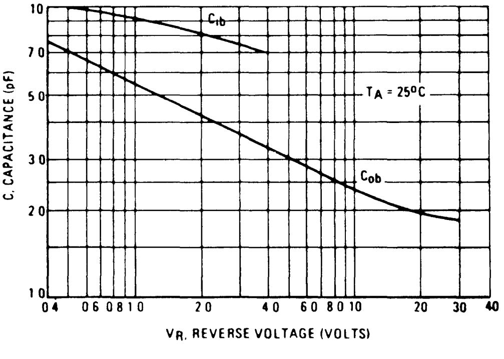


FIGURE 5 — CAPACITANCES

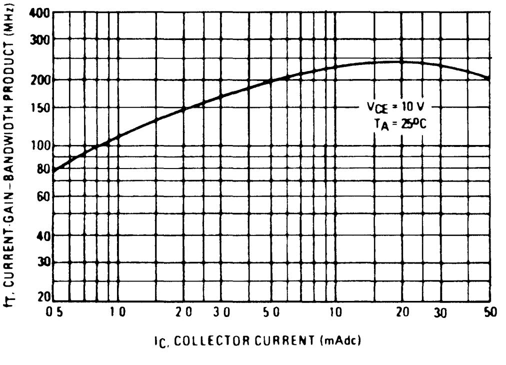
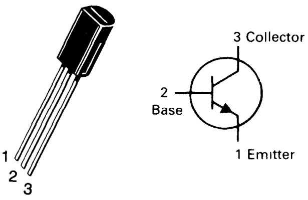


FIGURE 6 — CURRENT GAIN-BANDWIDTH PRODUCT

BDB01A, B, C, D

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BDB 01A	BDB 01B	BDB 01C	BDB 01D	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	100	Vdc
Collector-Base Voltage	V_{CES}	45	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0				Vdc
Collector Current − Continuous	I_C	0.5				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0				Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20				Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$			
BDB01A		45		Vdc
BDB01B		60		
BDB01C		80		
BDB01D		100		
Collector Cutoff Current	I_{CBO}			
(V_{CB} = 45 V, I_E = 0) BDB01A			0.1	μAdc
(V_{CB} = 60 V, I_E = 0) BDB01B			0.1	
(V_{CB} = 80 V, I_E = 0) BDB01C			0.1	
(V_{CB} = 100 V, I_E = 0) BDB01D			0.1	
Emitter Cutoff Current (I_C = 0, V_{EB} = 5.0 V)	I_{EBO}		100	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			
(I_C = 100 mA, V_{CE} = 1 V)		40	400	
(I_C = 500 mA, V_{CE} = 2 V)		25		
Collector-Emitter Saturation Voltage* (I_C = 1000 mA, I_B = 100 mA)	$V_{CE(sat)}$		0.7	Vdc
Collector-Emitter On Voltage* (I_C = 1000 mA, V_{CE} = 1 V)	$V_{BE(on)}$		1.2	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 200 mA, V_{CE} = 5 V, f = 100 MHz)	f_T	50		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}		30	pF

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

FIGURE 1 – D.C. CURRENT GAIN

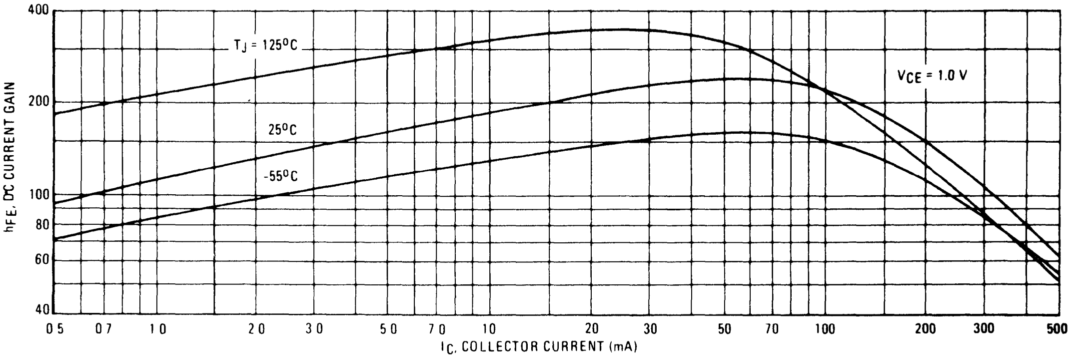


FIGURE 2 – COLLECTOR SATURATION REGION

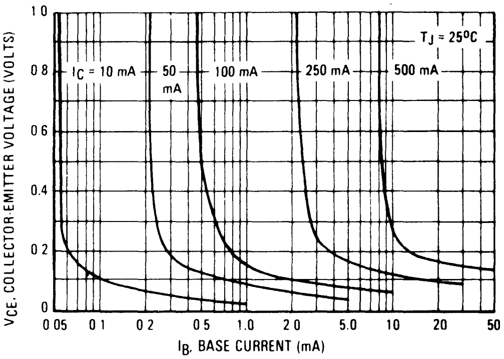


FIGURE 3 – ON VOLTAGES

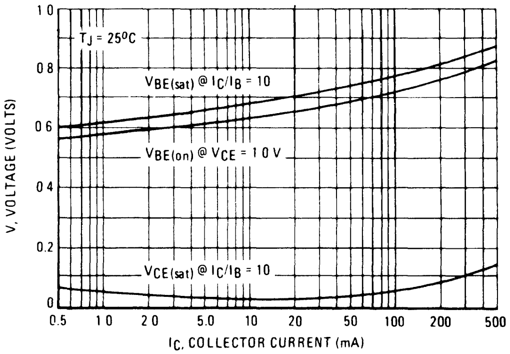


FIGURE 4 – BASE-EMITTER TEMPERATURE COEFFICIENT

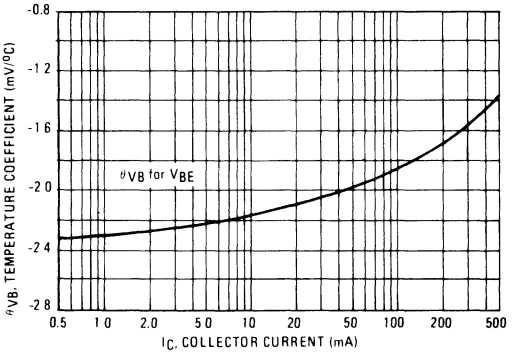


FIGURE 5 – CAPACITANCE

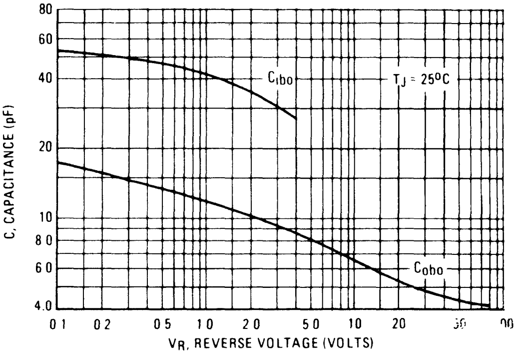


FIGURE 6 – CURRENT GAIN-BANDWIDTH PRODUCT

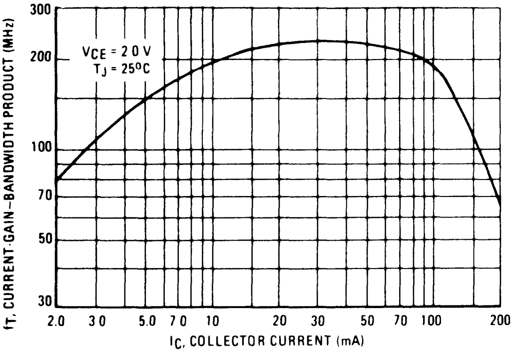
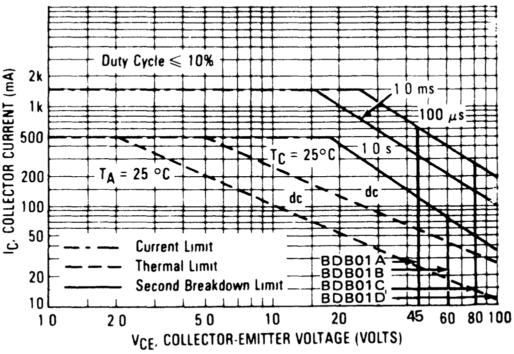


FIGURE 7 – ACTIVE REGION-SAFE OPERATING AREA



BDB02A, B, C, D

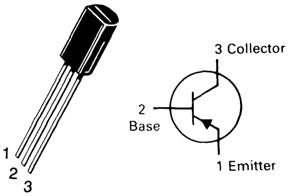
MAXIMUM RATINGS

Rating	Symbol	BDB 02A	BDB 02B	BDB 02C	BDB 02D	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	100	Vdc
Collector-Base Voltage	V_{CES}	45	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0				Vdc
Collector Current – Continuous	I_C	0.5				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0				Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20				Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

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

Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Voltage (I_C = 10 mA, I_B = 0) BDB02A BDB02B BDB02C BDB02D	$V_{(BR)CEO}$	 45 60 80 100		Vdc
Collector Cutoff Current (V_{CB} = 45 V, I_E = 0) BDB02A (V_{CB} = 60 V, I_E = 0) BDB02B (V_{CB} = 80 V, I_E = 0) BDB02C (V_{CB} = 100 V, I_E = 0) BDB02D	I_{CBO}		 0.1 0.1 0.1 0.1	μAdc
Emitter Cutoff Current (I_C = 0, V_{EB} = 5.0 V)	I_{EBO}		100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 100 mA, V_{CE} = 1 V) (I_C = 500 mA, V_{CE} = 2 V)	h_{FE}	 40 25	 400	
Collector-Emitter Saturation Voltage* (I_C = 1000 mA, I_B = 100 mA)	$V_{CE(sat)}$		0.7	Vdc
Collector-Emitter On Voltage* (I_C = 1000 mA, V_{CE} = 1 V)	$V_{BE(on)}$		1.2	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 200 mA, V_{CE} = 5 V, f = 100 MHz)	f_T	50		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}		30	pF

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

FIGURE 1 – D.C. CURRENT GAIN

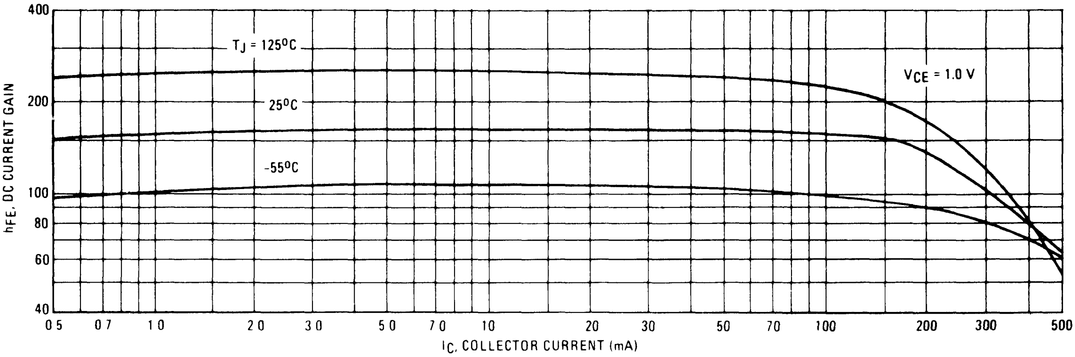


FIGURE 2 – COLLECTOR SATURATION REGION

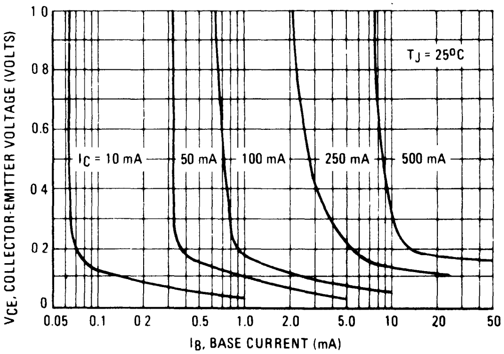


FIGURE 3 – ON VOLTAGES

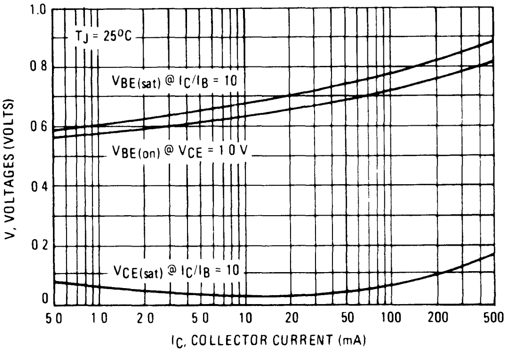


FIGURE 4 – BASE-EMITTER TEMPERATURE COEFFICIENT

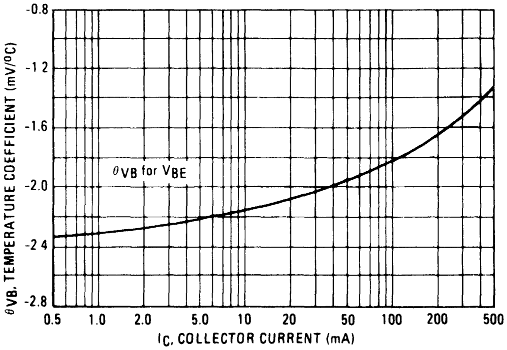


FIGURE 5 – CAPACITANCE

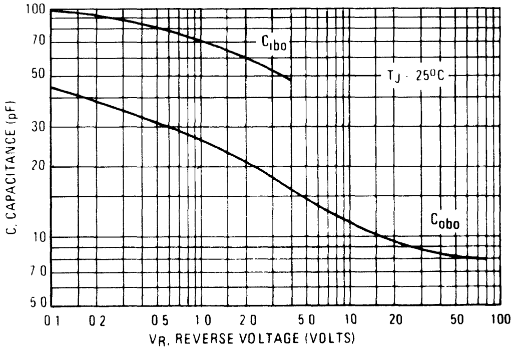


FIGURE 6 – CURRENT GAIN-BANDWIDTH PRODUCT

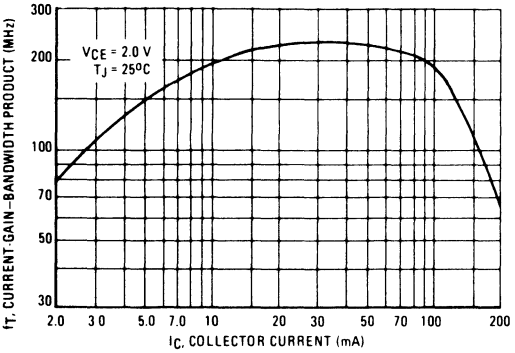
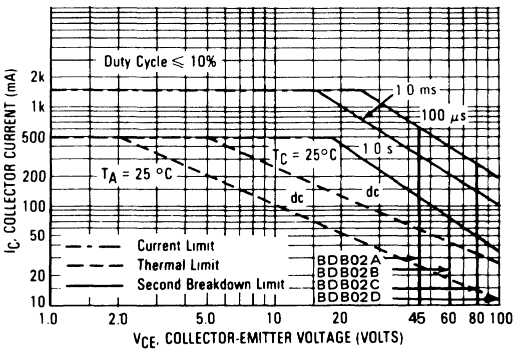


FIGURE 7 – ACTIVE REGION-SAFE OPERATING AREA



BDC01A, B, C, D

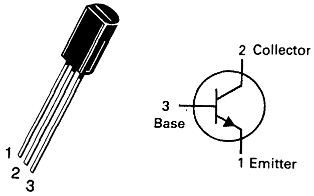
MAXIMUM RATINGS

Rating	Symbol	BDC 01A	BDC 01B	BDC 01C	BDC 01D	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0				Vdc
Collector Current − Continuous	I_C	0.5				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0				Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20				Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

CASE 29-03, STYLE 14
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

Refer to BDB01A for graphs.

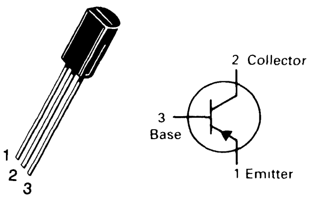
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Voltage (I_C = 10 mA, I_B = 0) BDC01A BDC01B BDC01C BDC01D	$V_{(BR)CEO}$	 45 60 80 100		Vdc
Collector Cutoff Current (V_{CB} = 45 V, I_E = 0) BDC01A (V_{CB} = 60 V, I_E = 0) BDC01B (V_{CB} = 80 V, I_E = 0) BDC01C (V_{CB} = 100 V, I_E = 0) BDC01D	I_{CBO}		 0.1 0.1 0.1 0.1	μAdc
Emitter Cutoff Current (I_C = 0, V_{EB} = 5.0 V)	I_{EBO}		100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 100 mA, V_{CE} = 1 V) (I_C = 500 mA, V_{CE} = 2 V)	h_{FE}	 40 25	 400	
Collector-Emitter Saturation Voltage* (I_C = 1000 mA, I_B = 100 mA)	$V_{CE(sat)}$		0.7	Vdc
Collector-Emitter On Voltage* (I_C = 1000 mA, V_{CE} = 1 V)	$V_{BE(on)}$		1.2	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 200 mA, V_{CE} = 5 V, f = 100 MHz)	f_T	50		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}		30	pF

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

BDC02A, B, C, D

CASE 29-03, STYLE 14
TO-92 (TO-226AE)



ONE WATT
AMPLIFIER TRANSISTORS

PNP SILICON

Refer to BDB02A for graphs.

MAXIMUM RATINGS

Rating	Symbol	BDC 02A	BDC 02B	BDC 02C	BDC 02D	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	45	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0				Vdc
Collector Current − Continuous	I_C	0.5				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0				Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20				Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

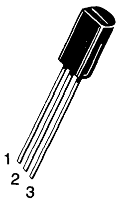
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

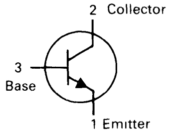
Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Voltage (I_C = 10 mA, I_B = 0) BDC02A BDC02B BDC02C BDC02D	$V_{(BR)CEO}$	 45 60 80 100		Vdc
Collector Cutoff Current (V_{CB} = 45 V, I_E = 0) (V_{CB} = 60 V, I_E = 0) (V_{CB} = 80 V, I_E = 0) (V_{CB} = 100 V, I_E = 0)	I_{CBO}		 0.1 0.1 0.1 0.1	μAdc
Emitter Cutoff Current (I_C = 0, V_{EB} = 5.0 V)	I_{EBO}		100	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 100 mA, V_{CE} = 1 V) (I_C = 500 mA, V_{CE} = 2 V)	h_{FE}	 40 25	 400	
Collector-Emitter Saturation Voltage* (I_C = 1000 mA, I_B = 100 mA)	$V_{CE(sat)}$		0.7	Vdc
Collector-Emitter On Voltage* (I_C = 1000 mA, V_{CE} = 1 V)	$V_{BE(on)}$		1.2	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 200 mA, V_{CE} = 5 V, f = 100 MHz)	f_T	50		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}		30	pF

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

BDC05
BDC07

CASE 29-03, STYLE 14
TO-92 (TO-226AE)





ONE WATT HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSW42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BDC 05	BDC 07	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	Vdc
Collector-Base Voltage	V_{CBO}	300	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current − Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1 8.0		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 50		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

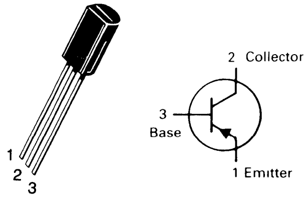
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) (I_C = 1 mAdc, I_B = 0) BDC05 BDC07	$V_{(BR)CEO}$	 300 250	 —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 µAdc, I_E = 0) BDC05 BDC07	$V_{(BR)CBO}$	 300 250	 —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0) BDC05 BDC07	$V_{(BR)EBO}$	 5.0 5.0	 —	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0) BDC05 BDC07	I_{CBO}	 —	 0.01	µAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0) BDC05 BDC07	I_{EBO}	 —	 10	µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 25 mAdc, V_{CE} = 20 Vdc) BDC05 BDC07	h_{FE}	 40 50	 — —	—
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$		2	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mA, I_B = 2.0 mA)	$V_{BE(sat)}$		2.0	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain−Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 50 MHz)	f_T	60	—	MHz
Collector-Base Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}		2.8	pF

(1) Pulse Test: Pulse Width ≦ 300 µs, Duty Cycle ≦ 2.0%.

BDC06
BDC08

CASE 29-03, STYLE 14
TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSW92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BDC 06	BDC 08	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	Vdc
Collector-Base Voltage	V_{CBO}	300	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

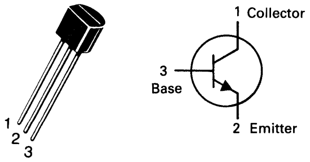
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1)		$V_{(BR)CEO}$			Vdc
($I_C = 1$ mAdc, $I_B = 0$)	BDC06		300		
	BDC08		250	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100$ μAdc, $I_E = 0$)	BDC06		300		
	BDC08		250	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
($I_E = 100$ μAdc, $I_C = 0$)	BDC06		5.0		
	BDC08		5.0	—	
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 200$ Vdc, $I_E = 0$)	BDC06			0.01	
	BDC08		—		
Emitter Cutoff Current		I_{EBO}			μAdc
($V_{BE} = 5.0$ Vdc, $I_C = 0$)	BDC06			10	
	BDC08		—		
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 25$ mA, $V_{CE} = 20$ Vdc)	BDC06		40	—	
	BDC08		50	—	
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$		2	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mA, $I_B = 2.0$ mA)		$V_{BE(sat)}$		2.0	Vdc
DYNAMIC CHARACTERISTICS					
Current Gain−Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 50 MHz)		f_T	60	—	MHz
Collector-Base Capacitance ($V_{CB} = 30$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{re}		2.8	pF

(1) Pulse Test: Pulse Width ≦ 300 μs, Duty Cycle ≦ 2.0%.

BF199

CASE 29-04, STYLE 21
TO-92 (TO-226AA)



RF TRANSISTOR

NPN SILICON

Refer to BF240 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current − Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

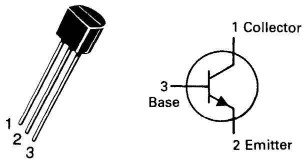
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage **(I_C = 1 mAdc, I_B = 0)**	$V_{(BR)CEO}$	25			Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40			Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4			Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}			100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 7 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	85		
Base-Emitter On Voltage (I_C = 7 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$		770	900	mVdc
SMALL-SIGNAL CHARACTERISTICS					
Current Gain−Bandwidth Product (2) (I_C = 5 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	750		MHz
Common Emitter Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}		0.25	0.35	pF
Noise Figure (I_C = 4 mA, V_{CE} = 10 V, R_S = 50 Ω, f = 35 MHz)	N_f		2.5		dB

BF224

CASE 29-04, STYLE 21
TO-92 (TO-226AA)



RF TRANSISTOR

NPN SILICON

Refer to BF240 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

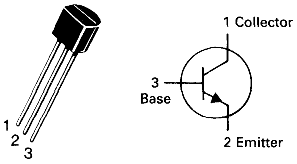
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	30			Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	45			Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4			Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) T_A = 25°C	I_{CBO}			100	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}			100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 7 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30			
Base-Emitter On Voltage (I_C = 7 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$		0.77	0.9	mVdc
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$			0.15	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current Gain–Bandwidth Product (I_C = 1.5 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) (I_C = 7 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	600 850		MHz
Common Emitter Feedback Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{re}		0.28		pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, R_S = 50 ohms, f = 100 MHz) f = 200 MHz	N_f		2.5 3.5		dB

BF240
BF241

CASE 29-04, STYLE 21
TO-92 (TO-226AA)



AM/FM TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current − Continuous	I_C	25	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic		Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (1) (I_C = 1 mAdc, I_B = 0)		$V_{(BR)CEO}$	40			Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	40			Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	4			Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)		I_{CBO}			100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 1 mAdc, V_{CE} = 10 Vdc)	BF240 BF241	h_{FE}	65 35		220 125	—
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		$V_{BE(on)}$	0.65	0.70	0.74	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current Gain−Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	BF240 BF241	f_T		600 470		MHz
Common Emitter Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{re}		0.28	0.34	pF

(1) Pulse test: Pulse Width ≦ 300 μs. Duty cycle ≦ 2.0%.

FIGURE 1 – CURRENT GAIN-BANDWIDTH PRODUCT

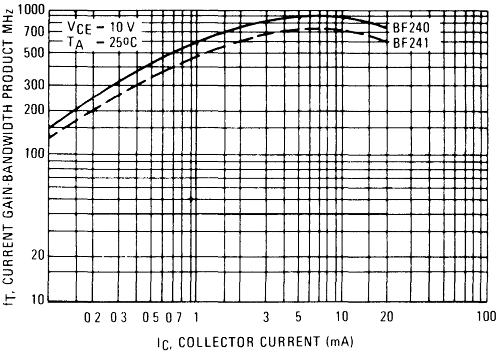


FIGURE 2 – CAPACITANCES

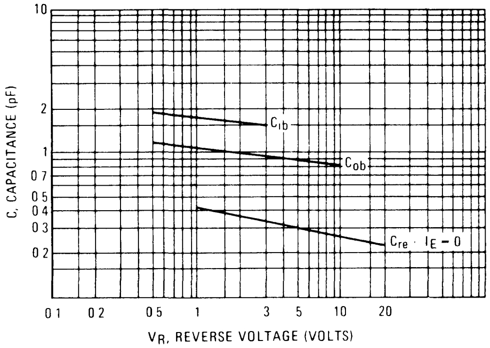


FIGURE 3 – DC CURRENT GAIN

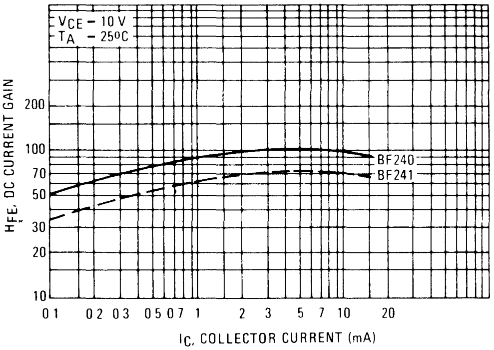


FIGURE 4 – b11e

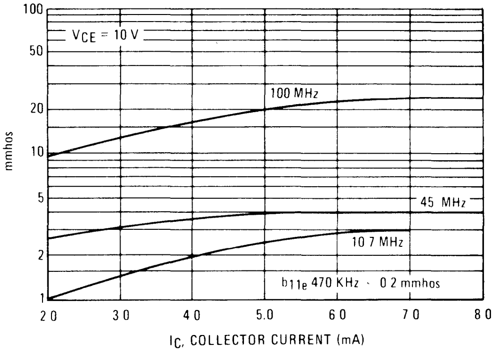


FIGURE 5 – b21e

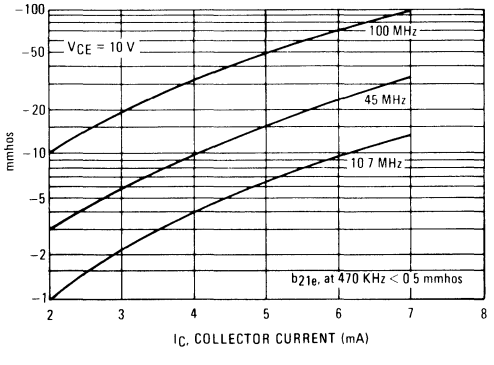


FIGURE 6 – b22e (boe)

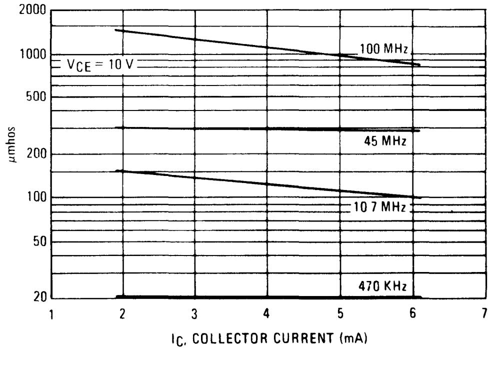


FIGURE 7 — g11e (gie)

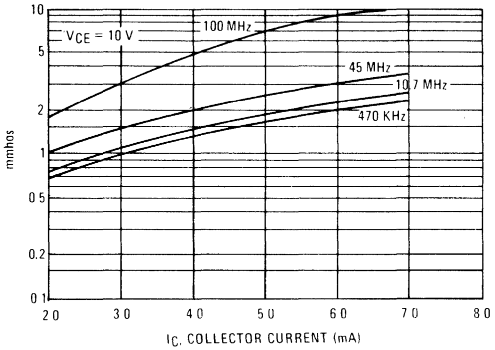


FIGURE 8 — g21e (Yfe)

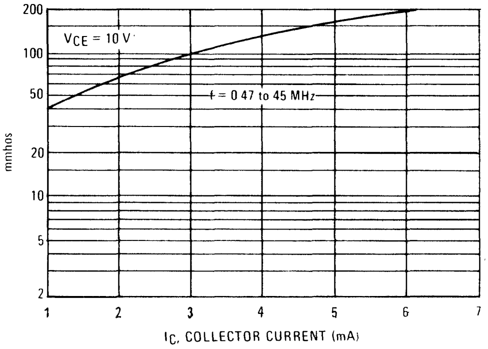
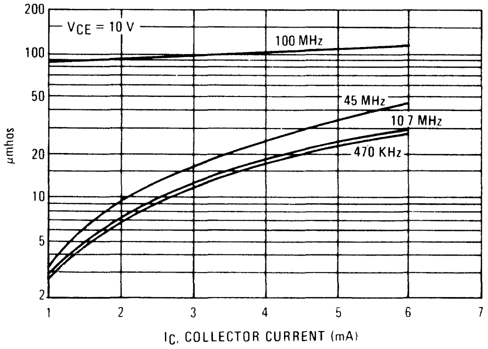
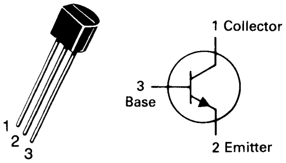


FIGURE 9 — g22e (goe)



BF254, -3, -4

CASE 29-04, STYLE 21
TO-92 (TO-226AA)



AM/FM TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic		Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	20			Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	30			Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0			Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)		I_{CBO}			100	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}			100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 1.0 mA, V_{CE} = 10 Vdc)	BF254 BF254-3 BF254-4	h_{FE}	65 65 100		220 125 220	
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	BF254	$V_{BE(on)}$		0.68		Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current Gain−Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	BF254	f_T		260		MHz
Common Emitter Feedback Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{re}		0.90		pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1 MHz, R_S = 50 ohms)		N_f		1.7		dB

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

TYPICAL ADMITTANCE PARAMETERS (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, frequency as stated.)

	f = 450 kHz	f = 10.7 MHz	
Symbol	**BF254**	**BF254**	**Unit**
g_{11e}	0.2	0.26	mmhos
b_{11e}	0.05	1.2	mmhos
g_{22e}	3.0	5.3	μmhos
b_{22e}	8.0	190	μmhos
b_{12e}	−5.0	−130	μmhos
g_{12e}	−0.7	−3.0	μmhos
g_{21e}	30	30	mmhos
b_{21e}	−0.003	−0.7	mmhos

FIGURE 1 — DC CURRENT GAIN

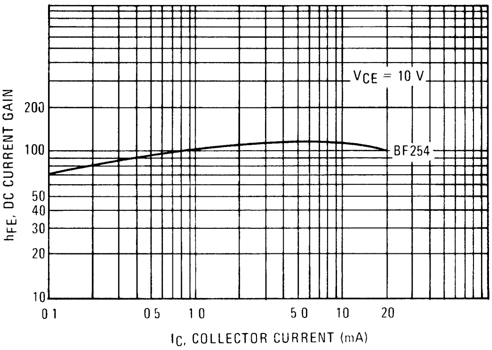


FIGURE 2 — CURRENT GAIN—BANDWITH PRODUCT

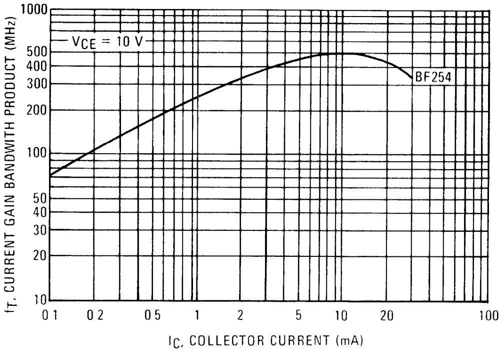


FIGURE 3 — "ON" VOLTAGE

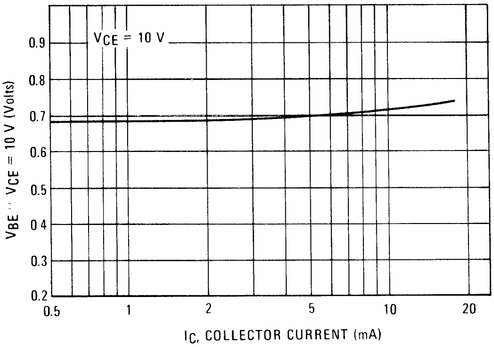
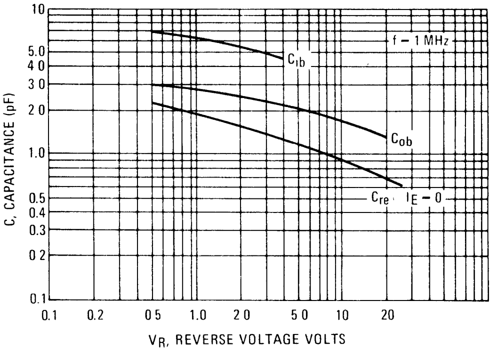
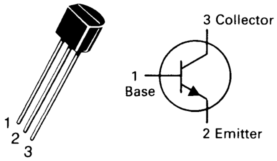


FIGURE 4 — CAPACITANCES



BF366

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	25	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

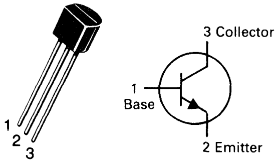
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	—	—	500	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 3.0 mAdc, V_{CE} = 10 Vdc)		15	—	—	
(I_C = 12 mAdc, V_{CE} = 7.0 Vdc)		5.5	—	—	
Base-Emitter On Voltage (I_C = 12 mAdc, V_{CE} = 7.0 Vdc)	$V_{BE(on)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current Gain–Bandwidth Product (I_C = 3.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	—	—	MHz
Feedback Capacitance (Common Emitter) (V_{CE} = 10 Vdc, f = 1 MHz)	C_{rb}	—	—	0.3	pF
Noise Figure (I_C ≈ 3.0 mAdc, V_{CB} ≈ 10 Vdc, R_S = 50 Ohms, f = 200 MHz)	N_f	—	—	3.5	dB
Common-Emitter Amplifier Power Gain (I_C ≈ 3.0 mAdc, V_{CB} ≈ 10 Vdc, R_S = 50 Ohms, f = 200 MHz)	G_{pb}	14	—	—	dB
Forward AGC Current (Gain Reduction = 30 dB, V_{CB} = 10 V, f = 200 MHz)	I_{AGC}	5	—	8	mAdc

BF371
BF373

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BF 371	BF 373	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Base Voltage	V_{CBO}	40	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current – Continuous	I_C	100		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

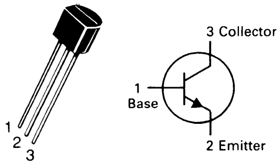
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	BF371 BF373	$V_{(BR)CEO}$	30 40	— —	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	BF371 BF373	$V_{(BR)CBO}$	40 45	— —	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)		I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 7.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 20$ mAdc, $V_{CE} = 2.0$ Vdc)		h_{FE}	 40 15	 — —	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 7.0$ mA, $V_{CE} = 10$ Vdc)		$V_{BE(on)}$	—	—	0.9	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	BF371 BF373	f_T	400 500	720 720	— —	MHz
Common-Emitter Feedback Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{re}	—	0.2	0.32	pF

BF374
BF375, C, D

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTORS

NPN SILICON

Refer to MPSH10 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current − Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25			Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30			Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0			Vdc
Collector Cutoff Current ($V_{CB} = 25$ Vdc, $I_E = 0$)	I_{CBO}			100	nAdc
Emitter Cutoff Current ($V_{EB} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}			100	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) BF374		70		250	
BF375		35		120	
BF375C		70		120	
BF375D		35		90	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				
($I_C = 1.0$ mAdc, $I_B = 0.1$ mAdc)			50		mVdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			70		mVdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$		830		mVdc
Base-Emitter On Voltage	$V_{BE(on)}$				
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)			700		mVdc
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc			770		mVdc
SMALL-SIGNAL CHARACTERISTICS					
Current Gain−Bandwidth Product ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	400	800		MHz
Common Emitter Feedback Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{re}		0.55	0.6	pF
Collector-Base Time Constant ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 31.8 MHz)	r_bC_c		6		ps
Noise Figure ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz, $R_s = 50$ ohms)	N_f		4		dB
Common-Emitter Amplifier Power Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 200 MHz)	G_{pe}		20		dB

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

TYPICAL ADMITTANCE PARAMETERS (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, frequency as stated)

Symbol	f = 10.7 MHz	f = 30 MHz	f = 100 MHz	Unit
G_{11e}	0.28	0.4	1.4	mmho
B_{11e}	0.6	1.6	5.0	mmho
G_{22e}	6.5	7	20	µmho
B_{22e}	0.1	0.3	1.0	mmho
G_{21e}	36	34	30	mmho
B_{21e}	− 0.8	− 2.5	− 9	mmho
B_{12e}	− 52	− 150	− 500	µmho

FIGURE 1 — INPUT ADMITTANCE (Output short circuit)

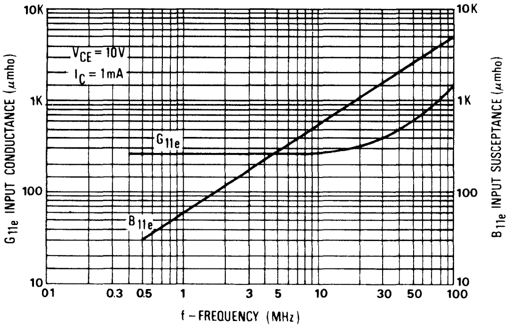


FIGURE 2 — OUTPUT ADMITTANCE (Input short circuit)

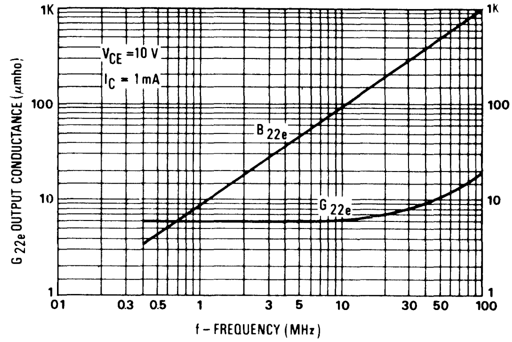


FIGURE 3 — FORWARD TRANSFER ADMITTANCE (Output short circuit)

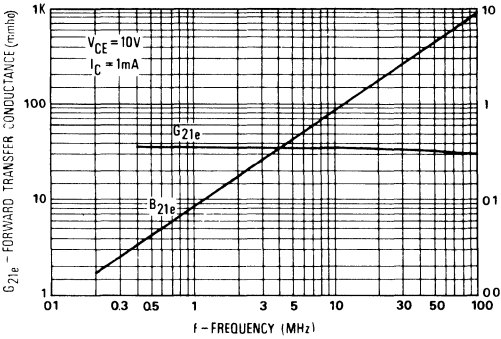
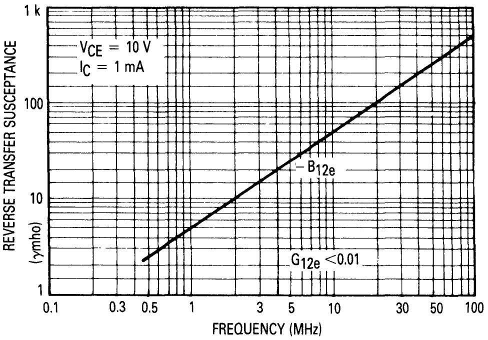
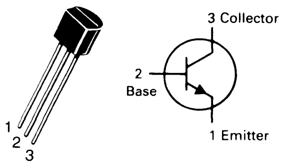


FIGURE 4 — REVERSE TRANSFER ADMITTANCE (Input short circuit)



BF391
thru
BF393

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BF 391	BF 392	BF 393	Unit
Collector-Emitter Voltage	V_{CEO}	200	250	300	Vdc
Collector-Base Voltage	V_{CBO}	200	250	300	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current – Continuous	I_C	500			mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

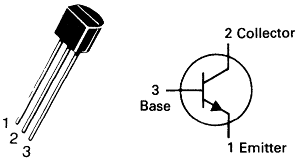
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) ($I_C = 1.0$ mAdc, $I_B = 0$)	BF391 BF392 BF393	$V_{(BR)CEO}$	200 250 300	— — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	BF391 BF392 BF393	$V_{(BR)CBO}$	200 250 300	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ µAdc, $I_C = 0$)	BF391 BF392 BF393	$V_{(BR)EBO}$	6.0 6.0 6.0	— — —	Vdc
Collector Cutoff Current ($V_{CB} = 160$ Vdc, $I_E = 0$) ($V_{CB} = 200$ Vdc, $I_E = 0$) ($V_{CB} = 200$ Vdc, $I_E = 0$)	BF391 BF392 BF393	I_{CBO}	— — —	0.1 0.1 0.1	µAdc
Emitter Cutoff Current ($V_{CB} = 4.0$ Vdc, $I_C = 0$) ($V_{CB} = 6.0$ Vdc, $I_C = 0$) ($V_{CB} = 6.0$ Vdc, $I_C = 0$)	BF391 BF392 BF393	I_{EBO}	— — —	0.1 0.1 0.1	µAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	All Types All Types	h_{FE}	25 40	— —	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$		2.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mA, $I_B = 2.0$ mA)		$V_{BE(sat)}$		2.0	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Common Emitter Feedback Capacitance ($V_{CB} = 60$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{re}		2.0	pF

(1) Pulse Test: Pulse Width ≦ 300 µs, Duty Cycle ≦ 2.0%.

BF420
BF422

CASE 29-04, STYLE 14
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BF 420	BF 422	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	Vdc
Collector-Base Voltage	V_{CBO}	300	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current − Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	800 6.4		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.75 22		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	156	°C/W

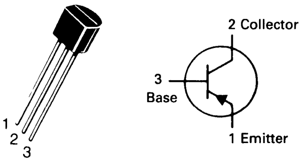
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1)		$V_{(BR)CEO}$			Vdc
(I_C = 1 mAdc, I_B = 0)	BF420		300		
	BF422		250	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 µAdc, I_E = 0)	BF420		300		
	BF422		250	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 100 µAdc, I_C = 0)	BF420		5.0		
	BF422		5.0	—	
Collector Cutoff Current		I_{CBO}			µAdc
(V_{CB} = 200 Vdc, I_E = 0)	BF420			0.01	
	BF422		—		
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{BE} = 5.0 Vdc, I_C = 0)	BF420			100	
	BF422		—		
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 25 mAdc, V_{CE} = 20 Vdc)	BF420		50	—	
	BF422		50	—	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$		0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mA, I_B = 2.0 mA)		$V_{BE(sat)}$		2.0	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain − Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 50 MHz)		f_T	60	—	MHz
Common Emitter Feedback Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)		C_{re}		1.6	pF

(1) Pulse Test: Pulse Width ≦ 300 µs, Duty Cycle ≦ 2.0%.

BF421
BF423

CASE 29-04, STYLE 14
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BF 421	BF 423	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	Vdc
Collector-Base Voltage	V_{CBO}	300	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current − Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	800 6.4		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.75 22		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	156	°C/W

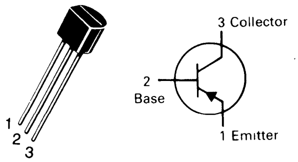
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) ($I_C = 1$ mAdc, $I_B = 0$)	BF421 BF423	$V_{(BR)CEO}$	300 250	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	BF421 BF423	$V_{(BR)CBO}$	300 250	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ µAdc, $I_C = 0$)	BF421 BF423	$V_{(BR)EBO}$	5.0 5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ Vdc, $I_E = 0$)	BF421 BF423	I_{CBO}	—	0.01	µAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	BF421 BF423	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 25$ mA, $V_{CE} = 20$ Vdc)	BF421 BF423	h_{FE}	50 50	— —	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$		0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mA, $I_B = 2.0$ mA)		$V_{BE(sat)}$		2.0	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain − Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 50 MHz)		f_T	60	—	MHz
Common Emitter Feedback Capacitance ($V_{CB} = 30$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{re}		2.8	pF

(1) Pulse Test: Pulse Width ≦ 300 µs, Duty Cycle ≦ 2.0%.

BF491
thru
BF493

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BF 491	BF 492	BF 493	Unit
Collector-Emitter Voltage	V_{CEO}	200	250	300	Vdc
Collector-Base Voltage	V_{CBO}	200	250	300	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current – Continuous	I_C	500			mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0			mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

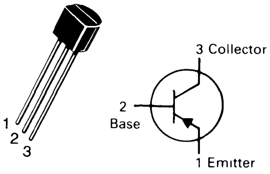
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic		Symbol	Min.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) ($I_C = 1$ mAdc, $I_B = 0$)	BF491	$V_{(BR)CEO}$	200	—	Vdc
	BF492		250	—	
	BF493		300	—	
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	BF491	$V_{(BR)CBO}$	200	—	Vdc
	BF492		250	—	
	BF493		300	—	
Emitter-Base Breakdown Voltage ($I_E = 100$ µAdc, $I_C = 0$)	BF491	$V_{(BR)EBO}$	6.0	—	Vdc
	BF492		6.0	—	
	BF493		6.0	—	
Collector Cutoff Current ($V_{CB} = 160$ Vdc, $I_E = 0$)	BF491	I_{CBO}	—	0.1	µAdc
($V_{CB} = 200$ Vdc, $I_E = 0$)	BF492		—	0.1	
($V_{CB} = 200$ Vdc, $I_E = 0$)	BF493		—	0.1	
Emitter Cutoff Current ($V_{CB} = 4.0$ Vdc, $I_C = 0$)	BF491	I_{EBO}	—	0.1	µAdc
($V_{CB} = 6.0$ Vdc, $I_C = 0$)	BF492		—	0.1	
($V_{CB} = 6.0$ Vdc, $I_C = 0$)	BF493		—	0.1	
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	All Types	h_{FE}	25	—	—
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	All Types		40	—	
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$		2.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mA, $I_B = 2.0$ mA)		$V_{BE(sat)}$		2.0	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Common Emitter Feedback Capacitance ($V_{CB} = 100$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{re}		1.6	pF

(1) Pulse Test: Pulse Width ≦ 300 µs, Duty Cycle ≦ 2.0%.

BF493S

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

Refer to MPSA93 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	350	Vdc
Collector-Base Voltage	V_{CBO}	350	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

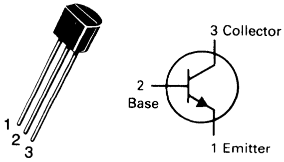
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	350	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	350	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 250 Vdc)	I_{CES}	—	10	nAdc
Emitter Cutoff Current (V_{BE} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 250 Vdc, I_E = 0, T_A = 25°C) (V_{CB} = 250 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 0.005 1.0	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 25 40	 — —	—
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	2.0	Vdc
Base-Emitter On Voltage (I_C = 20 mA, I_B = 2.0 mA)	$V_{BE(sat)}$	—	2.0	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Common-Emitter Feedback Capacitance (V_{CB} = 100 Vdc, I_E = 0, f = 1.0 MHz)	C_{re}	—	1.6	pF

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

BF844
BF845

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BF 844	BF 845	Unit
Collector-Emitter Voltage	V_{CEO}	400	350	Vdc
Collector-Base Voltage	V_{CBO}	450	400	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current – Continuous	I_C	300		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

Refer to MPSA44 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	BF844 BF845	$V_{(BR)CEO}$	400 350	— —	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100$ µAdc, $V_{BE} = 0$)	BF844 BF845	$V_{(BR)CES}$	450 400	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	BF844 BF845	$V_{(BR)CBO}$	450 400	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ µAdc, $I_C = 0$)	Both Types	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 400$ Vdc, $I_E = 0$) ($V_{CB} = 320$ Vdc, $I_E = 0$)	BF844 BF845	I_{CBO}	— —	0.1 0.1	µAdc
Collector Cutoff Current ($V_{CE} = 400$ Vdc, $V_{BE} = 0$) ($V_{CE} = 320$ Vdc, $V_{BE} = 0$)	BF844 BF845	I_{CES}	— —	500 500	nAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	Both Types	I_{EBO}	—	0.1	µAdc
ON CHARACTERISTICS					
DC Current Gain (1) ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 10$ Vdc)	Both Types Both Types Both Types Both Types	h_{FE}	40 50 45 20	— 200 — —	—
Collector-Emitter Saturation Voltage (1) ($I_C = 1.0$ mAdc, $I_B = 0.1$ mAdc) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	Both Types Both Types Both Types	$V_{CE(sat)}$	— — —	0.4 0.5 0.75	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{BE(sat)}$	—	0.75	Vdc

(1) Pulse Test: Pulse Width ≦ 300 µS — Duty Cycle ≦ 2.0%.

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

Characteristic		Symbol	Min	Max	Unit
DYNAMIC CHARACTERISTICS					
High Frequency Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)	Both Types	$\lvert h_{fe} \rvert$	2.0	—	
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	Both Types	C_{ob}	—	6.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	Both Types	C_{ib}	—	110	pF
Turn-On Time (V_{CC} = 150 Vdc, $V_{BE(off)}$ = 4.0 V, I_C = 30 mAdc, I_{B1} = 3.0 mAdc)	Both Types	t_{on}	—	0.6	µs
Turn-Off Time (V_{CC} = 150 Vdc, I_C = 30 mAdc, I_{B1} = I_{B2} = 3.0 mAdc)	Both Types	t_{off}	—	10	µs

FIGURE 1 — DC CURRENT GAIN

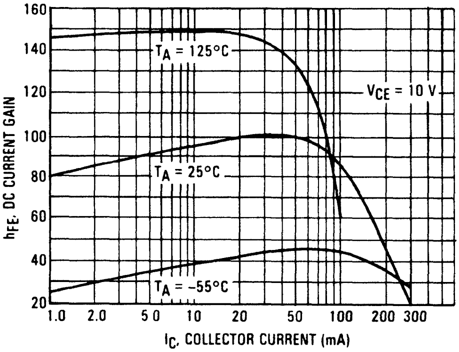
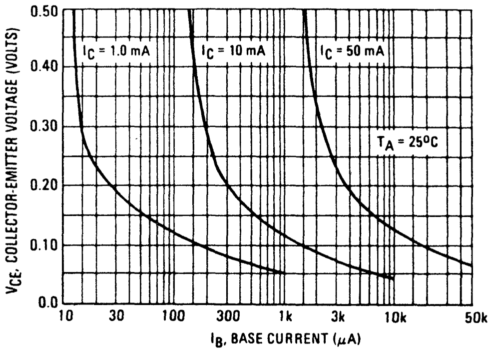
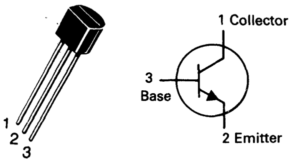


FIGURE 2 — COLLECTOR SATURATION REGION



BF959

CASE 29-04, STYLE 21
TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	– 55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min.	Typ.	Max.	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5 mAdc, V_{CE} = 10 Vdc) (I_C = 20 mAdc, V_{CE} = 10 Vdc)	h_{FE}	35 40	— —	— —	
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 2.0 mAdc)	$V_{BE(sat)}$	—	—	1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_t	700 600	— —	— —	MHz
Common Emitter Feedback Capacitance (V_{CB} = 10 Vdc, P_f = 0, f = 10 MHz)	C_{re}	—	0.65’	—	pF
Noise Figure (I_C = 4 mA, V_{CE} = 10 V, R_S = 50 Ω, f = 200 MHz)	N_f	—	3	—	dB

FIGURE 1 – Hfe AT 10 V

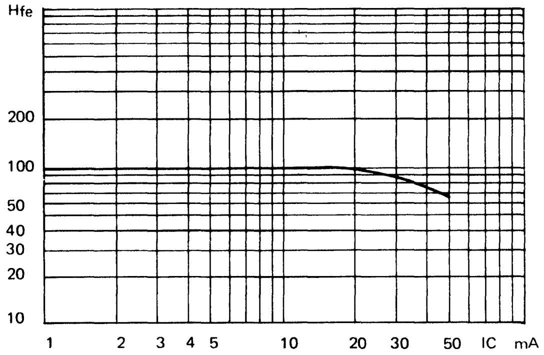


FIGURE 2 – VCE Sat AT IC/IB = 10

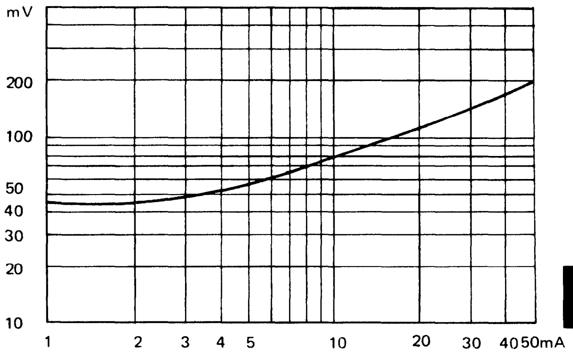


FIGURE 3 – CURRENT-GAIN – BANDWIDTH-PRODUCT

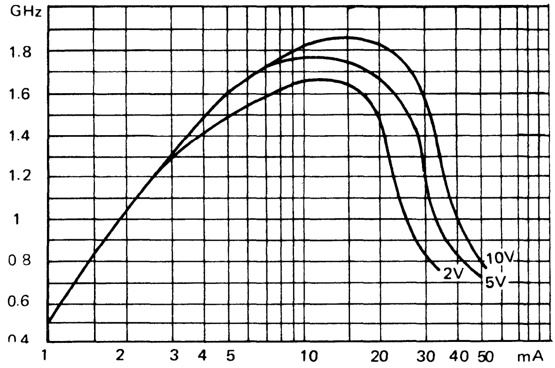


FIGURE 4 – CAPACITANCES

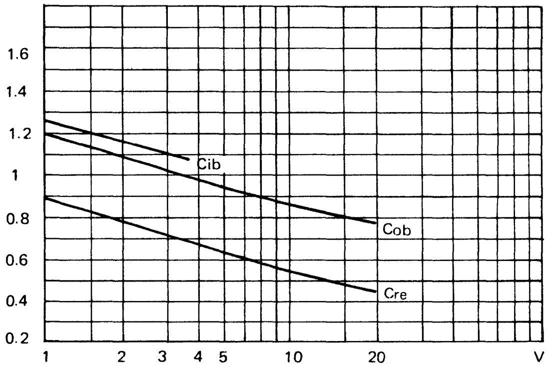


FIGURE 5 – INPUT IMPEDANCE AT 30 MHz

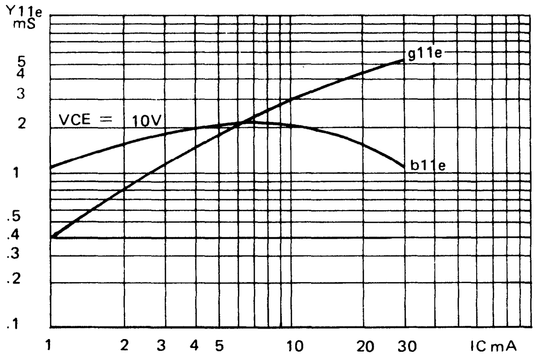
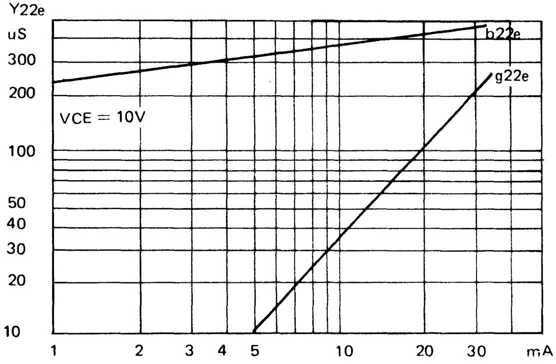


FIGURE 6 – OUTPUT IMPEDANCE AT 30 MHz



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	25	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

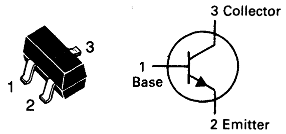
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BFR92L = P1

BFR92L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF TRANSISTOR

NPN SILICON

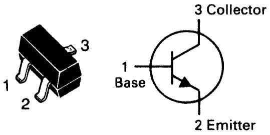
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mA)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V)	I_{CBO}	—	50	nA
ON CHARACTERISTICS				
DC Current Gain (I_C = 14 mA, V_{CE} = 10 V)(1)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage(1) (I_C = 25 mA, I_B = 5.0 mA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 25 mA, I_B = 5.0 mA)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 14 mA, V_{CE} = 10 V, f = 500 MHz)	f_T	5 GHz (Typ)	—	MHz
Noise Figure (V_{CE} = 1.5 V, I_C = 3.0 mA, R_S = 50 Ω, f = 500 MHz)	NF	—	3.0 (Typ)	dB
Capacitance-Collector to Base (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{cb}	—	0.7 (Typ)	pF

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

BFR93L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	25	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BFR93L = R1

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu A$)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 10$ V)	I_{CEO}	—	50	nA
Collector Cutoff Current ($V_{CB} = 10$ V)	I_{CBO}	—	50	nA
Emitter Cutoff Current ($V_{EB} = 1.0$ V)	I_{EBO}	—	10	nA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0$ mA, $V_{CE} = 5.0$ V) ($I_C = 30$ mA, $V_{CE} = 5.0$ V)	h_{FE}	 25 25	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 35$ mA, $I_B = 7.0$ mA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 35$ mA, $I_B = 7.0$ mA)	$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 30$ mA, $V_{CE} = 5.0$ V, f = 500 MHz)	f_T	4.5	—	GHz
Noise Figure ($V_{CE} = 5.0$ V, $I_C = 2.0$ mA, $R_S = 50\ \Omega$, f = 30 MHz)	NF	—	3.0	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

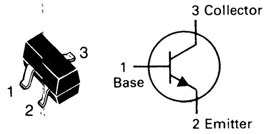
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BFS17L = E1

BFS17L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF TRANSISTOR

NPN SILICON

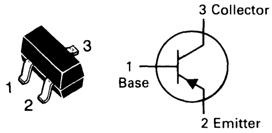
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	$V_{(BR)CBO}$	25	—	Vdc
Collector Cutoff Current ($V_{CE} = 10$ V)	I_{CEO}	—	25	nA
Collector Cutoff Current ($V_{CB} = 10$ V)	I_{CBO}	—	25	nA
Emitter Cutoff Current ($V_{EB} = 4.0$ V)	I_{EBO}	—	100	μA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 2.0$ mA, $V_{CE} = 1.0$ V) ($I_C = 25$ mA, $V_{CE} = 1.0$ V)	h_{FE}	 20 20	 150 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{CE(sat)}$	—	0.4	V
Base-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1.0$ mA)	$V_{BE(sat)}$	—	1.0	V
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 2.0$ mA, $V_{CE} = 5.0$ V, f = 500 MHz) ($I_C = 25$ mA, $V_{CE} = 5.0$ V, f = 500 MHz)	f_T	 1.0 1.3*	 — —	GHz
Output Capacitance ($V_{CB} = 10$ V, f = 1.0 MHz)	CCB	—	1.0*	pF
Noise Figure ($I_C = 2.0$ mA, $V_{CE} = 5.0$ V, $R_S = 50\ \Omega$, f = 30 MHz)	NF	—	5.0*	dB

*Typ

BSS63L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Emitter Voltage R_{BE} = 10 kΩ	V_{CER}	110	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

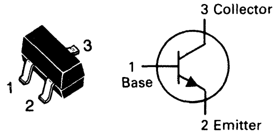
BSS63L = T1

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc)	$V_{(BR)CEO}$	100	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, I_E = 0, R_{BE} = 10 kΩ)	$V_{(BR)CER}$	110	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 90 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
Collector Cutoff Current (V_{CE} = 110 Vdc, R_{BE} = 10 kΩ)	I_{CER}	—	—	10	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)	I_{EBO}	—	—	200	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 25 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 30 30	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 25 mAdc, I_B = 2.5 mAdc)	$V_{CE(sat)}$	—	—	250	mVdc
Base-Emitter Saturation Voltage (I_C = 25 mAdc, I_B = 2.5 mAdc)	$V_{BE(sat)}$	—	—	900	mVdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 25 mAdc, V_{CE} = 5.0 Vdc, f = 35 MHz)	f_T	50	95	—	MHz
Case Capacitance (I_E = I_C = 0, V_{CB} = 10 Vdc)	C_C	—	—	5.0	pF

BSS64L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



DRIVER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSS64L = AM

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 4.0$ mA)	$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$)	$V_{(BR)CBO}$	120	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu A$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 90$ V) ($T_A = 150°C$)	I_{CBO}	 — —	 0.1 500	μA
Emitter Cutoff Current ($V_{BE} = 4.0$ V)	I_{EBO}	—	200	nA
ON CHARACTERISTICS				
DC Current Gain ($V_{CE} = 1.0$ V, $I_C = 10$ mA)	h_{FE}	20	—	—
Collector-Emitter Saturation Voltage ($I_C = 4.0$ mA, $I_B = 400\ \mu A$) ($I_C = 50$ mA, $I_B = 15$ mA)	$V_{CE(sat)}$	 — —	 0.15 0.2	Vdc
Forward Base-Emitter Voltage	$V_{BE(sat)}$	—	—	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 4.0$ mA, $V_{CE} = 10$ V, f = 35 MHz)	f_T	60	—	MHz
Output Capacitance ($V_{CE} = 10$ V, f = 1.0 MHz)	C_{ob}	—	5.0	pF

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	75	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	800	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

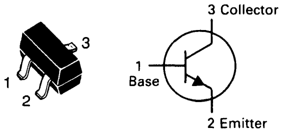
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSS79BL = CE; BSS79CL = CF

BSS79BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

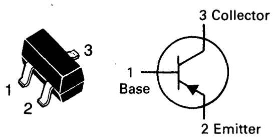
NPN SILICON

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc)		$V_{(BR)CBO}$	75	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc) (V_{CB} = 60 Vdc, T_A = 150°C)		I_{CBO}	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc)		I_{EBO}	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 10 Vdc)	BSS79BL BSS79CL	h_{FE}	40 100	120 300	— —
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	 — —	 0.3 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (V_{CE} = 20 Vdc, I_C = 20 mAdc, f = 100 MHz)		f_T	250	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)		C_{obo}	—	8.0	pF
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 30 Vdc, I_C = 150 mAdc) (I_{B1} = I_{B2} = 15 mAdc)		t_d	—	10	ns
Rise Time (V_{CC} = 30 Vdc, I_C = 150 mAdc) (I_{B1} = I_{B2} = 15 mAdc)		t_r	—	10	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc) (I_{B1} = I_{B2} = 15 mAdc)		t_s	—	225	ns
Fall Time (V_{CC} = 30 Vdc, I_C = 150 mAdc) (I_{B1} = I_{B2} = 15 mAdc)		t_f	—	60	ns

BSS80BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	800	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSS80BL = CH; BSS80CL = CJ

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current	I_{CBO}			
(V_{CB} = 50 Vdc)		—	10	nA
(V_{CB} = 50 Vdc, T_A = 150°C)		—	10	μA
Emitter Cutoff Current (V_{BE} = 3.0 Vdc)	I_{EBO}	—	10	nA
ON CHARACTERISTICS				
DC Current Gain (I_C = 150 mA, V_{CE} = 10 Vdc) BSS80BL	h_{FE}	40	120	—
BSS80CL		100	300	—
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 150 mA, I_B = 15 mA)		—	0.4	
(I_C = 500 mA, I_B = 50 mA)		—	1.6	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{obo}	—	8.0	pF

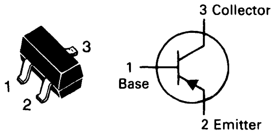
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	($I_{B1} \approx I_{B2} \approx$ 15 mA, V_{CC} = 30 V, I_C = 150 mA)	t_d	—	10	ns
Rise Time		t_r	—	40	ns
Storage Time	($I_{B1} \approx I_{B2} \approx$ 15 mA, V_{CC} = 30 V, I_C = 150 mA)	t_s	—	80	ns
Fall Time		t_f	—	30	ns

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

BSS82BL, CL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSS82BL = CH; BSS82CL = CM

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)		$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 50 V) (V_{CB} = 50 V, T_A = 150°C)		I_{CBO}	 — —	 10 10	 nA μA
Emitter Cutoff Current (V_{EB} = 3.0 V)		I_{EBO}	—	10	nA
ON CHARACTERISTICS					
DC Current Gain (I_C = 150 mA, V_{CE} = 10 V)	BSS82BL BSS82CL	h_{FE}	40 100	120 300	— —
Collector-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA) (I_C = 500 mA, I_B = 50 mA)		$V_{CE(sat)}$	 — —	 0.4 1.6	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 20 V, f = 200 MHz)		f_T	100	—	MHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

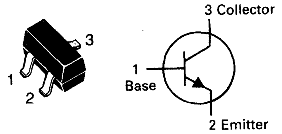
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSV52L = B2

BSV52L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



SWITCHING TRANSISTOR

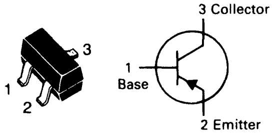
NPN SILICON

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc)	$V_{(BR)CEO}$	12	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0) (V_{CB} = 10 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}	 — —	 100 5.0	nAdc µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 25 40 25	 — 120 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 300 µAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 — — —	 300 250 400	mVdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 700 —	 850 1200	mVdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc)	f_T	400	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF
Input Capacitance (V_{EB} = 1.0 Vdc, I_C = 0)	C_{ibo}	—	4.5	pF
SWITCHING CHARACTERISTICS				
Storage Time (I_C = I_{B1} = I_{B2} = 10 mAdc)	t_s	—	13	ns
Turn-On Time (V_{BE} = 1.5 Vdc, I_C = 10 mAdc, I_B = 3.0 mAdc)	t_{on}	—	12	ns
Turn-Off Time (I_C = 10 mAdc, I_B = 3.0 mAdc)	t_{off}	—	18	ns

MMBA811C5L
thru
MMBA811C8L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

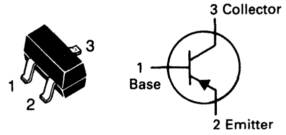
MMBA811C5L = C5; MMBA811C6L = C6; MMBA811C7L = C7;
MMBA811C8L = C8

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc)		$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc)		$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_C = 10$ μAdc)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 3.0$ Vdc)			150	—	
($I_C = 0.5$ mAdc, $V_{CE} = 3.0$ Vdc)			135	900	
(For Reference Only)			—	—	
($I_C = 0.5$ mAdc, $V_{CE} = 3.0$ Vdc)	MMBA811C5L		135	270	
	MMBA811C6L		200	400	
	MMBA811C7L		300	600	
	MMBA811C8L		450	900	
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter On Voltage ($I_C = 0.5$ mAdc, $V_{CE} = 3.0$ Vdc)		$V_{BE(on)}$	0.55	0.7	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 1.0$ mAdc, $V_{CE} = 6.0$ Vdc, f = 100 MHz)		f_T	75	—	MHz

MMBA812M5L
thru
MMBA812M7L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

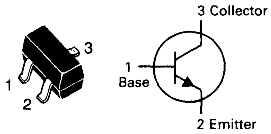
MMBA812M5L = M5; MMBA812M6L = M6; MMBA812M7L = M7

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$)		I_{CBO}	—	0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain ($V_{CE} = 6.0$ Vdc, $I_C = 1.0$ mAdc)	MMBA812M5L	h_{FE}	135	270	—
	MMBA812M6L		200	400	
	MMBA812M7L		300	600	
Collector-Emitter Saturation Voltage ($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($V_{CE} = 6.0$ Vdc, $I_C = 1.0$ mAdc)		$V_{BE(on)}$	—	0.8	Vdc

MMBC1009F1L
MMBC1009F3L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AM/FM RF AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

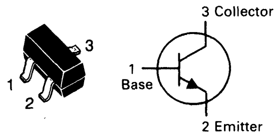
MMBC1009F1L = F1; MMBC1009F3L = F3

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 0.5 mAdc, V_{CE} = 3.0 Vdc)	MMBC1009F1L	h_{FE}	30	—	60	
	MMBC1009F3L		60	—	120	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	—	0.3	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)		f_T	150	—	—	MHz
Output Capacitance (V_{CB} = 6.0 V, I_E = 0, f = 1.0 MHz)		C_{obo}	—	2.0	—	pF
Noise Figure (I_C = 0.5 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 MHz, R_G = 500 Ω)		NF	—	2.5	—	dB

MMBC1622D6L
MMBC1622D7L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

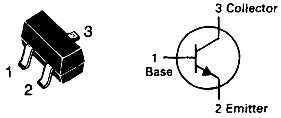
MMBC1622D6L = D6; MMBC1622D7L = D7

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(V_{CE} = 3.0 Vdc, I_C = 0.1 mAdc)	All		150	—	
(V_{CE} = 3.0 Vdc, I_C = 0.5 mAdc)	MMBC1622D6L		200	400	
	MMBC1622D7L		300	600	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter On Voltage (V_{CE} = 3.0 Vdc, I_C = 0.5 mAdc)		$V_{BE(on)}$	0.55	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (V_{CE} = 6.0 Vdc, I_E = 1.0 mAdc, f = 100 Mhz)		f_T	100	—	MHz

MMBC1623L5L
thru
MMBC1623L7L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

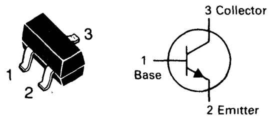
MMBC1623L5L = L5; MMBC1623L6L = L6; MMBC1623L7L = L7

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	MMBC1623L5L	h_{FE}	135	270	—
	MMBC1623L6L		200	400	
	MMBC1623L7L		300	600	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mAdc)		$V_{BE(sat)}$	—	1.0	Vdc
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)		$V_{BE(on)}$	0.6	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (V_{CE} = 60 Vdc, I_E = 10 mAdc, f = 100 MHz)		f_T	200	—	MHz

MMBC1653N2L
thru
MMBC1653N4L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	130	Vdc
Collector-Base Voltage	V_{CBO}	150	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

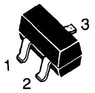
MMBC1653N2L = N2; MMBC1653N3L = N3; MMBC1653N4L = N4

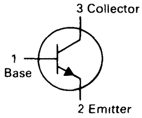
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Cutoff Current (V_{CB} = 100 Vdc, I_E = 0)		I_{CBO}	—	—	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	—	0.1	μAdc
ON CHARACTERISTICS						
DC Current Gain (V_{CE} = 3.0 Vdc, I_C = 15 mAdc)	MMBC1653N2L	h_{FE}	50	—	130	—
	MMBC1653N3L		100	—	220	
	MMBC1653N4L		150	—	330	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_F = 10 mAdc, f = 100 MHz)		f_T	—	150	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	4.5	—	pF

MMBC1654N5L
thru
MMBC1654N7L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	160	Vdc
Collector-Base Voltage	V_{CBO}	180	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

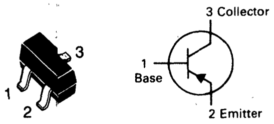
MMBC1654N5L = N5; MMBC1654N6L = N6; MMBC1654N7L = N7

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Cutoff Current (V_{CB} = 100 V, I_E = 0)		I_{CBO}	—	—	0.1	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	—	0.1	μAdc
ON CHARACTERISTICS						
DC Current Gain (V_{CE} = 3.0 V, I_C = 15 mAdc)		h_{FE}				—
	MMBC1654N5L		50	—	130	
	MMBC1654N6L		100	—	220	
	MMBC1654N7L		150	—	330	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_E = 10 mAdc, f = 100 MHz)		f_T	—	150	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0MHz)		C_{obo}	—	4.5	—	pF

MMBR536L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH FREQUENCY TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	30	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR536L = 7R

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ *For both package types unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 2.0$ mA, $I_B = 0$)	$V_{(BR)CEO}$	10	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA, $I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μA, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 20$ mA, $V_{CE} = 5.0$ V)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Current Gain-Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 GHz)	f_T	—	5.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_F = 0$, f = 1.0 MHz)	C_{cb}	—	0.8	1.2	pF
FUNCTIONAL TESTS					
Gain @ Noise Figure ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc) f = 500 MHz f = 1.0 GHz	G_{NF}	 — —	 14 8.0	 — —	dB
Noise Figure ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc) f = 500 MHz f = 1.0 GHz	NF	 — —	 4.5 6.0	 — —	dB

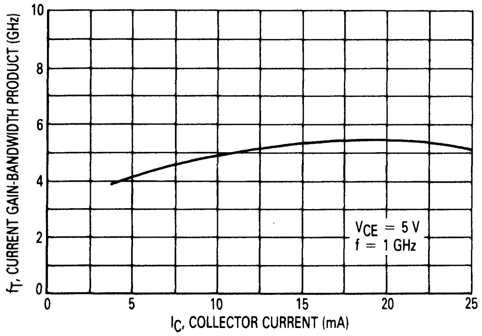


Figure 1. Current Gain-Bandwidth Product versus Collector Current

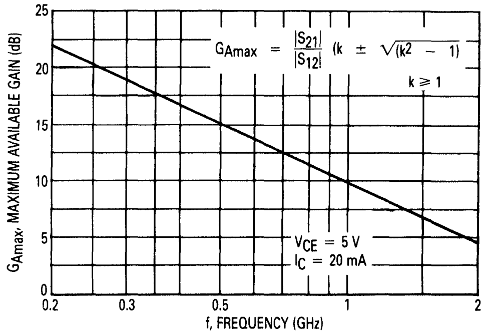


Figure 2. Maximum Available Gain (G_{Amax}) versus Frequency

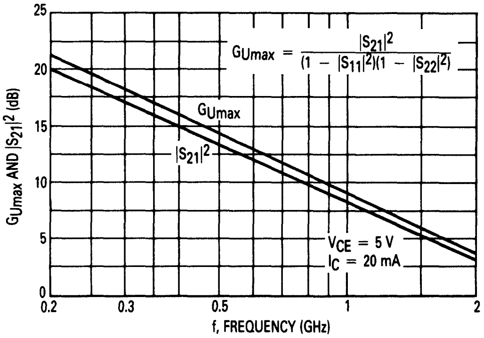


Figure 3. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

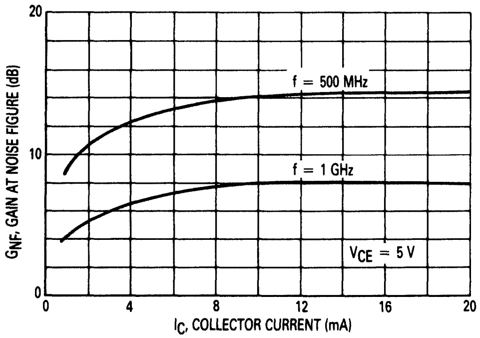


Figure 4. Gain at Noise Figure versus Collector Current

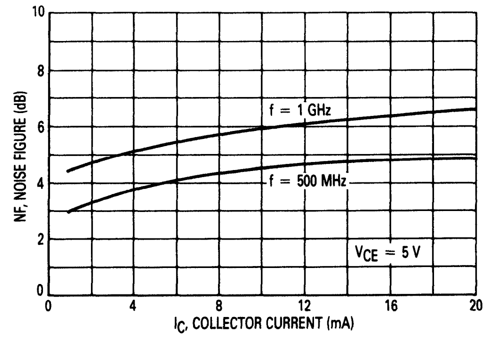


Figure 5. Noise Figure versus Collector Current

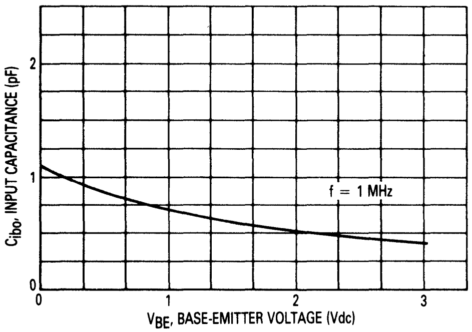


Figure 6. Input Capacitance versus Emitter-Base Voltage

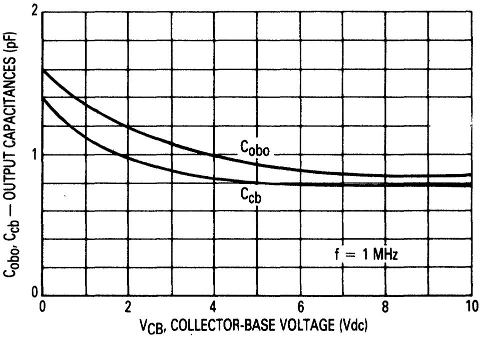
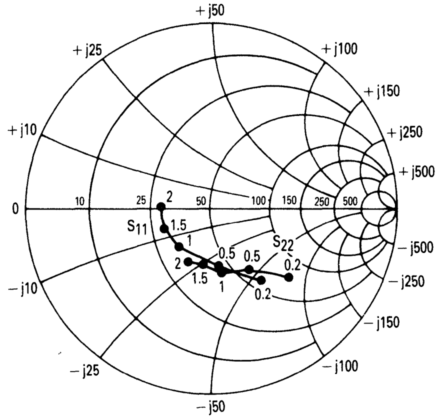
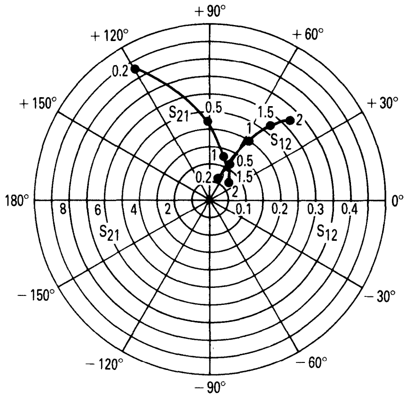


Figure 7. Output Capacitance versus Collector-Base Voltage

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY V_{CE} = 10 V, I_C = 10 mA



FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY V_{CE} = 10 V, I_C = 10 mA



COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} ∠φ	S_{21} $\|S_{21}\|$	S_{21} ∠φ	S_{12} $\|S_{12}\|$	S_{12} ∠φ	S_{22} $\|S_{22}\|$	S_{22} ∠φ
10	5	200	0.60	−44	6.47	126	0.07	66	0.68	−35
		500	0.37	−70	3.57	97	0.14	60	0.48	−50
		1000	0.27	−105	2.16	74	0.22	53	0.40	−69
		1500	0.24	−138	1.62	58	0.29	46	0.37	−87
		2000	0.22	−166	1.38	44	0.33	42	0.34	−103
	10	200	0.48	−54	8.65	120	0.06	66	0.58	−40
		500	0.30	−82	4.32	94	0.12	62	0.38	−58
		1000	0.24	−122	2.52	74	0.20	57	0.32	−78
		1500	0.24	−155	1.84	59	0.27	51	0.30	−96
		2000	0.24	178	1.54	46	0.32	47	0.28	−112
	20	200	0.39	−63	10.10	115	0.06	67	0.49	−50
		500	0.25	−94	4.77	91	0.11	65	0.32	−65
		1000	0.24	−136	2.72	73	0.19	60	0.27	−84
		1500	0.24	−167	1.96	58	0.26	54	0.26	−102
		2000	0.26	168	1.63	46	0.32	50	0.25	−119

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

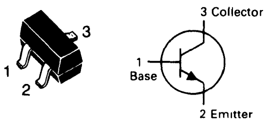
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR901L = 7A

MMBR901L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER TRANSISTOR

NPN SILICON

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	200	—
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	1.0	pF
Common-Emitter Amplifier Power Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)	G_{pe}(1)	16 (Typ)	—	dB
Noise Figure (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	NF(1)	—	1.9 (Typ)	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50Ω system.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

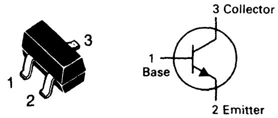
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR920L = 7B

MMBR920L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER/SWITCHING TRANSISTOR

NPN SILICON

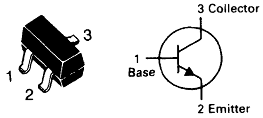
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	250	—
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	NF(1)	 — —	 2.4 3.0	 — —	dB
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	G_{pe}(1)	 — —	 15 10	 — —	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBR930L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AMPLIFIER/SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR930L = 7C

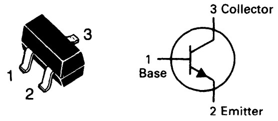
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	25	—	250	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 GHz)	NF(1)	 — —	 1.9 2.5	 — —	dB
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)	G_{pe}(1)	 — —	 11 8.0	 — —	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBR931L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	5.0	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR931L = 7D

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)	$V_{(BR)CEO}$	5.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	10	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.25 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30	—	150	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 1.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	0.5	pF
Noise Figure (I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	NF(1)	—	4.3	—	dB
Gate Power Dissipation (I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	PG(1)	—	10	—	—

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	14	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

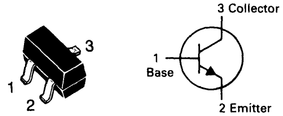
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR2060L = 7E

MMBR2060L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER TRANSISTOR

NPN SILICON

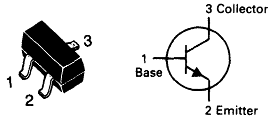
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	14	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0, I_C = 0)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 500 MHz)	h_{FE}	 20 2.0	 — —	—
Collector-Emitter Saturation Voltage (I_C = 80 mAdc, I_B = 8.0 mAdc)	$V_{CE(sat)}$	—	0.38	Vdc
Base-Emitter Saturation Voltage (I_C = 40 mAdc, I_B = 20 mAdc)	$V_{BE(sat)}$	—	0.98	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	f_T	—	1.0	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0)	C_{cb}	—	1.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0)	C_{eb}	—	3.0	pF
Noise Figure (V_{CE} = 10 Vdc, I_E = 1.5 mAdc, f = 450 MHz)	NF(1)	—	3.5	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 10 Vdc, I_E = 1.5 mAdc, f = 450 Mhz)	G_{pe}(1)	12.5	—	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBR2857L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	40	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

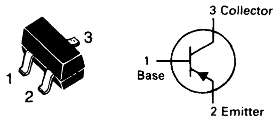
MMBR2857L = 7K

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	0.05	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30	—	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	1000	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	—	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	50	—	—
Noise Figure (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 450 MHz)	NF	—	4.5	dB
Common-Emitter Amplifier Power Gain (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	G_{PE}	12.5	—	dB

MMBR4957L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR4957L = 7F

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_C = 0)	I_{CBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	150	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_E = 2.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	1,200	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.8	pF
Common-Emitter Amplifier Power Gain(1) (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 450 MHz)	G_{pe}	17 (Typ)	—	dB
Noise Figure(1) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 450 MHz)	NF	—	3.0 (Typ)	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

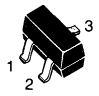
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

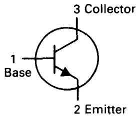
DEVICE MARKING

MMBR5031L = 7G

MMBR5031L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





RF AMPLIFIER TRANSISTOR

NPN SILICON

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	300	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1,000	—	MHz
Collector-Base Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	—	1.5	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	NF(1)	—	2.5	dB
Common-Emitter Amplifier Power Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	G_{pe}(1)	14	25	dB

(1) Noise figure and power gain measure on Ailtech 7380 50 Ω system.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

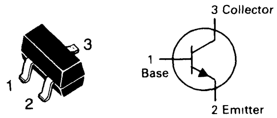
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBR5179L = 7H

MMBR5179L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



RF AMPLIFIER TRANSISTOR

NPN SILICON

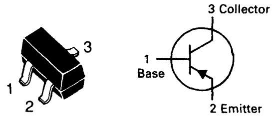
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	0.02	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	900	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	—	1.0	pF
Small Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	—	—
Noise Figure (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 200 Mhz)	NF(1)	—	4.5	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	G_{pe}(1)	15	—	dB

(1) Noise figure and power gain measured on the Ailtech 7380 50 Ω system.

MMBT404L, AL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



CHOPPER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value 404L	Value 404AL	Unit
Collector-Emitter Voltage	V_{CEO}	24	35	Vdc
Collector-Base Voltage	V_{CBO}	25	40	Vdc
Emitter-Base Voltage	V_{EBO}	12	25	Vdc
Collector Current — Continuous	I_C	150		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

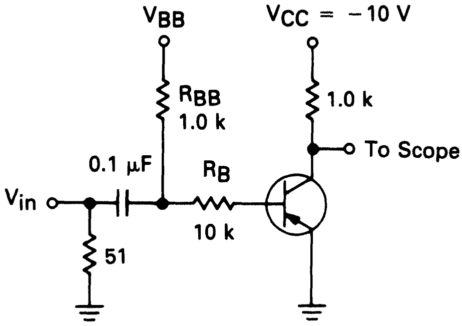
DEVICE MARKING

MMBT404L = 2M; MMBT404AL = 2N

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 10$ mAdc, $I_B = 0$)	MMBT404L MMBT404AL	$V_{(BR)CEO}$	24 35	— —	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	MMBT404L MMBT404AL	$V_{(BR)CBO}$	25 40	— —	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	MMBT404L MMBT404AL	$V_{(BR)EBO}$	12 25	— —	— —	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)		I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 10$ Vdc, $I_C = 0$)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS						
DC Current Gain ($I_C = 12$ mAdc, $V_{CE} = 0.15$ Vdc)		h_{FE}	30	—	400	—
Collector-Emitter Saturation Voltage ($I_C = 12$ mAdc, $I_B = 0.4$ mAdc) ($I_C = 24$ mAdc, $I_B = 1.0$ mAdc)		$V_{CE(sat)}$	— —	— —	0.15 0.20	Vdc
Base-Emitter Saturation Voltage ($I_C = 12$ mAdc, $I_B = 0.4$ mAdc) ($I_C = 24$ mAdc, $I_B = 1.0$ mAdc)		$V_{BE(sat)}$	— —	— —	0.85 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Output Capacitance ($V_{CB} = 6.0$ Vdc, $I_E = 0$)		C_{obo}	—	—	20	pF
SWITCHING CHARACTERISTICS						
Delay Time ($V_{CC} = 10$ Vdc, $I_C = 10$ mAdc) (Figure 1)		t_d	—	43	—	ns
Rise Time ($I_{B1} = 1.0$ mAdc, $V_{BE(off)} = 14$ Vdc)		t_r	—	180	—	ns
Storage Time ($V_{CC} = 10$ Vdc, $I_C = 10$ mAdc)		t_s	—	675	—	ns
Fall Time ($I_{B1} = I_{B2} = 1.0$ mAdc) (Figure 1)		t_f	—	160	—	ns

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



	V_{in} (Volts)	V_{BB} (Volts)
t_{on}, t_d, t_r	− 12	+1.4
t_{off}, t_s and t_f	+20.6	−11.6

Voltages and resistor values shown are for I_C = 10 mA, I_C/I_B = 10 and I_{B1} = I_{B2}

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

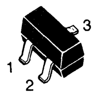
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

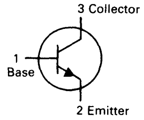
DEVICE MARKING

MMBT918L = 3B

MMBT918L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





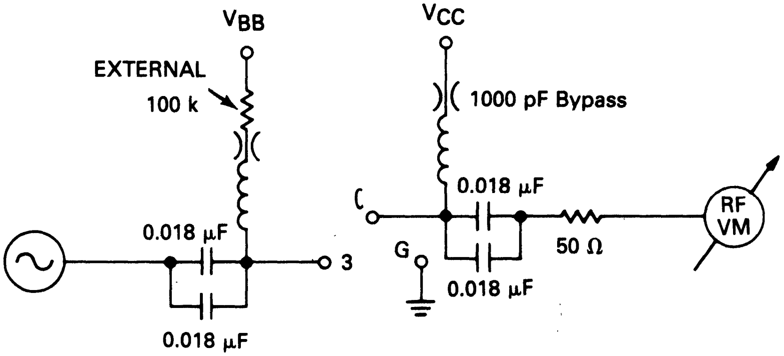
VHF/UHF TRANSISTOR

NPN SILICON

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	—	MHz
Output Capacitance (V_{CB} = 0 Vdc, I_E = 0, f = 1.0 MHz) (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	 — —	 3.0 1.7	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	2.0	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 60 MHz) (Figure 1)	NF	—	6.0	dB
Power Output (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, f = 500 MHz)	P_{out}	30	—	mW
Common-Emitter Amplifier Power Gain (I_C = 6.0 mAdc, V_{CB} = 12 Vdc, f = 200 MHz)	G_{pe}	11	—	dB

FIGURE 1 — NF, Gpe MEASUREMENT CIRCUIT 20-200



NF Test Conditions

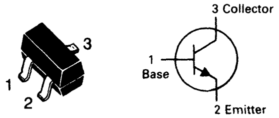
I_C = 1.0 Amp
V_{CE} = 6.0 Volts
R_S = 50 Ω
f = 60 MHz

Gpe Test Conditions

I_C = 6.0 mA
V_{CE} = 12 Volts
f = 200 MHz

MMBT930L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	30	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT930L = 1X

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 5.0 Vdc, I_B = 0)	I_{CEO}	—	10	nAdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)	I_{CBO}	—	10	nAdc
Collector Cutoff Current (V_{CE} = 45 Vdc, V_{BE} = 0)	I_{CES}	—	10	nAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) (I_C = 500 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 100 150 —	 300 — 600	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)	$V_{BE(sat)}$	0.6	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 30 MHz)	f_T	30	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 kHz)	NF	—	3.0	dB

MAXIMUM RATINGS

Rating	Symbol	MMBT2222L	MMBT2222AL	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current — Continuous	I_C	600		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

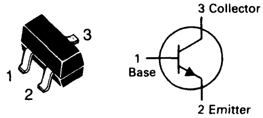
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2222L = 1B; MMBT2222AL = 1P

MMBT2222L, AL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MPS2222 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MMBT2222L		30	—	
	MMBT2222AL		40	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	MMBT2222L		60	—	
	MMBT2222AL		75	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	MMBT2222L		5.0	—	
	MMBT2222AL		6.0	—	
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222AL	I_{CEX}	—	10	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MMBT2222L		—	0.01	
(V_{CB} = 60 Vdc, I_E = 0)	MMBT2222AL		—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MMBT2222L		—	10	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MMBT2222AL		—	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	MMBT2222AL	I_{EBO}	—	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MMBT2222AL	I_{BL}	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	MMBT2222AL only		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)			100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)(1)			50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	MMBT2222L		30	—	
	MMBT2222AL		40	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MMBT2222L		—	0.4	
	MMBT2222AL		—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)	MMBT2222L		—	1.6	
	MMBT2222AL		—	1.0	

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

Characteristic		Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MMBT2222L		—	1.3	
	MMBT2222AL		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)	MMBT2222L		—	2.6	
	MMBT2222AL		—	2.0	

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product(2)		f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT2222L		250	—	
	MMBT2222AL		300	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MMBT2222L		—	30	
	MMBT2222AL		—	25	
Input Impedance		h_{ie}			kΩ
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		0.25	1.25	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		—	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		—	4.0	
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		75	375	
Output Admittance		h_{oe}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT2222AL		25	200	
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	MMBT2222AL	$rb'C_c$	—	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	MMBT2222AL	NF	—	4.0	dB

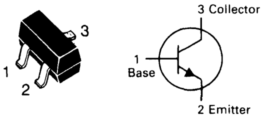
SWITCHING CHARACTERISTICS MMBT2222A only

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	10	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	60	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

MMBT2369L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



SWITCHING TRANSISTOR

NPN SILICON

Refer to MPS2369 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2369L = 1J

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}	 — —	 — —	 0.4 30	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	 40 20	 — —	 120 —	—
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	0.7	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	—	4.0	pF
Small Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	h_{fe}	5.0	—	—	—
SWITCHING CHARACTERISTICS					
Storage Time (I_{B1} = I_{B2} = I_C = 10 mAdc)	t_s	—	5.0	13	ns
Turn-On Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	—	8.0	12	ns
Turn-Off Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc)	t_{off}	—	10	18	ns

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

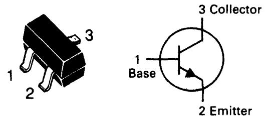
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2484L = 1U

MMBT2484L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



LOW NOISE TRANSISTOR

NPN SILICON

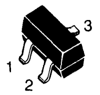
Refer to MPSA18 for graphs.

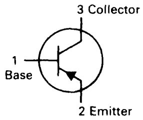
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0) (V_{CB} = 45 Vdc, I_E = 0, T_A 150°C)	I_{CBO}	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 250 —	 — 800	—
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	0.35	Vdc
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1 MHz)	C_{obo}	—	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1 MHz)	C_{ibo}	—	6.0	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz)	NF	—	3.0	dB

MMBT2907L, AL

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to MPS2907 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPS2907L	MPS2907AL	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT2907L = 2B; MMBT2907AL = 2F

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MMBT2907L		40	—	
	MMBT2907AL		60	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc)		I_{CEX}	—	50	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MMBT2907L		—	0.020	
	MMBT2907AL		—	0.010	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MMBT2907L		—	20	
	MMBT2907AL		—	10	
Base Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc)		I_B	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MMBT2907L		35	—	
	MMBT2907AL		75	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MMBT2907L		50	—	
	MMBT2907AL		100	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MMBT2907L		75	—	
	MMBT2907AL		100	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)	MMBT2907L, MMBT2907AL		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	MMBT2907L		30	—	
	MMBT2907AL		50	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.6	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	2.6	

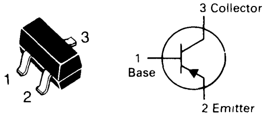
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1),(2) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
SWITCHING CHARACTERISTICS					
Turn-On Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	45	ns
Delay Time		t_d	—	10	ns
Rise Time		t_r	—	40	ns
Turn-Off Time	(V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	100	ns
Storage Time		t_s	—	80	ns
Fall Time		t_f	—	30	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

MMBT3640L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



SWITCHING TRANSISTOR

PNP SILICON

Refer to MPS3640 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	80	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT3640L = 2J

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	12	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = 65°C)	I_{CES}	— —	0.01 1.0	μAdc
Base Current (V_{CE} = 6.0 Vdc, V_{BE} = 0)	I_B	—	10	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 0.3 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30 20	120 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = 65°C)	$V_{CE(sat)}$	— — —	0.2 0.6 0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	0.75 0.8 —	0.95 1.0 1.5	Vdc
SMALL SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	500	—	MHz
Output Capacitance (V_{CB} = = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	3.5	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	3.5	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 Vdc, I_{B1} = 5.0 mAdc)	t_d	—	10	ns
Rise Time	t_r	—	30	ns
Storage Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, I_{B1} = I_{B2} = 5.0 mAdc)	t_s	—	20	ns
Fall Time	t_f	—	12	ns
Turn-On Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 Vdc, I_{B1} = 5.0 mAdc) (V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 0.5 mAdc)	t_{on}	— —	25 60	ns
Turn-Off Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 V, I_{B1} = I_{B2} = 5.0 mAdc) (V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 0.5 mAdc)	t_{off}	— —	35 75	ns

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

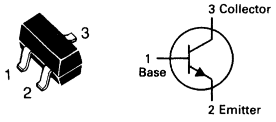
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT3903L = 1Y; MMBT3904L = 1A

MMBT3903L
MMBT3904L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3903 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{BL}	—	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{CEX}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	MMBT3903L MMBT3904L	h_{FE}	20 40	— —	—
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	MMBT3903L MMBT3904L		35 70	— —	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	MMBT3903L MMBT3904L		50 100	150 300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	MMBT3903L MMBT3904L		30 60	— —	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MMBT3903L MMBT3904L		15 30	— —	
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	— —	0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{BE(sat)}$	0.65 —	0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MMBT3903L MMBT3904L	f_T	250 300	— —	MHz

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

Characteristic		Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT3903L	h_{ie}	1.0	8.0	k ohms
	MMBT3904L		1.0	10	
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT3903L	h_{re}	0.1	5.0	X 10^{-4}
	MMBT3904L		0.5	8.0	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MMBT3903L	h_{fe}	50	200	—
	MMBT3904L		100	400	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	40	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohms, f = 1.0 kHz)	MMBT3903L	NF	—	6.0	dB
	MMBT3904L		—	5.0	

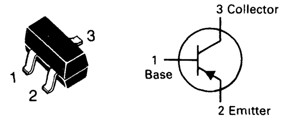
SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	—	35	ns
Rise Time			t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	MMBT3903L	t_s	—	175	ns
		MMBT3904L		—	200	
Fall Time			t_f	—	50	ns

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

MMBT3906L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N3905 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT3906L = 2A

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 3.0$ Vdc)	I_{BL}	—	50	nAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 3.0$ Vdc)	I_{CEX}	—	50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)		60	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)		80	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		100	300	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)		60	—	
($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)		30	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		—	0.25	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		—	0.4	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		0.65	0.85	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		—	0.95	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	250	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	4.5	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	10.0	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ie}	2.0	12	k ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{re}	0.1	10	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	100	400	—

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

Characteristic	Symbol	Min	Max	Unit
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	3.0	60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)	NF	—	4.0	dB

SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	—	225	ns
Fall Time		t_f	—	75	ns

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	5.0	V
Collector Current — Continuous	I_C	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

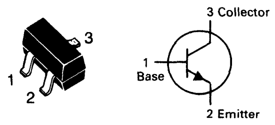
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT4123L = 5B

MMBT4123L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N4123 for graphs.

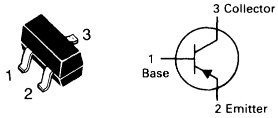
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_E = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain(1)	h_{FE}			—
($I_C = 2.0$ mAdc, $V_{CE} = 1.0$ Vdc)		50	150	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)		25	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	250	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	4.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	8.0	pF
Collector-Base Capacitance ($I_E = 0$, $V_{CB} = 5.0$ V, f = 100 kHz)	C_{cb}	—	4.0	pF
Small-Signal Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	50	200	—
Current Gain — High Frequency ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	$\lvert h_{fe}\rvert$	2.5	—	—
Noise Figure ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 1.0$ kohm, f = 1.0 kHz)	NF	—	6.0	dB

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MMBT4125L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4125 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT4125L = ZD

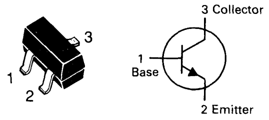
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_E = 0$)	$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 2.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 50 25	 150 —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	—	MHz
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	10	pF
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{cb}	—	4.5	pF
Small-Signal Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	50	200	—
Current Gain — High Frequency ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	$\|h_{fe}\|$	2.0	—	—
Noise Figure ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 1.0$ kohm, Noise Bandwidth = 10 Hz to 15.7 kHz)	NF	—	5.0	dB

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MMBT4401L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT4401L = 2X

Refer to 2N4401 for graphs.

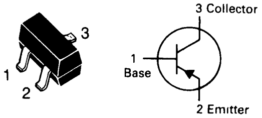
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current ($V_{CE} = 35$ Vdc, $V_{EB} = 0.4$ Vdc)	I_{BEV}	—	0.1	µAdc
Collector Cutoff Current ($V_{CE} = 35$ Vdc, $V_{EB} = 0.4$ Vdc)	I_{CEX}	—	0.1	µAdc
ON CHARACTERISTICS(1)				
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	20	—	—
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)		40	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		80	—	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)		100	300	
($I_C = 500$ mAdc, $V_{CE} = 2.0$ Vdc)		40	—	
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
($I_C = 500$ mAdc, $I_B = 50$ mAdc)		—	0.75	
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	0.75	0.95	Vdc
($I_C = 500$ mAdc, $I_B = 50$ mAdc)		—	1.2	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	250	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{cb}	—	6.5	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{eb}	—	30	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ie}	1.0	15	k ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{re}	0.1	8.0	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	40	500	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{oe}	1.0	30	µmhos
SWITCHING CHARACTERISTICS				
Delay Time ($V_{CC} = 30$ Vdc, $V_{EB} = 2.0$ Vdc, $I_C = 150$ mAdc, $I_{B1} = 15$ mAdc)	t_d	—	15	ns
Rise Time	t_r	—	20	ns
Storage Time ($V_{CC} = 30$ Vdc, $I_C = 150$ mAdc, $I_{B1} = I_{B2} = 15$ mAdc)	t_s	—	225	ns
Fall Time	t_f	—	30	ns

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

MMBT4403L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	600	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT4403L = 2T

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current (V_{CE} = 35 Vdc, V_{BE} = 0.4 Vdc)	I_{BEV}	—	0.1	μAdc
Collector Cutoff Current (V_{CE} = 35 Vdc, V_{BE} = 0.4 Vdc)	I_{CEX}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30	—	—
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		60	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		100	—	
(I_C = 150 mAdc, V_{CE} = 2.0 Vdc)(1)		100	300	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)(1)		20	—	
Collector-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	0.75	
Base-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	0.75	0.95	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	1.3	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	200	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{cb}	—	8.5	pF
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{eb}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	1.5k	15k	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	0.1	8.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	60	500	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	1.0	100	μmhos
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 30 Vdc, V_{BE} = 2.0 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	ns
Rise Time	t_r	—	20	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	225	ns
Fall Time	t_f	—	30	ns

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

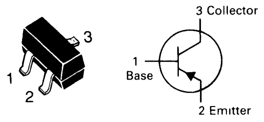
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT5086L = 2P; MMBT5087L = 2Q

MMBT5086L
MMBT5087L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



LOW NOISE TRANSISTORS

PNP SILICON

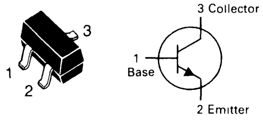
Refer to 2N5086 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	50	—	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 10 Vdc, I_E = 0)			—	10	
(V_{CB} = 35 Vdc, I_E = 0)			—	50	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	MMBT5086L		150	500	
	MMBT5087L		250	800	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT5086L		150	—	
	MMBT5087L		250	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT5086L		150	—	
	MMBT5087L		250	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	40	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	pF
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	MMBT5086L		150	600	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	MMBT5087L		250	900	
Noise Figure		NF			dB
(I_C = 20 mAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 kHz)	MMBT5086L		—	3.0	
	MMBT5087L		—	2.0	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 3.0 kΩ, f = 1.0 kHz)	MMBT5086L		—	3.0	
	MMBT5087L		—	2.0	

MMBT5088L
MMBT5089L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



LOW NOISE TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		MMBT5088L	MMBT5089L	
Collector-Emitter Voltage	V_{CEO}	30	25	Vdc
Collector-Base Voltage	V_{CBO}	35	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	50		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

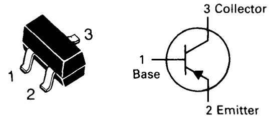
MMBT5088L = 1Q; MMBT5089L = 1R

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	MMBT5088L MMBT5089L	$V_{(BR)CEO}$	30 25	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MMBT5088L MMBT5089L	$V_{(BR)CBO}$	35 30	— —	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0)	MMBT5088L MMBT5089L	I_{CBO}	— —	50 50	nAdc
Emitter Cutoff Current ($V_{EB(off)}$ = 3.0 Vdc, I_C = 0) ($V_{EB(off)}$ = 4.5 Vdc, I_C = 0)	MMBT5088L MMBT5089L	I_{EBO}	— —	50 100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	MMBT5088L MMBT5089L	h_{FE}	300 400	900 1200	—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT5088L MMBT5089L		350 450	— —	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT5088L MMBT5089L		300 400	— —	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	0.8	Vdc
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	50	—	MHz
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz emitter guarded)		C_{cb}	—	4.0	pF
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz collector guarded)		C_{eb}	—	10	pF
Small Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	MMBT5088L MMBT5089L	h_{fe}	350 450	1400 1800	—
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 Hz)	MMBT5088L MMBT5089L	NF	— —	3.0 2.0	dB

MMBT5401L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

Refer to 2N5401 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	150	Vdc
Collector-Base Voltage	V_{CBO}	160	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT5401L = 2L

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

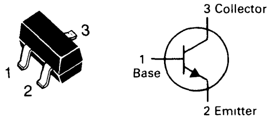
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	150	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	160	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 120 Vdc, I_E = 0) (V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	 — —	 50 50	 nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 50 60 50	 — 240 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 — —	 0.20 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 — —	 1.0 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	100	300	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Small Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	40	200	—
Noise Figure (I_C = 200 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 ohms, f = 10 Hz to 15.7 kHz)	NF	—	8.0	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	140	Vdc
Collector-Base Voltage	V_{CBO}	160	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	600	mAdc

MMBT5550L
MMBT5551L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to 2N5550 for graphs.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT5550L = 1F; MMBT5551L = G1

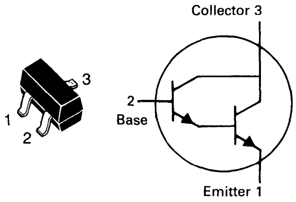
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MMBT5550L		140	—	
	MMBT5551L		160	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	MMBT5550L		160	—	
	MMBT5551L		180	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			
(V_{CB} = 100 Vdc, I_E = 0)	MMBT5550L		—	100	nAdc
(V_{CB} = 120 Vdc, I_E = 0)	MMBT5551L		—	50	
(V_{CB} = 100 Vdc, I_E = 0, T_A = 100°C)	MMBT5550L		—	100	μAdc
(V_{CB} = 120 Vdc, I_E = 0, T_A = 100°C)	MMBT5551L		—	50	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550L		60	—	
	MMBT5551L		80	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550L		60	250	
	MMBT5551L		80	250	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MMBT5550L		20	—	
	MMBT5551L		30	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	0.15	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	MMBT5550L		—	0.25	
	MMBT5551L		—	0.20	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	Both Types		—	1.0	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	MMBT5550L		—	1.2	
	MMBT5551L		—	1.0	

(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MMBT6427L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT6427L = 1V

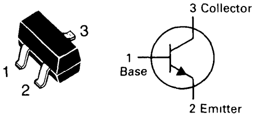
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current (V_{CE} = 25 Vdc, I_B = 0)	I_{CEO}	—	1.0	μAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 10,000 20,000 14,000	 100,000 200,000 140,000	—
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 0.5 mAdc) (I_C = 500 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$*	 — —	 1.2 1.5	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 0.5 mAdc)	$V_{BE(sat)}$	—	2.0	Vdc
Base-Emitter On Voltage (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	1.75	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	7.0	pF
Input Capacitance (V_{BE} = 0.5, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	15	pF
Current Gain — High Frequency (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	$\lvert h_{fe} \rvert$	1.3	—	Vdc
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 100 kΩ, f = 1.0 kHz to 15.7 kHz)	NF	—	10	dB

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

MMBT6428L
MMBT6429L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		MMBT6428L	MMBT6429L	
Collector-Emitter Voltage	V_{CEO}	50	45	Vdc
Collector-Base Voltage	V_{CBO}	60	55	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

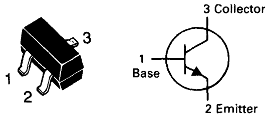
MMBT6428L = 1K; MMBT6429L = 1L

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0) (I_C = 1.0 mAdc, I_B = 0)	 MMBT6428L MMBT6429L	$V_{(BR)CEO}$	 50 45	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0) (I_C = 0.1 mAdc, I_E = 0)	 MMBT6428L MMBT6429L	$V_{(BR)CBO}$	 60 55	 — —	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc)		I_{CEO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	0.01	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	0.01	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.01 mAdc, V_{CE} = 5.0 Vdc)	 MMBT6428L MMBT6429L	h_{FE}	 250 500	 — —	—
(I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428L MMBT6429L		250 500	650 1250	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428L MMBT6429L		250 500	— —	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MMBT6428L MMBT6429L		250 500	— —	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 100 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	 — —	 0.2 0.6	Vdc
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.56	0.66	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	700	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	8.0	pF

MMBT6517L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to 2N6517 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	350	Vdc
Collector-Base Voltage	V_{CBO}	350	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Base Current	I_B	250	mA
Collector Current — Continuous	I_C	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT6517L = 1Z

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA)	$V_{(BR)CEO}$	350	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	350	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 250 V)	I_{CBO}	—	50	nA
Emitter Cutoff Current (V_{EB} = 5.0 V)	I_{EBO}	—	50	nA
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mA, V_{CE} = 10 V) (I_C = 10 mA, V_{CE} = 10 V) (I_C = 30 mA, V_{CE} = 10 V) (I_C = 50 mA, V_{CE} = 10 V) (I_C = 100 mA, V_{CE} = 10 V)	h_{FE}	 20 30 30 20 15	 — — 200 200 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA) (I_C = 20 mA, I_B = 2.0 mA) (I_C = 30 mA, I_B = 3.0 mA) (I_C = 50 mA, I_B = 5.0 mA)	$V_{CE(sat)}$*	 — — — —	 0.30 0.35 0.50 1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA) (I_C = 20 mA, I_B = 2.0 mA) (I_C = 30 mA, I_B = 3.0 mA)	$V_{BE(sat)}$	 — — —	 0.75 0.85 0.90	Vdc
Base-Emitter On Voltage (I_C = 100 mA, V_{CE} = 10 V)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 20 V, f = 20 MHz)	f_T	40	200	MHz
Collector-Base Capacitance (V_{CB} = 20 V, f = 1.0 MHz)	C_{cb}	—	6.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5 V, f = 1.0 MHz)	C_{eb}	—	80	pF

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

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	350	Vdc
Collector-Base Voltage	V_{CBO}	350	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Base Current	I_B	250	mA
Collector Current — Continuous	I_C	500	mAdc

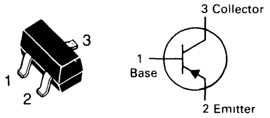
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

MMBT6520L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

Refer to 2N6520 for graphs.

DEVICE MARKING

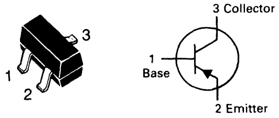
MMBT6520L = 2Z

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mA)	$V_{(BR)CEO}$	350	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA)	$V_{(BR)CBO}$	350	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μA)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 250$ V)	I_{CBO}	—	50	nA
Emitter Cutoff Current ($V_{EB} = 4.0$ V)	I_{EBO}	—	50	nA
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
($I_C = 1.0$ mA, $V_{CE} = 10$ V)		20	—	
($I_C = 10$ mA, $V_{CE} = 10$ V)		30	—	
($I_C = 30$ mA, $V_{CE} = 10$ V)		30	200	
($I_C = 50$ mA, $V_{CE} = 10$ V)		20	200	
($I_C = 100$ mA, $V_{CE} = 10$ V)		15	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
($I_C = 10$ mA, $I_B = 1.0$ mA)		—	0.30	
($I_C = 20$ mA, $I_B = 2.0$ mA)		—	0.35	
($I_C = 30$ mA, $I_B = 3.0$ mA)		—	0.50	
($I_C = 50$ mA, $I_B = 5.0$ mA)		—	1.0	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
($I_C = 10$ mA, $I_B = 1.0$ mA)		—	0.75	
($I_C = 20$ mA, $I_B = 2.0$ mA)		—	0.85	
($I_C = 30$ mA, $I_B = 3.0$ mA)		—	0.90	
Base-Emitter On Voltage ($I_C = 100$ mA, $V_{CE} = 10$ V)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mA, $V_{CE} = 20$ V, f = 20 MHz)	f_T	40	200	MHz
Collector-Base Capacitance ($V_{CB} = 20$ V, f = 1.0 MHz)	C_{cb}	—	6.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5$ V, f = 1.0 MHz)	C_{eb}	—	100	pF

MMBT8598L
MMBT8599L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N4125 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MMBT8598L	MMBT8599L	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	V
Collector-Base Voltage	V_{CBO}	60	80	V
Emitter-Base Voltage	V_{EBO}	5.0		V
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBT8598L = 2K; MMBT8599L = 2W

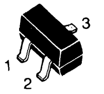
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

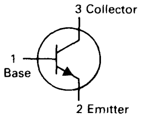
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_E = 0)	MMBT8598L MMBT8599L	$V_{(BR)CEO}$	60 80	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MMBT8598L MMBT8599L	$V_{(BR)CBO}$	60 80	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	 100 100 75	 300 — —	—
Collector-Emitter Saturation Voltage(1) (I_C = 100 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter On Voltage(1) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, I_B = 5.0 mAdc)	 MMBT8598L MMBT8599L	$V_{BE(on)}$	 — —	 0.7 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	150	—	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	4.5	pF

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MMBTA05L
MMBTA06L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





DRIVER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MMBTA05L	MMBTA06L	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA05L = 1H; MMBTA06L = 1G

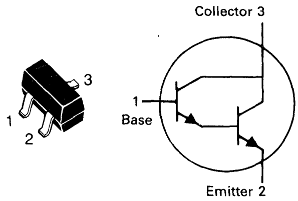
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	MMBTA05L MMBTA06L	$V_{(BR)CEO}$	60 80	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CEO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	MMBTA05L MMBTA06L	I_{CBO}	— —	0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	100 100	— —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 10 mA, V_{CE} = 2.0 V, f = 100 MHz)		f_T	100	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

MMBTA13L
MMBTA14L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



DARLINGTON AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	300	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA13L = 1M; MMBTA14L = 1N

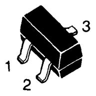
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

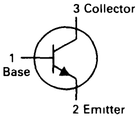
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc) MMBTA13L		5000	—	
MMBTA14L		10,000	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc) MMBTA13L		10,000	—	
MMBTA14L		20,000	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	V_{BE}	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	125	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

MMBTA20L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





GENERAL PURPOSE AMPLIFIER

NPN SILICON

Refer to MPS3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

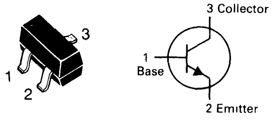
MMBTA20L = 1C

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

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

MMBTA42L
MMBTA43L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MMBTA42L	MMBTA43L	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	6.0	Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA42L = 1D; MMBTA43L = 1E

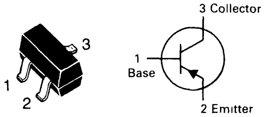
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MMBTA42L		300	—	
	MMBTA43L		200	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	MMBTA42L		300	—	
	MMBTA43L		200	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 200 Vdc, I_E = 0)	MMBTA42L		—	0.1	
(V_{CB} = 160 Vdc, I_E = 0)	MMBTA43L		—	0.1	
Emitter Cutoff Current		I_{EBO}			μAdc
(V_{BE} = 6.0 Vdc, I_C = 0)	MMBTA42L		—	0.1	
(V_{BE} = 4.0 Vdc, I_C = 0)	MMBTA43L		—	0.1	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	Both Types		25	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	Both Types		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	MMBTA42L		40	—	
	MMBTA43L		40		
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 20 mAdc, I_B = 2.0 mAdc)	MMBTA42L		—	0.5	
	MMBTA43L		—	0.5	
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	—	MHz
Collector-Base Capacitance		C_{cb}			pF
(V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	MMBTA42L		—	3.0	
	MMBTA43L		—	4.0	

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

MMBTA55L
MMBTA56L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



DRIVER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MMBTA55L	MMBTA56L	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA55L = 2H; MMBTA56L = 2G

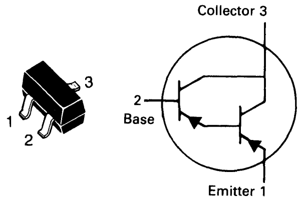
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	 MMBTA55L MMBTA56L	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CEO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	 MMBTA55L MMBTA56L	I_{CBO}	 — —	 0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	 100 100	 — —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)		f_T	50	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

MMBTA63L
MMBTA64L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



DARLINGTON TRANSISTORS

PNP SILICON

Refer to MPSA75 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA63L = 2U; MMBTA64L = 2V

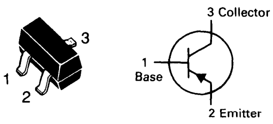
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc)	$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) MMBTA63L (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) MMBTA64L (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) MMBTA63L (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) MMBTA64L	h_{FE}	 5,000 10,000 10,000 20,000	 — — — —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	125	—	MHz

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

MMBTA70L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

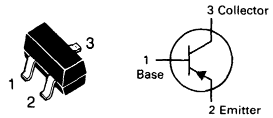
MMBTA70L = 2C

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

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

MMBTA92L
MMBTA93L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MMBTA92L	MMBTA93L	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	5.0	Vdc
Collector Current — Continuous	I_C	500		mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTA92L = 2D; MMBTA93L = 2E

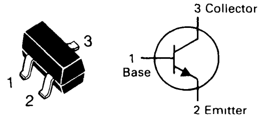
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MMBTA92L		300	—	
	MMBTA93L		200	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	MMBTA92L		300	—	
	MMBTA93L		200	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 200 Vdc, I_E = 0)	MMBTA92L		—	0.25	
(V_{CB} = 160 Vdc, I_E = 0)	MMBTA93L		—	0.25	
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	Both Types		25	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	Both Types		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	MMBTA92L		25	—	
	MMBTA93L		25	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 20 mAdc, I_B = 2.0 mAdc)	MMBTA92L		—	0.5	
	MMBTA93L		—	0.5	
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	—	MHz
Collector-Base Capacitance		C_{cb}			pF
(V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	MMBTA92L		—	6.0	
	MMBTA93L		—	8.0	

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

MMBTH10L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



VHF/UHF TRANSISTOR

NPN SILICON

Refer to MPSH10 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

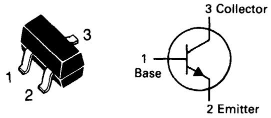
MMBTH10L = 3E

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	60	—	—
Collector-Emitter Saturation Voltage ($I_C = 4.0$ mAdc, $I_B = 0.4$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc)	V_{BE}	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	650	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	0.7	pF
Common-Base Feedback Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{rb}	—	0.65	pF
Collector Base Time Constant ($I_C = 4.0$ mAdc, $V_{CB} = 10$ Vdc, f = 31.8 MHz)	$r_b'C_c$	—	9.0	ps

MMBTH24L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)



VHF MIXER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBTH24L = 3A

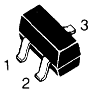
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

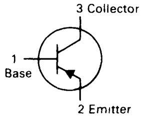
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 8.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	620	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.25	0.45	pF
Conversion Gain	—				dB
(213 MHz to 45 MHz) (I_C = 8.0 mAdc, V_{CC} = 20 Vdc, Oscillator Injection = 150 mVrms)	C_G	19	24	—	
(60 MHz to 45 MHz) (I_C = 8.0 mAdc, V_{CC} = 20 Vdc, Oscillator Injection = 150 mVrms)		24	29	—	

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

MMBTH69L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





UHF/VHF TRANSISTOR

PNP SILICON

- Designed for UHF/VHF Amplifier Applications
- High Current Gain Bandwidth Product
  f_T = 2000 MHz Min @ 10 mA

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

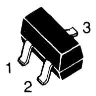
MMBTH69L = 3J

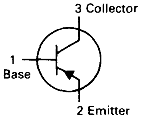
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	300	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	2000	—	—	MHz
Collector-Base Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{rb}	—	—	0.35	pF

MMBTH81L

CASE 318-03, STYLE 6
SOT-23 (TO-236AB)





UHF/VHF TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

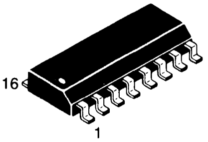
MMBTH81L = 3D

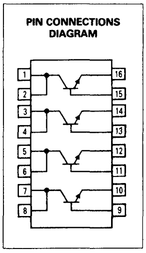
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 2.0 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	60	—	—	—
Collector-Emitter Saturation Voltage (I_C = 5.0 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	—	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	—	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	0.85	pF
Collector-Emitter Capacitance (I_B = 0, V_{CB} = 10 Vdc, f = 1.0 MHz)	C_{ce}	—	—	0.65	pF

MMPQ2222, A

CASE 751B-03, STYLE 1
SO-16





QUAD GENERAL-PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MMPQ2222	MMPQ2222A	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CB}	60	75	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.52 4.2	1.0 8.0	Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.8 6.4	2.4 19.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1)	MMPQ2222	$V_{(BR)CEO}$	30	—	—	Vdc
($I_C = 10$ mAdc, $I_B = 0$)	MMPQ2222A		40	—	—	
Collector-Base Breakdown Voltage	MMPQ2222	$V_{(BR)CBO}$	60	—	—	Vdc
($I_C = 10$ μAdc, $I_E = 0$)	MMPQ2222A		75	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	5.0	—	—	Vdc
($I_B = 10$ μAdc, $I_C = 0$)			—	—	—	
Collector Cutoff Current		I_{CBO}				nAdc
($V_{CB} = 50$ Vdc, $I_E = 0$)	MMPQ2222		—	—	50	
($V_{CB} = 60$ Vdc, $I_E = 0$)	MMPQ2222A		—	—	10	
Emitter Cutoff Current	MMPQ2222	I_{EBO}	—	—	50	nAdc
($V_{BE} = 3.0$ Vdc, $I_C = 0$)	MMPQ2222A		—	—	10	
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
($I_C = 100$ μA, $V_{CE} = 10$ V)	MMPQ2222A		35	—	—	
($I_C = 1.0$ mA, $V_{CE} = 10$ V)	MMPQ2222A		50	—	—	
($I_C = 10$ mA, $V_{CE} = 10$ V)	MMPQ2222		75	—	—	
	MMPQ2222A		75	—	—	
($I_C = 150$ mA, $V_{CE} = 10$ V)	MMPQ2222		100	—	—	
	MMPQ2222A		100	—	300	
($I_C = 300$ mA, $V_{CE} = 10$ V)	MMPQ2222		30	—	—	
($I_C = 500$ mA, $V_{CE} = 10$ V)	MMPQ2222A		40	—	—	
($I_C = 150$ mA, $V_{CE} = 1.0$ V)	MMPQ2222A		50	—	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$				Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)	MMPQ2222		—	—	0.4	
	MMPQ2222A		—	—	0.3	
($I_C = 300$ mAdc, $I_B = 30$ mAdc)	MMPQ2222		—	—	1.6	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)	MMPQ2222A		—	—	1.0	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$				Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)	MMPQ2222		—	—	1.3	
	MMPQ2222A		—	—	1.2	
($I_C = 300$ mAdc, $I_B = 30$ mAdc)	MMPQ2222		—	—	2.6	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)	MMPQ2222A		—	—	2.0	

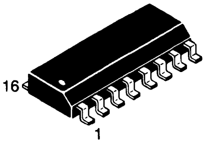
ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	—	350	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	4.5	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	—	17	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	25	—	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	250	—	ns

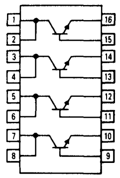
(1) Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle = 2.0%.

MMPQ2369

CASE 751B-03, STYLE 1
SO-16



PIN CONNECTIONS DIAGRAM



QUAD SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Collector Current — Continuous	I_C	500	mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

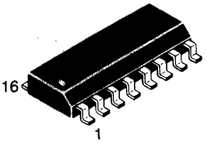
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

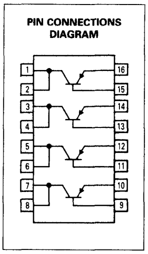
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.5 —	— —	— —	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)	I_{CBO}	—	—	0.4	μAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	0.5	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 2.0$ Vdc)	h_{FE}	 40 20	 — —	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	—	0.9	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	450	550	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 140 kHz)	C_{ob}	—	2.5	4.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ib}	—	3.0	5.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($V_{CC} = 3.0$ Vdc, $V_{BE(off)} = 1.5$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc)	t_{on}	—	9.0	—	ns
Turn-Off Time ($V_{CC} = 3.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc, $I_{B2} = 1.5$ mAdc)	t_{off}	—	15	—	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

MMPQ2907, A

CASE 751B-03, STYLE 1
SO-16





PIN CONNECTIONS DIAGRAM

QUAD GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MMPQ2907	MMPQ2907A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.52 4.2	1.0 8.0	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.8 6.4	2.4 19.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1)	MMPQ2907	$V_{(BR)CEO}$	40	—	—	Vdc
(I_C = 10 mAdc, I_B = 0)	MMPQ2907A		60	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	5.0	—	—	Vdc
(I_E = 10 μAdc, I_C = 0)			—	—	—	
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 30 Vdc, I_E = 0)	MMPQ2907		—	—	50	
(V_{CB} = 50 Vdc, I_E = 0)	MMPQ2907A		—	—	10	
Emitter Cutoff Current (V_{CB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
(I_C = 100 μAdc, V_{CE} = 10 V)	MMPQ2907A		75	—	—	
(I_C = 1.0 mAdc, V_{CE} = 10 V)	MMPQ2907A		100	—	—	
(I_C = 10 mAdc, V_{CE} = 10 V)	MMPQ2907/2907A		75/100	—	—	
(I_C = 150 mAdc, V_{CE} = 10 V)	MMPQ2907/2907A		100	—	300	
(I_C = 300 mAdc, V_{CE} = 10 V)	MMPQ2907/2907A		30/50	—	—	
(I_C = 500 mAdc, V_{CE} = 10 V)	MMPQ2907/2907A		50	—	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MMPQ2907		—	—	0.4	
(I_C = 300 mAdc, I_B = 30 mAdc)	MMPQ2907		—	—	1.6	
(I_C = 500 mAdc, I_B = 50 mAdc)	MMPQ2907A		—	—	1.6	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MMPQ2907		—	—	1.3	
(I_C = 300 mAdc, I_B = 30 mAdc)	MMPQ2907		—	—	2.6	
(I_C = 500 mAdc, I_B = 50 mAdc)	MMPQ2907A		—	—	2.6	

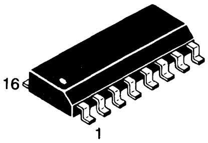
ELECTRICAL CHARACTERISTICS (Continued)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	—	350	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	6.0	—	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	—	20	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	30	—	ns
Turn-Off Time (V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	100	—	ns

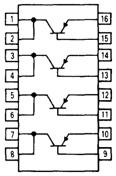
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

MMPQ3467

CASE 751B-03, STYLE 1
SO-16



PIN CONNECTIONS DIAGRAM



QUAD MEMORY DRIVER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	mAdc

		Each Transistor	Four Transistors Equal Power	
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.52 4.2	1.2 9.6	Watts mW/°C
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

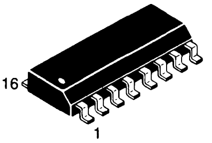
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

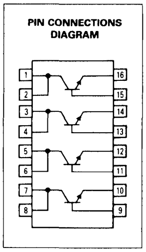
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0 —	— —	— —	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	200	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	200	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	—	—	—
Collector-Emitter Saturation Voltage(1) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	—	0.23	0.5	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	—	0.9	1.2	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	—	190	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	10	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	—	55	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (I_C = 500 mAdc, I_{B1} = 50 mAdc)	t_{on}	—	20	—	ns
Turn-Off Time (I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_{off}	—	60	—	ns

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

MMPQ3725, A

CASE 751B-03, STYLE 1
SO-16





QUAD CORE DRIVER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MMPQ3725	MMPQ3725A	Unit
Collector-Emitter Voltage	V_{CEO}	40	50	Vdc
Collector-Emitter Voltage	V_{CES}	60	70	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 4.8	1.4 11.2	Watts mW/°C
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	2.5 2.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

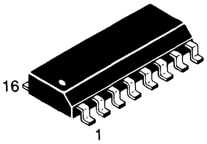
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	MMPQ3725 MMPQ3725A	$V_{(BR)CEO}$	40 50	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	MMPQ3725 MMPQ3725A	$V_{(BR)CES}$	60 70	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0 —	— —	— —	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)		I_{CBO}	—	—	0.5	μAdc
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				—
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MMPQ3725		35	75	200	
	MMPQ3725A		40	80	—	
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	MMPQ3725		25	45	—	
	MMPQ3725A		30	50	—	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	—	0.32	0.45	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$	0.8	0.9	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MMPQ3725 MMPQ3725A	f_T	— —	275 250	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	—	5.1	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	—	62	—	pF
SWITCHING CHARACTERISTICS						
Turn-On Time (I_C = 500 mAdc, I_{B1} = 50 mAdc, $V_{BE(off)}$ = 3.8 Vdc)		t_{on}	—	20	—	ns
Turn-Off Time (I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)		t_{off}	—	50	—	ns

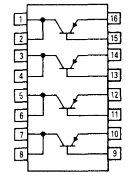
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MMPQ3762

CASE 751B-03, STYLE 1
SO-16



PIN CONNECTIONS DIAGRAM



QUAD MEMORY DRIVER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	1.5	mAdc

		Each Transistor	Four Transistors Equal Power	
Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.6 4.8	1.4 11	Watts mW/°C
Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

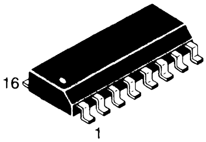
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

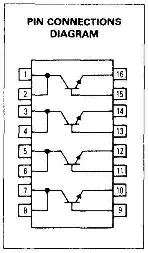
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0 —	— —	— —	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 2.0$ Vdc) ($I_C = 1.0$ Adc, $V_{CE} = 2.0$ Vdc)	h_{FE}	 35 30 20	 70 65 35	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 500$ mAdc, $I_B = 50$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	$V_{CE(sat)}$	 — —	 0.3 0.6	 0.55 0.9	Vdc
Base-Emitter Saturation Voltage ($I_C = 500$ mAdc, $I_B = 50$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	$V_{BE(sat)}$	 — —	 0.9 1.0	 1.25 1.4	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	—	275	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{ob}	—	9.0	—	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ib}	—	55	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($V_{CC} = 30$ Vdc, $I_C = 1.0$ Adc, $I_{B1} = 100$ mAdc, $V_{BE(off)} = 2.0$ Vdc)	t_{on}	—	25	—	ns
Turn-Off Time ($V_{CC} = 30$ Vdc, $I_C = 1.0$ Adc, $I_{B1} = I_{B2} = 100$ mAdc)	t_{off}	—	60	—	ns

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

MMPQ3904

CASE 751B-03, STYLE 1
SO-16





QUAD AMPLIFIER/SWITCH TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	60	Vdc
Emitter-Base Voltage	V_{EB}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

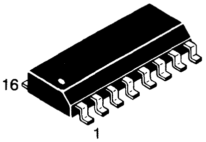
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.0 —	— —	— —	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain	h_{FE}				—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)		30	90	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)		50	160	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		75	200	—	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.1	0.2	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	0.65	0.85	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	250	300	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 140 kHz)	C_{ob}	—	2.0	4.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ib}	—	4.0	8.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_C = 10$ Vdc, $V_{BE(off)} = 0.5$ Vdc, $I_{B1} = 1.0$ mAdc)	t_{on}	—	37	—	ns
Turn-Off Time ($I_C = 10$ mAdc, $I_{B1} = I_{B2} = 1.0$ mAdc)	t_{off}	—	136	—	ns

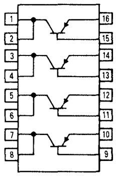
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MMPQ3906

CASE 751B-03, STYLE 1
SO-16



PIN CONNECTIONS DIAGRAM



QUAD AMPLIFIER/SWITCH TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

		Each Transistor	Four Transistors Equal Power	
Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

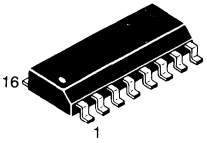
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0 —	— —	— —	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 40 60 75	 160 180 200	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.1	0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	0.65	0.85	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 140 kHz)	C_{ob}	—	3.3	4.5	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ib}	—	4.8	10	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_C = 10$ mAdc, $V_{BE(off)} = 0.5$ Vdc, $I_{B1} = 1.0$ mAdc)	t_{on}	—	43	—	ns
Turn-Off Time ($I_C = 10$ mAdc, $I_{B1} = I_{B2} = 1.0$ mAdc)	t_{off}	—	155	—	ns

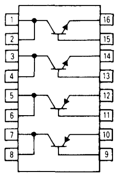
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle $\leq 2.0\%$.

MMPQ6700

CASE 751B-03, STYLE 1
SO-16



PIN CONNECTIONS DIAGRAM



QUAD COMPLEMENTARY PAIR TRANSISTORS

PNP/NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

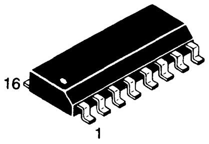
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

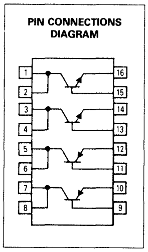
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)		30		
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)		50	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		70	—	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain — Bandwidth Product(1) ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{ob}	—	4.5	pF
Input Capacitance	C_{ib}			pF
($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz) PNP		—	10	
NPN		—	8.0	

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

MMPQ6842

CASE 751B-03, STYLE 1
SO-16





QUAD MPU CLOCK BUFFER TRANSISTORS

PNP/NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc

		Each Transistor	Four Transistors Equal Power	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.4 3.2	0.72 6.4	Watts mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.66 5.3	1.92 15.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 0.5 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 30 50 70	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 0.5 mAdc, I_B = 0.05 mAdc, 0°C ≤ T ≤ 70°C)	$V_{CE(sat)}$	—	0.05	0.15	Vdc
Base-Emitter Saturation Voltage (I_C = 0.5 mAdc, I_B = 0.05 mAdc)	$V_{BE(sat)}$	—	0.65	0.9	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	350	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	3.0	4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz) PNP NPN	C_{ib}	 — —	 5.0 4.0	 10 8.0	pF
SWITCHING CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 Vdc)					
Propagation Delay Time (50% Points TP1 to TP3) (50% Points TP2 to TP4)	 t_{PLH} t_{PHL}	 — —	 15 6.0	 25 15	ns
Rise Time (0.3 V to 4.7 V, TP3 or TP4)	t_r	5.0	25	35	ns
Fall Time (4.7 V to 0.3 V, TP3 or TP4)	t_f	5.0	10	20	ns

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

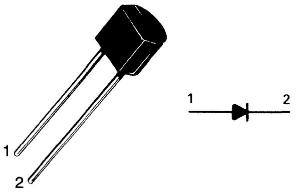
HIGH VOLTAGE SILICON PIN DIODE

. designed primarily for VHF band switching applications but also suitable for use in general-purpose switching and attenuator circuits. Supplied in a cost effective TO-92 type plastic package for economical, high-volume consumer and industrial requirements.

- Long Reverse Recovery Time
  t_{rr} = 300 ns (Typ)
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz —
  R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Sturdy TO-92 Type Package for Handling Ease
- Reverse Breakdown Voltage = 200 V (Min)

MPN3700

CASE 182-02, STYLE 1
TO-92 (TO-226AC)



SILICON PIN
SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	200	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	400 4.0	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	200	—	—	Volts
Diode Capacitance (Note 1) (V_R = 20 Vdc, f = 1.0 MHz)	C_T	—	—	1.0	pF
Series Resistance (Figure 5) (I_F = 10 mA)	R_S	—	0.4	1.0	Ohms
Reverse Leakage Current (V_R = 150 Vdc)	I_R	—	—	0.1	μA
Reverse Recovery Time (I_F = I_R = 10 mA)	t_{rr}	—	300	—	ns

NOTE:
1. C_T is measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 SERIES RESISTANCE

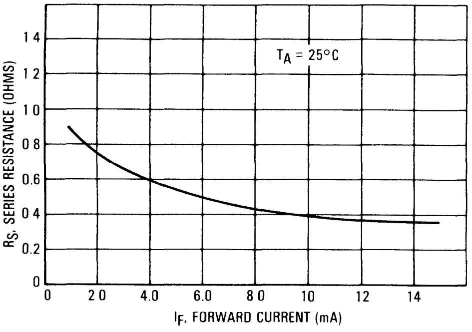


FIGURE 2 — FORWARD VOLTAGE

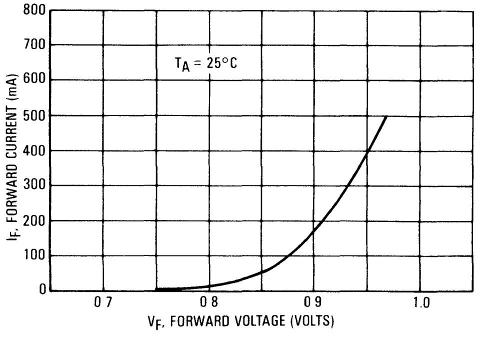


FIGURE 3 — DIODE CAPACITANCE

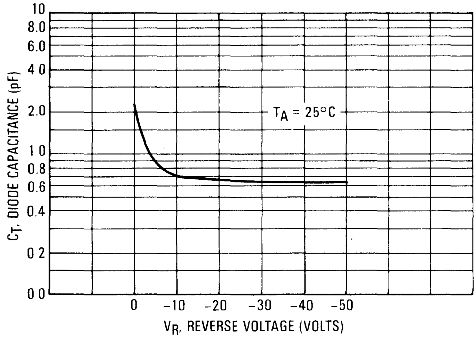


FIGURE 4 — LEAKAGE CURRENT

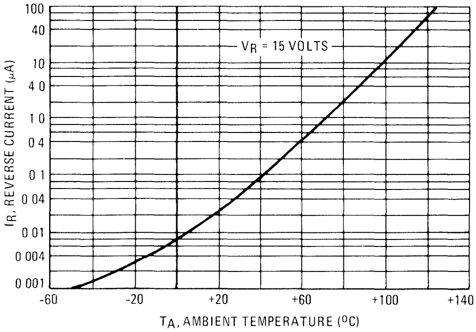
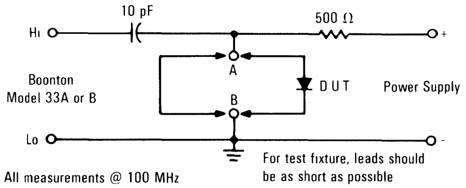


FIGURE 5 — FORWARD SERIES RESISTANCE TEST METHOD



To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

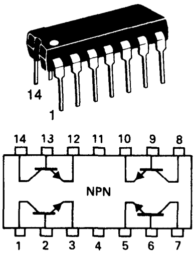
1. The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.
2. Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
3. Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
4. Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
5. Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (R_S) can now be calculated from

$$R_S = \frac{2.533\ G}{C^2}$$

Where
G — in micromhos,
C — in pF,
R_S — in ohms

MPQ2483
MPQ2484

CASE 646-06, STYLE 1
TO-116



QUAD AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2919 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 0.825 6.7	 2.4 19.2	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	151	250	°C/W
	Effective, 4 Die	52	134	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)		I_{CBO}	—	—	20	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS						
DC Current Gain(2)		h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)	MPQ2483 MPQ2484		100 200	— —	— —	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MPQ2483 MPQ2484		150 300	— —	— —	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPQ2483 MPQ2484		150 300	— —	— —	
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	 — —	 0.13 0.15	 0.35 0.5	Vdc
Base-Emitter Saturation Voltage(2) (I_C = 100 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(sat)}$	 — —	 0.58 0.70	 0.7 0.8	Vdc

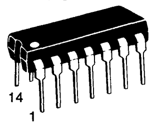
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

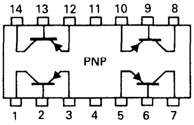
Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	50	100	—	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	4.0	8.0	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	1.8	6.0	pF
Noise Figure	NF				dB
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, MPQ2483		—	3.0	—	
f = 10 Hz to 15.7 kHz, BW = 10 kHz) MPQ2484		—	2.0	—	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPQ3467

CASE 646-06, STYLE 1
TO-116





QUAD MEMORY DRIVER TRANSISTORS

PNP SILICON

Refer to MD3467 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ $T_A = 25°C$(1) Derate above 25°C	P_D	 650 5.2	 1500 12	 mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.25 10	 3.2 25.6	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second Breakdown occurs at power levels greater than 2 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		$R_{\theta JC}$ Junction to Case	$R_{\theta JA}$ Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	100 39	193 83.2	°C/W °C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	45 5.0	55 10	% %

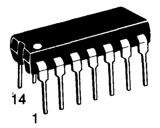
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

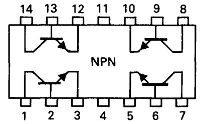
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	—	200	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	200	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	20	—	—	—
Collector-Emitter Saturation Voltage(2) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	—	0.23	0.5	Vdc
Base-Emitter Saturation Voltage(2) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{BE(sat)}$	—	0.90	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	125	190	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	10	25	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	55	80	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_C = 500$ mAdc, $I_{B1} = 50$ mAdc)	t_{on}	—	—	40	ns
Turn-Off Time ($I_C = 500$ mAdc, $I_{B1} = I_{B2} = 50$ mAdc)	t_{off}	—	—	90	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPQ3725, A

CASE 646-06, STYLE 1
TO-116





QUAD CORE DRIVER TRANSISTORS

NPN SILICON

Refer to MD3725 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPQ3725	MPQ3725A	Unit
Collector-Emitter Voltage	V_{CEO}	40	50	Vdc
Collector-Emitter Voltage	V_{CES}	60	70	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
		One Transistor	**Four Transistors Equal Power**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max		Unit
		One Transistor	**Effective For Four Transistors**	
Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	125	50	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

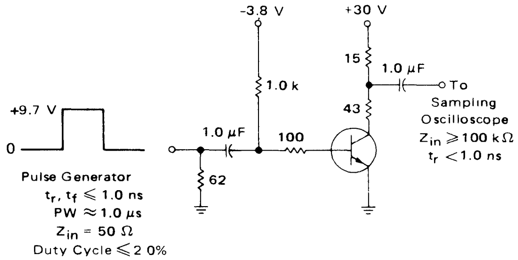
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	MPQ3725 MPQ3725A	$V_{(BR)CEO}$	40 50	— —	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	MPQ3725 MPQ3725A	$V_{(BR)CES}$	60 70	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)		I_{CBO}	—	—	0.5	μAdc
ON CHARACTERISTICS(2)						
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MPQ3725 MPQ3725A	h_{FE}	35 40	75 80	200 —	—
(I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	MPQ3725 MPQ3725A		25 30	45 50	— —	
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{CE(sat)}$	—	0.32	0.45	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)		$V_{BE(sat)}$	0.8	0.9	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPQ3725 MPQ3725A	f_T	250 200	275 250	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	5.1	10	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	62	80	pF

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

Characteristic	Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS					
Turn-On Time (I_C = 500 mAdc, I_{B1} = 50 mAdc, $V_{BE(off)}$ = 3.8 Vdc)	t_{on}	—	20	35	ns
Turn-Off Time (I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_{off}	—	50	60	ns

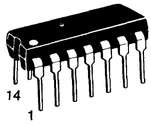
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

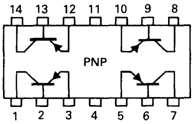
FIGURE 1 – SWITCHING TIMES TEST CIRCUIT



MPQ3762

CASE 646-06, STYLE 1
TO-116





QUAD MEMORY DRIVER TRANSISTORS

PNP SILICON

Refer to MD3467 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 750 5.98	 1700 13.6	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.25 10	 3.2 25.6	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance(1)	Each Die	100	167	°C/W
	Effective, 4 Die	39	73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	46	56	%
	Q1-Q2 or Q3-Q4	5.0	10	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 2.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)	h_{FE}	 35 30 20	 70 65 35	 — — —	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{CE(sat)}$	 — —	 0.3 0.6	 0.55 0.9	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{BE(sat)}$	 — —	 0.9 1.0	 1.25 1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	150	275	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	9.0	15	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	55	80	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc, $V_{BE(off)}$ = 2.0 Vdc)	t_{on}	—	—	50	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc)	t_{off}	—	—	120	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

EQUIVALENT TEST CIRCUITS

FIGURE 1 – TURN-ON

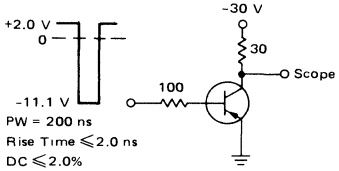
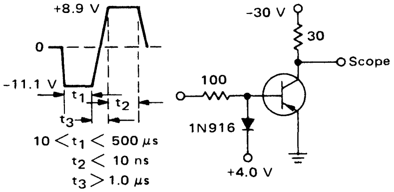
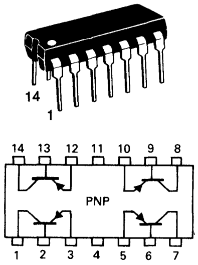


FIGURE 2 – TURN-OFF



MPQ3798
MPQ3799

CASE 646-06, STYLE 1
TO-116



QUAD AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N3810 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPQ3798	MPQ3799	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	 0.5 4.0	 0.9 7.2	 Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 0.825 6.7	 2.4 19.2	 Watts m/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		$R_{\theta JC}$ Junction to Case	$R_{\theta JA}$ Junction to Ambient	Unit
Thermal Resistance	Each Die	151	250	°C/W
	Effective, 4 Die	52	139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2)	$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0) MPQ3798		40	—	—	
MPQ3799		60	—	—	
Collector-Base Breakdown Voltage (I_C = 10 µAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 µAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	10	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}			—	—
(I_C = 10 µAdc, V_{CE} = 5.0 Vdc) MPQ3798		100	—	—	
MPQ3799		225	—		
				—	
(I_C = 100 µAdc, V_{CE} = 5.0 Vdc) MPQ3798		150	—	—	
MPQ3799		300	—		
				—	
(I_C = 500 µAdc, V_{CE} = 5.0 Vdc) MPQ3798		150	—	—	
MPQ3799		300	—		
				—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc) MPQ3798		125	—	—	
MPQ3799		250	—		
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 100 µAdc, I_B = 10 µAdc)		—	0.12	0.2	
(I_C = 1.0 mAdc, I_B = 100 µAdc)		—	0.07	0.25	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 100 µAdc, I_B = 10 µAdc)		—	0.62	0.7	
(I_C = 1.0 mAdc, I_B = 100 µAdc)		—	0.68	0.8	

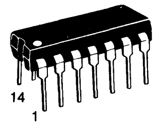
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

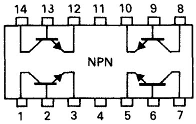
Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	60	250	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	2.1	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	5.5	8.0	pF
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 3.0 kohms, MPQ3798 f = 10 Hz to 15.7 kHz) MPQ3799	NF	 — —	 2.5 1.5	 — —	dB

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPQ3904

CASE 646-06, STYLE 1
TO-116





QUAD AMPLIFIER SWITCHING TRANSISTORS

NPN SILICON

Refer to 2N3904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Device Dissipation	P_D			
@ T_A = 25°C		500	900	mW
Derate above 25°C		4.0	7.2	mW/°C
Total Device Dissipation	P_D			
@ T_C = 25°C		825	2.4	Watts
Derate above 25°C		6.7	19.2	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	151	250	°C/W
	Effective, 4 Die	52	139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

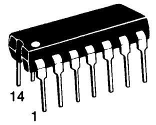
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

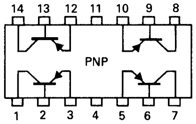
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{BE} = 40 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain	h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		30	90	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		50	160	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		75	200	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.1	0.2	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.65	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	250	300	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	2.0	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	4.0	8.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (I_C = 10 mAdc, V_{BE} = 0.5 Vdc, I_{B1} = 1.0 mAdc)	t_{on}	—	37	—	ns
Turn-Off Time (I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_{off}	—	136	—	ns

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

MPQ3906

CASE 646-06, STYLE 1
TO-116





QUAD AMPLIFIER SWITCHING TRANSISTORS

PNP SILICON

Refer to 2N3906 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 825 6.7	 2.4 19.2	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	151	250	°C/W
	Effective, 4 Die	52	139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain	h_{FE}				—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)		40	160	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)		60	180	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		75	200	—	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.1	0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	0.65	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	3.3	4.5	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	4.8	10	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_C = 10$ mAdc, $V_{BE(off)} = 0.5$ Vdc, $I_{B1} = 1.0$ mAdc)	t_{on}	—	43	—	ns
Turn-Off Time ($I_C = 10$ mAdc, $I_{B1} = I_{B2} = 1.0$ mAdc)	t_{off}	—	155	—	ns

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

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

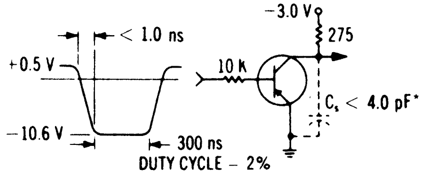
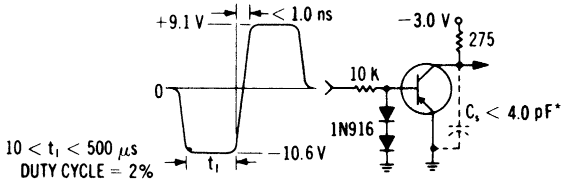


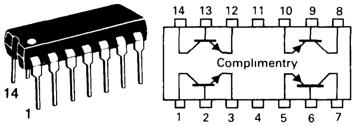
FIGURE 2 – STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



*Total shunt capacitance of test jig and connectors

MPQ6001
MPQ6002
STYLE 1
MPQ6501
MPQ6502
STYLE 2

CASE 646-06
TO-116



QUAD COMPLEMENTARY PAIR TRANSISTORS
NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Transistor	**Four Transistors Equal Power**	
Total Device Dissipation @ T_A = 25°C(1) MPQ6001, MPQ6002, MPQ6501, MPQ6502	P_D	0.65	1.25	Watts
Derate above 25°C MPQ6001, MPQ6002, MPQ6501, MPQ6502		5.18	10	mW/°C
Total Device Dissipation @ T_C = 25°C MPQ6001, MPQ6002, MPQ6501, MPQ6502	P_D	1.0	3.0	Watts
Derate above 25°C MPQ6001, MPQ6002, MPQ6501, MPQ6502		8.0	24	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance				°C/W
Each Die	MPQ6001, MPQ6002, MPQ6501, MPQ6502	125	193	
Effective, 4 Die	MPQ6001, MPQ6002, MPQ6501, MPQ6502	41.6	100	
Coupling Factors				%
Q1–Q4 or Q2–Q3	MPQ6001, MPQ6002, MPQ6501, MPQ6502	30	60	
Q1–Q2 or Q3–Q4	MPQ6001, MPQ6002, MPQ6501, MPQ6502	20	24	

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)		I_{CBO}	—	—	30	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	30	nAdc
ON CHARACTERISTICS						
DC Current Gain(2)		h_{FE}				—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MPQ6001, MPQ6501		25	—	—	
	MPQ6002, MPQ6502		50	—	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MPQ6001, MPQ6501		35	—	—	
	MPQ6002, MPQ6502		75	—	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MPQ6001, MPQ6501		40	—	—	
	MPQ6002, MPQ6502		100	—	—	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)	MPQ6001, MPQ6501		20	—	—	
	MPQ6002, MPQ6502		30	—	—	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage(2)		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	0.4	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.4	
Base-Emitter Saturation Voltage(2)		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	1.3	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	2.0	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	350	—	MHz
Output Capacitance		C_{obo}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	PNP		—	6.0	8.0	
	NPN		—	4.5	8.0	
Input Capacitance		C_{ibo}				pF
(V_{EB} = 2.0 Vdc, I_C = 0, f = 100 kHz)	PNP		—	20	30	
	NPN		—	17	30	
SWITCHING CHARACTERISTICS						
Turn-On Time (V_{CC} = 30 Vdc, V_{BE} = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc, Figure 1)		t_{on}	—	30	—	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)		t_{off}	—	225	—	ns

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

NPN DATA

FIGURE 1 — NORMALIZED DC CURRENT GAIN

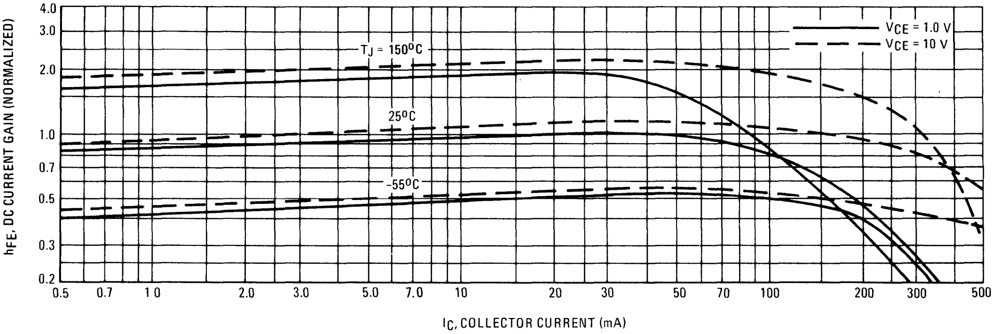


FIGURE 2 — "ON" VOLTAGES

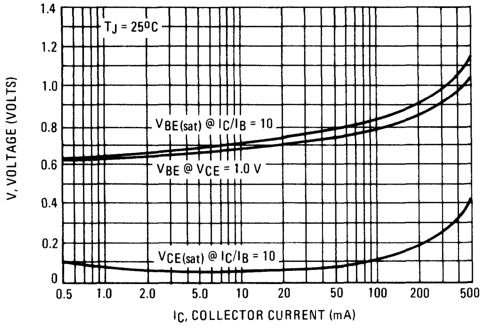
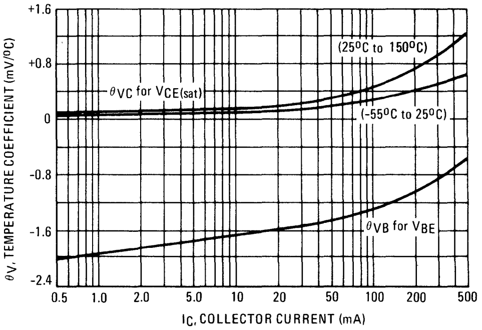


FIGURE 3 — TEMPERATURE COEFFICIENTS



NOISE FIGURE
(V$_{CE}$ = 10 Vdc, T$_A$ = 25°C)

FIGURE 4 — FREQUENCY EFFECTS

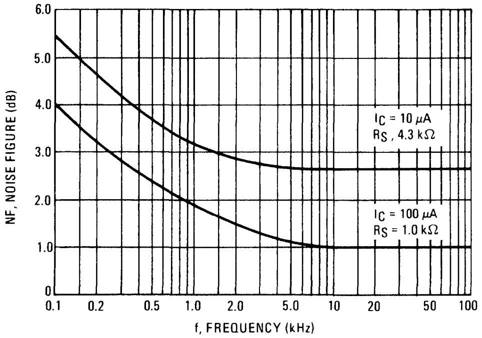
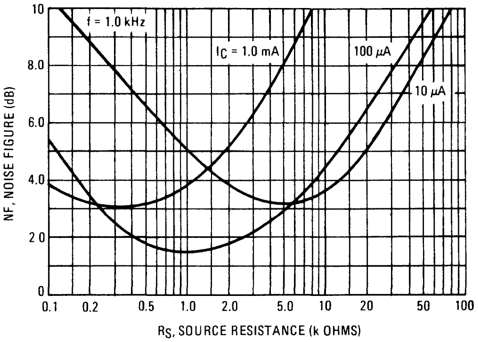


FIGURE 5 — SOURCE RESISTANCE EFFECTS



MPQ6100, A

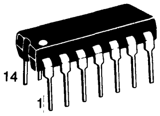
STYLE 1

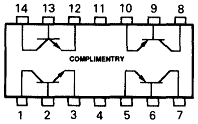
MPQ6600, A

STYLE 2

CASE 646-06

TO-116





QUAD COMPLEMENTARY PAIR TRANSISTORS

NPN/PNP SILICON

Refer to MHQ2483 for NPN Curves.

Refer to MHQ3798 for PNP Curves.

MAXIMUM RATINGS

Rating	Symbol	MPQ6100 MPQ6600	MPQ6100A MPQ6600A	Unit
Collector-Emitter Voltage	V_{CEO}	40	45	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 0.825 6.7	 2.4 19.2	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance(1)	Each Die	151	250	°C/W
	Effective, 4 Die	52	139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	 MPQ6100,6600 MPQ6100A,6600A	$V_{(BR)CEO}$	 40 45	 — —	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)		I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS(2)						
DC Current Gain (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	 MPQ6100,6600 MPQ6100A,6600A	h_{FE}	 50 100	 — —	 — —	—
(I_C = 500 μAdc, V_{CE} = 5.0 Vdc)	MPQ6100,6600 MPQ6100A,6600A		75 150	— —	— —	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MPQ6100,6600 MPQ6100A,6600A		75 150	— —	— —	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPQ6100,6600 MPQ6100A,6600A		60 125	— —	— —	
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 100 μAdc)		$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 100 μAdc)		$V_{BE(sat)}$	—	—	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	50	—	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	 PNP NPN	C_{obo}	 — —	 1.2 1.8	 4.0 4.0	pF

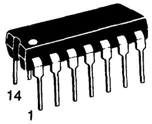
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

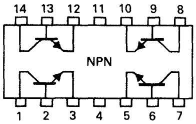
Characteristic		Symbol	Min	Typ	Max	Unit
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	PNP	C_{ibo}	—	—	8.0	pF
	NPN		—	—	8.0	
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 10 Hz to 15.7 kHz, BW = 10 kHz)		NF	—	4.0	—	dB

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPQ6426
MPQ6427

CASE 646-06, STYLE 1
TO-116





QUAD DARLINGTON TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage MPQ6426 MPQ6427	V_{CEO}	 30 40		Vdc
Collector-Base Voltage MPQ6426 MPQ6427	V_{CBO}	 40 50		Vdc
Emitter-Base Voltage	V_{EBO}	12		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Die	**Four Die Equal Power**	
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 825 6.7	 2400 19.2	 mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W °C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	% %

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	 MPQ6426 MPQ6427	$V_{(BR)CEO}$	 30 40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPQ6426 MPQ6427	$V_{(BR)CBO}$	 40 50	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	 5000 10,000	 — —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	125	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	15	pF

(2) Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle $\leq$ 2.0%.

NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

FIGURE 1 – NOISE VOLTAGE

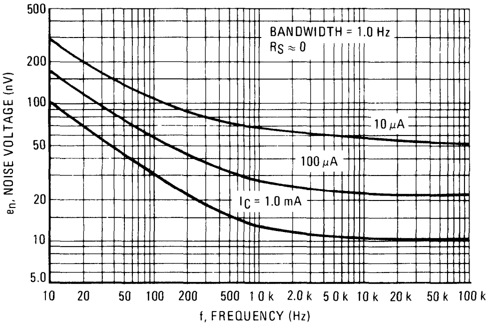


FIGURE 2 – NOISE CURRENT

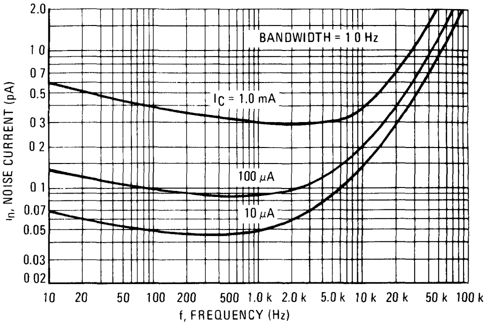


FIGURE 3 – TOTAL WIDEBAND NOISE VOLTAGE

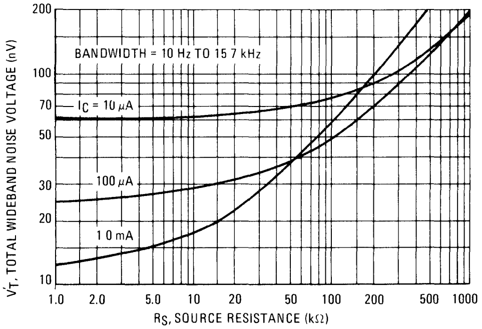
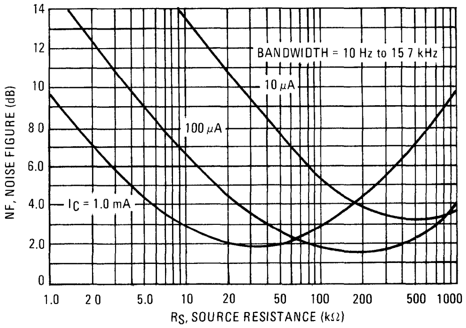


FIGURE 4 – WIDEBAND NOISE FIGURE



DYNAMIC CHARACTERISTICS

FIGURE 5 – CAPACITANCE

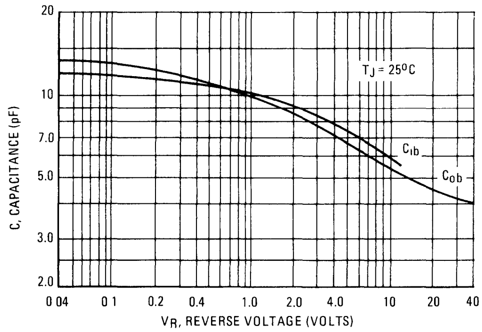
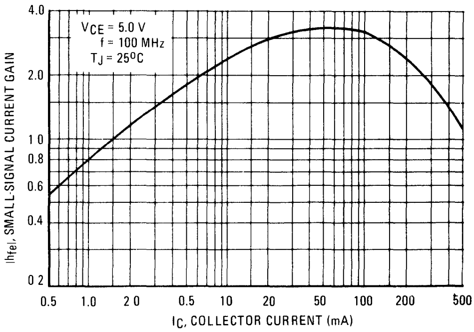


FIGURE 6 – HIGH FREQUENCY CURRENT GAIN

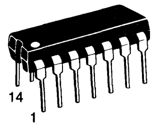


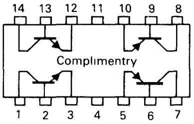
MPQ6501, MPQ6502 For Specifications, See MPQ6001 Data

MPQ6600,A For Specifications, See MPQ6100,A Data.

MPQ6700

CASE 646-06, STYLE 1
TO-116





QUAD COMPLEMENTARY PAIR TRANSISTORS

NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 825 6.7	 2400 19.2	 mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die Effective, 4 Die	151 52	250 139	°C/W °C/W
Coupling Factors	Q1-Q4 or Q2-Q3 Q1-Q2 or Q3-Q4	34 2.0	70 26	% %

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	50	nAdc
ON CHARACTERISTICS(2)				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 30 50 70	 — — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz) PNP NPN	C_{ibo}	 — —	 10 8.0	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

NPN **PNP**

FIGURE 1 – DC CURRENT GAIN

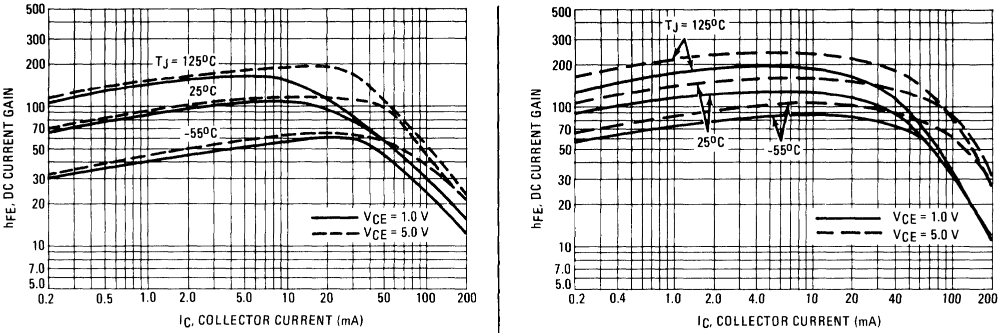


FIGURE 2 – "ON" VOLTAGE

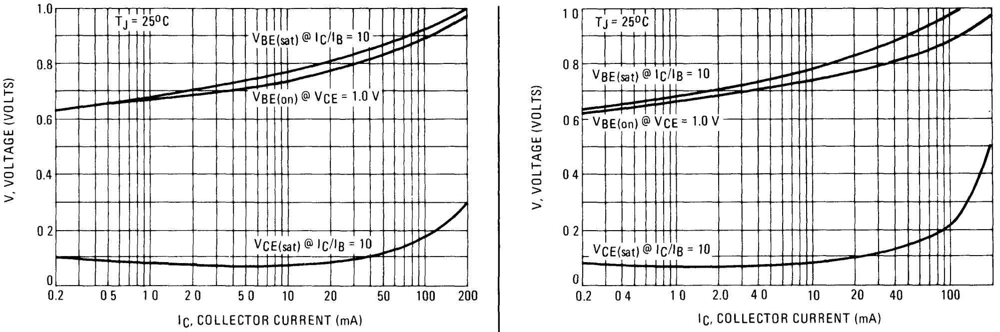
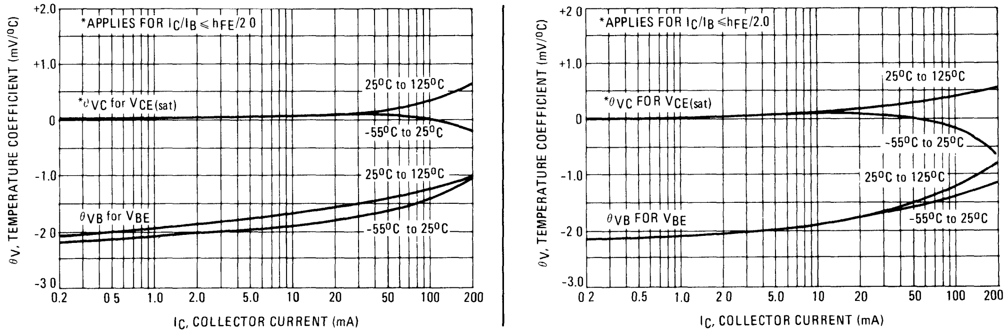


FIGURE 3 – TEMPERATURE COEFFICIENTS



NPN **PNP**

FIGURE 4 – COLLECTOR SATURATION REGION

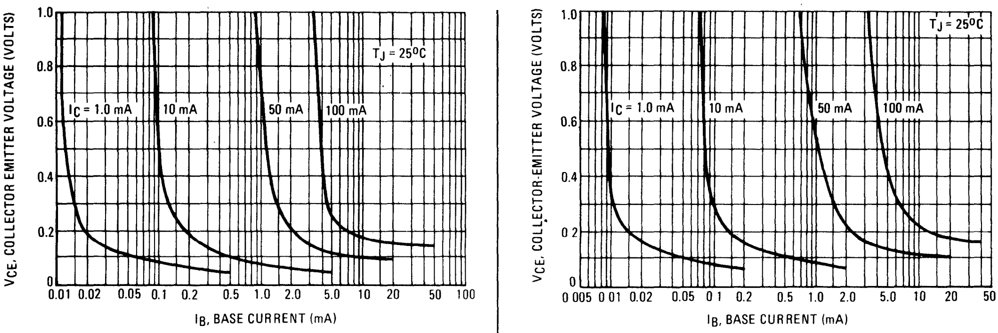


FIGURE 5 – TURN-ON TIME

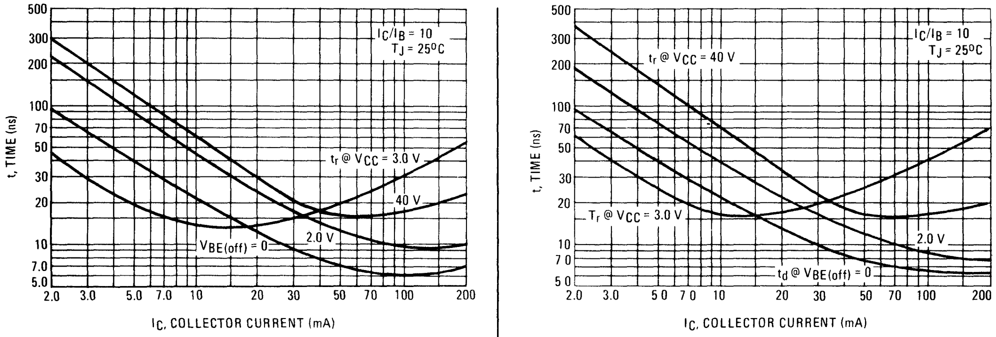
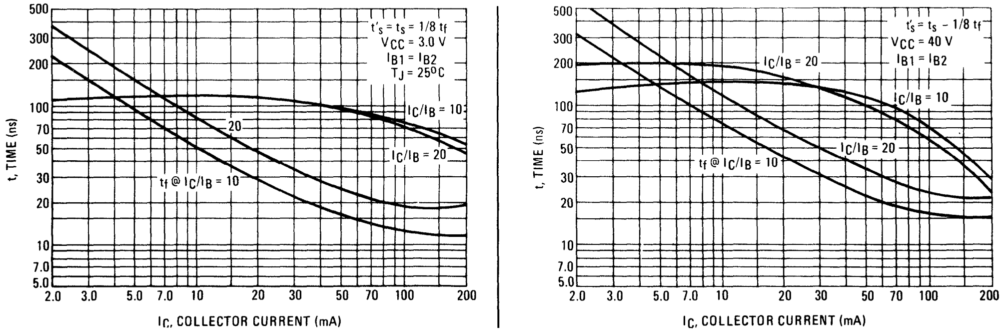


FIGURE 6 – TURN-OFF TIME



NPN **PNP**

FIGURE 7 — CURRENT-GAIN — BANDWIDTH PRODUCT

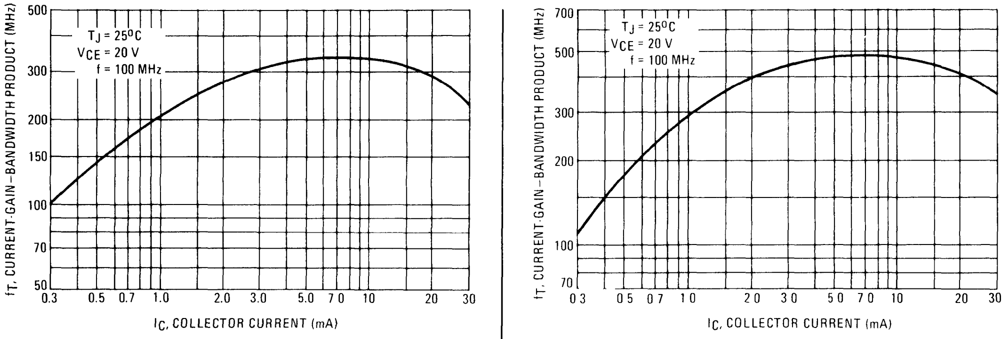
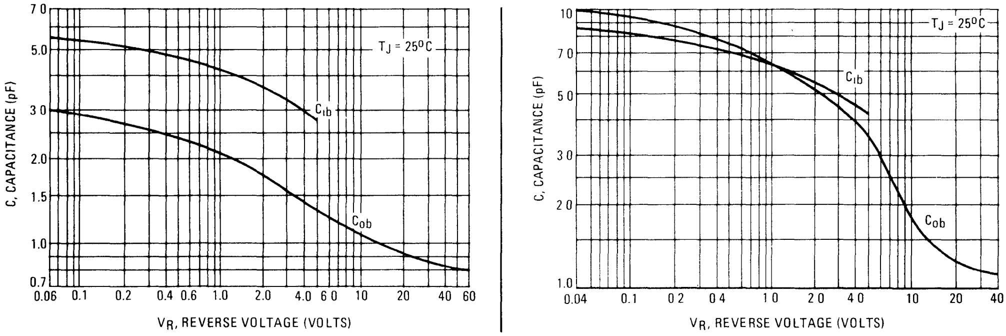
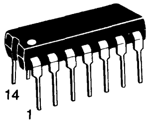


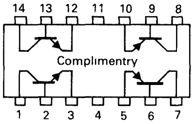
FIGURE 8 — CAPACITANCE



MPQ6842

CASE 646-06, STYLE 1
TO-116





QUAD COMPLEMENTARY PAIR TRANSISTORS

NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	30		Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	Four Transistors Equal Power	
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	 500 4.0	 900 7.2	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 825 6.7	 2400 19.2	 mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

(1) Second Breakdown occurs at power levels greater than 3 times the power dissipation rating.

THERMAL CHARACTERISTICS

Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	151	250	°C/W
	Effective, 4 Die	52	139	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	34	70	%
	Q1-Q2 or Q3-Q4	2.0	26	%

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain (I_C = 0.5 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30 50 70	— — —	— — —	—
Collector-Emitter Saturation Voltage (I_C = 0.5 mAdc, I_B = 0.05 mAdc, 0°C ≤ T ≤ 70°C)	$V_{CE(sat)}$	—	0.05	0.15	Vdc
Base-Emitter Saturation Voltage (I_C = 0.5 mAdc, I_B = 0.05 mAdc)	$V_{BE(sat)}$	—	0.65	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	350	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	3.0	4.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz) PNP NPN	C_{ibo}	 — —	 5.0 4.0	 10 8.0	pF
SWITCHING CHARACTERISTICS (T_A = 25°C, V_{CC} = 5.0 Vdc)					
Propagation Delay Time (50% Points TP1 to TP3) (50% Points TP2 to TP4)	 t_{PLH} t_{PHL}	 — —	 15 6.0	 25 15	ns
Rise Time (0.3 V to 4.7 V, TP3 or TP4)	t_r	5.0	25	35	ns
Fall Time (4.7 V to 0.3 V, TP3 or TP4)	t_f	5.0	10	20	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPQ6842

NPN

PNP

FIGURE 1 – DC CURRENT GAIN

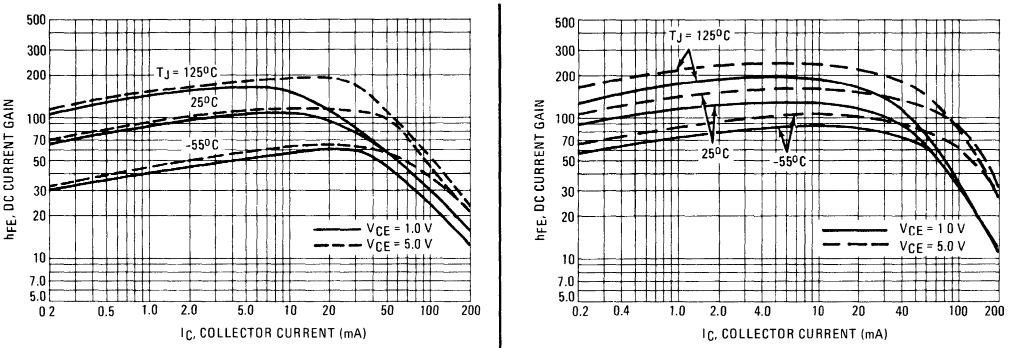


FIGURE 2 – "ON" VOLTAGE

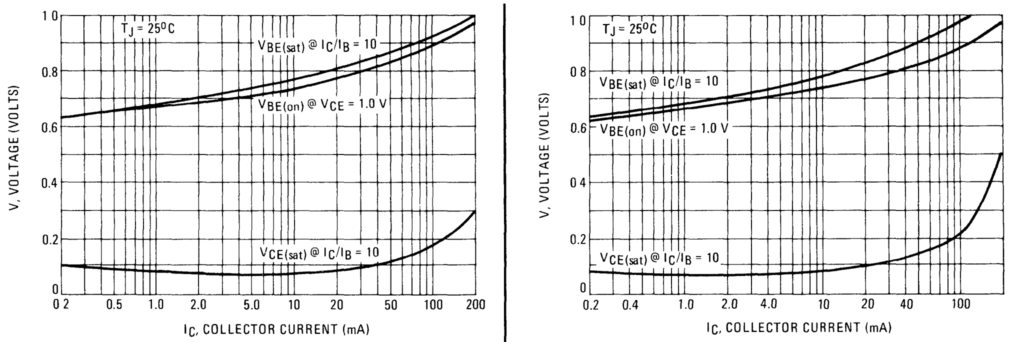


FIGURE 3 – TEMPERATURE COEFFICIENTS

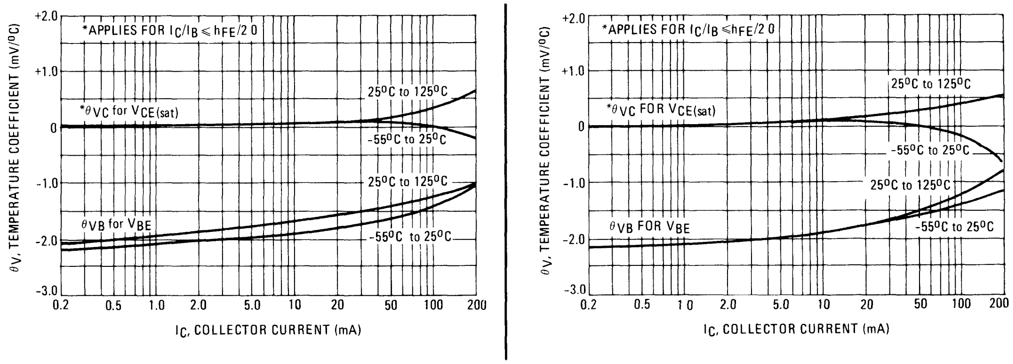
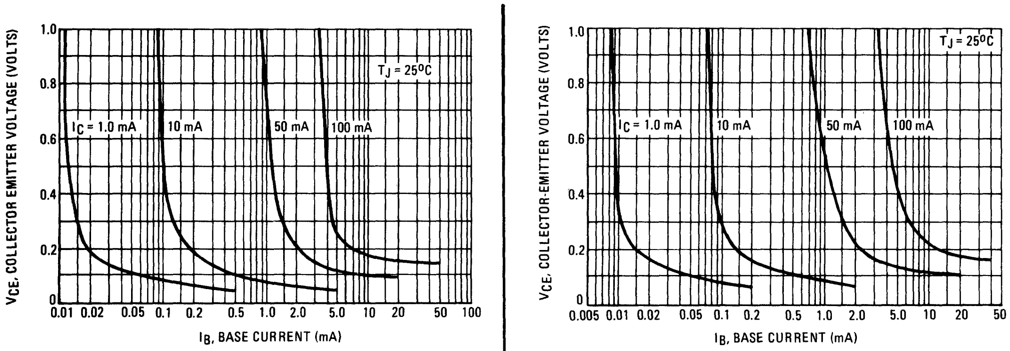
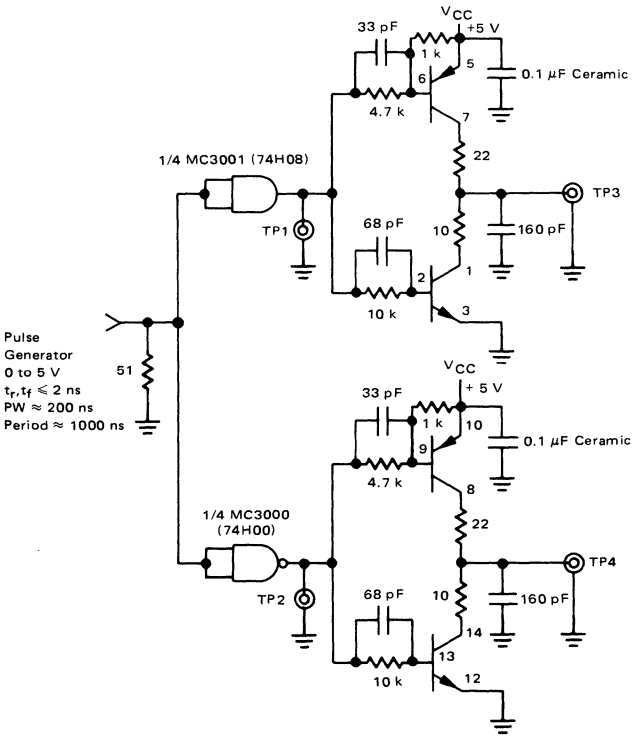


FIGURE 4 – COLLECTOR SATURATION REGION


NPN

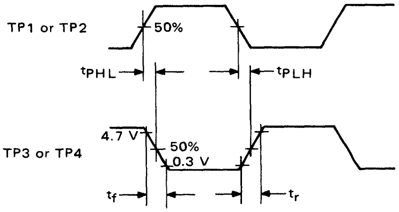
PNP

FIGURE 5 – SWITCHING TIMES TEST CIRCUIT AND WAVEFORMS



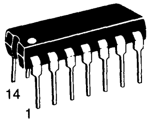
NOTES:

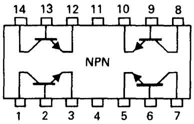
1. Unless otherwise noted, all resistors carbon composition ¼ W ±5%, all capacitors dipped mica ±2%.
2. Use short interconnect wiring with good power and ground busses.
3. TP1 thru TP4 are coaxial connectors to accept scope probe tip and provide a good ground.
4. Device under test is MPQ6842.
5. 160 pF load does not include stray or scope probe capacitance.
6. Scope probe resistance > 5 kΩ. Scope probe capacitance < 10 pF.



MPQ7041
thru
MPQ7043

CASE 646-06, STYLE 1
TO-116





QUAD
AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPQ7051 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPQ7041	MPQ7042	MPQ7043	Unit
Collector-Emitter Voltage	V_{CEO}	150	200	250	Vdc
Collector-Base Voltage	V_{CBO}	150	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous	I_C	500			mAdc
		Each Die	**Four Die Equal Power**		
Total Device Dissipation	P_D				
@ T_A = 25°C		750	1700		mW
Derate above 25°C		5.98	13.6		mW/°C
Total Device Dissipation	P_D				
@ T_C = 25°C		1.25	3.2		Watts
Derate above 25°C		10	25.6		mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

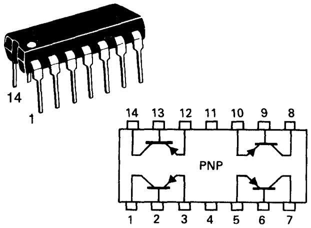
Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	100	167	°C/W
	Effective, 4 Die	39	73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	46	56	%
	Q1-Q2 or Q3-Q4	5.0	10	%

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPQ7041		150	—	—	
	MPQ7042		200	—	—	
	MPQ7043		250	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	MPQ7041		150	—	—	
	MPQ7042		200	—	—	
	MPQ7043		250	—	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 120 Vdc, I_E = 0)	MPQ7041		—	—	100	
(V_{CB} = 150 Vdc, I_E = 0)	MPQ7042		—	—	100	
(V_{CB} = 180 Vdc, I_E = 0)	MPQ7043		—	—	100	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			25	45	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			40	60	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)			40	80	—	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	0.3	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	80	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	2.5	5.0	pF
Input Capacitance (V_{EB} = 3.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	40	50	pF

MPQ7091
thru
MPQ7093

CASE 646-06, STYLE 1
TO-116



QUAD
AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MPQ7051 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPQ7091	MPQ7092	MPQ7093	Unit
Collector-Emitter Voltage	V_{CEO}	150	200	250	Vdc
Collector-Base Voltage	V_{CBO}	150	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous	I_C	500			mAdc
		Each Die	Four Die Equal Power		
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 750 5.98	 1700 13.6		 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.25 10	 3.2 25.6		 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

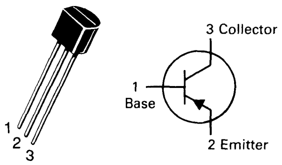
Characteristic		Junction to Case	Junction to Ambient	Unit
Thermal Resistance	Each Die	100	167	°C/W
	Effective, 4 Die	39	73.5	°C/W
Coupling Factors	Q1-Q4 or Q2-Q3	46	56	%
	Q1-Q2 or Q3-Q4	5.0	10	%

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPQ7091		150	—	—	
	MPQ7092		200	—	—	
	MPQ7093		250	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	MPQ7091		150	—	—	
	MPQ7092		200	—	—	
	MPQ7093		250	—		
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 120 Vdc, I_E = 0)	MPQ7091		—	—	250	
(V_{CB} = 150 Vdc, I_E = 0)	MPQ7092		—	—	250	
(V_{CB} = 180 Vdc, I_E = 0)	MPQ7093		—	—	250	
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25	40	—	—
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			35	55	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)			25	50	—	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	0.3	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	50	70	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.0	5.0	pF
Input Capacitance (V_{EB} = 3.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	60	75	pF

MPS536

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



HIGH FREQUENCY TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS536	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	30	mA
Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Storage Temperature	T_{stg}	−65 to +150	°C

*Free air

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ *For both package types unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 2.0$ mA, $I_B = 0$)	$V_{(BR)CEO}$	10	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu A$, $I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu A$, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 20$ mA, $V_{CE} = 5.0$ V)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Current Gain-Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_F = 0$, f = 1.0 MHz)	C_{cb}	—	0.8	1.2	pF
FUNCTIONAL TESTS					
Gain @ Noise Figure ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc) f = 500 MHz f = 1.0 GHz	G_{NF}	— —	14 8.0	— —	dB
Noise Figure ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc) f = 500 MHz f = 1.0 GHz	NF	— —	4.5 6.0	— —	dB

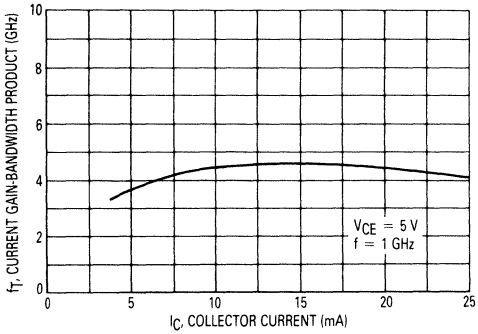


Figure 1. Current Gain-Bandwidth Product versus Collector Current

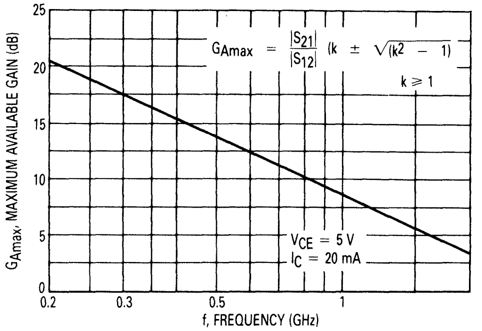


Figure 2. Maximum Available Gain (G_{Amax}) versus Frequency

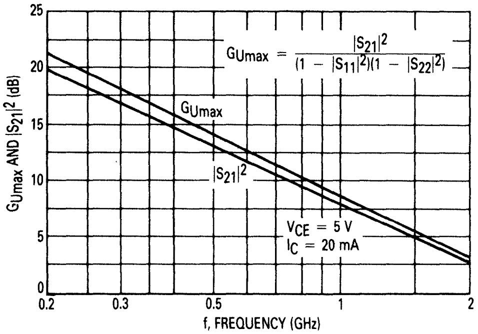


Figure 3. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

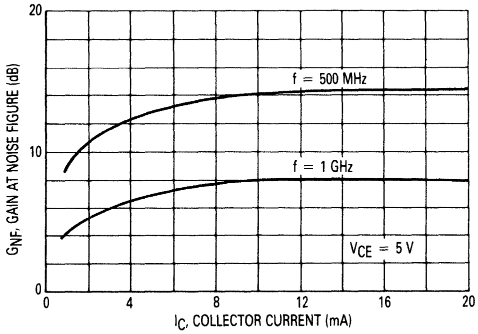


Figure 4. Gain at Noise Figure versus Collector Current

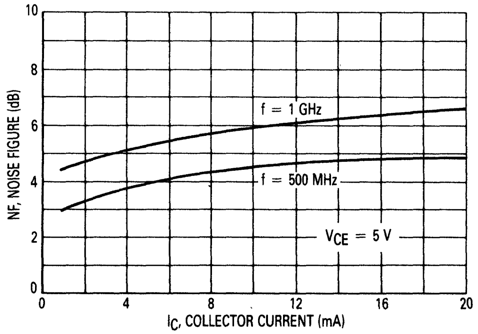


Figure 5. Noise Figure versus Collector Current

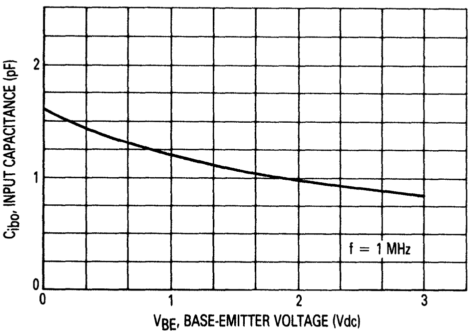


Figure 6. Input Capacitance versus Emitter-Base Voltage

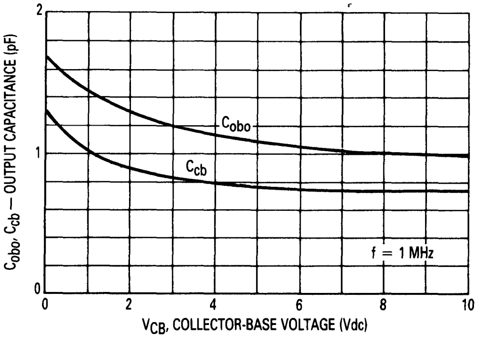
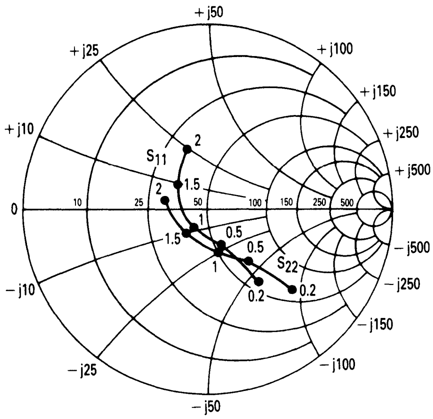
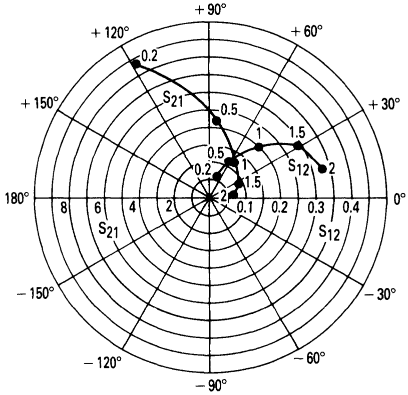


Figure 7. Output Capacitance versus Collector-Base Voltage

INPUT/OUTPUT REFLECTION COEFFICIENT
versus
FREQUENCY
V_{CE} = 10 V, I_C = 10 mA



FORWARD/REVERSE
TRANSMISSION COEFFICIENTS
versus
FREQUENCY
V_{CE} = 10 V, I_C = 10 mA

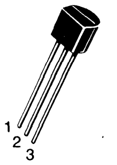


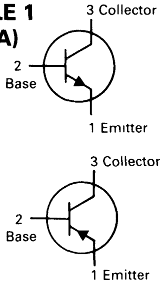
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
10	5	200	0.60	−43	6.60	125	0.07	68	0.71	−35
		500	0.30	−60	3.64	87	0.14	57	0.47	−43
		1000	0.17	−103	2.11	56	0.22	43	0.32	−69
		1500	0.15	156	1.70	28	0.30	28	0.22	−112
		2000	0.28	110	1.29	2	0.33	13	0.25	−174
	10	200	0.48	−52	8.78	118	0.06	69	0.62	−42
		500	0.21	−66	4.31	84	0.12	60	0.37	−46
		1000	0.12	−122	2.40	54	0.20	47	0.24	−73
		1500	0.18	138	1.90	29	0.29	31	0.16	−126
		2000	0.32	104	1.41	4	0.33	16	0.23	170
	20	200	0.38	−59	10.21	112	0.06	70	0.54	−46
		500	0.14	−76	4.72	81	0.12	63	0.30	−47
		1000	0.11	−144	2.58	53	0.20	49	0.19	−74
		1500	0.22	132	1.99	28	0.29	34	0.12	−139
		2000	0.35	103	1.46	4	0.33	19	0.22	161

NPN
MPS650, MPS651
PNP
MPS750, MPS751

CASE 29-04, STYLE 1
TO-92 (TO-226AA)





AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	MPS650 MPS750	MPS651 MPS751	Unit
Collector-Emitter Voltage	V_{CE}	40	60	Vdc
Collector-Base Voltage	V_{CB}	60	80	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	2.0		Adc
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 625 5.0		 mW mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.5 12		 Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	 MPS650, MPS750 MPS651, MPS751	$V_{(BR)CEO}$	 40 60	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPS650, MPS750 MPS651, MPS751	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 10 μAdc)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	 MPS650, MPS750 MPS651, MPS751	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 4.0 V, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 50 mA, V_{CE} = 2.0 V) (I_C = 500 mA, V_{CE} = 2.0 V) (I_C = 1.0 A, V_{CE} = 2.0 V) (I_C = 2.0 A, V_{CE} = 2.0 V)		h_{FE}	 75 75 75 40	 — — — —	—
Collector-Emitter Saturation Voltage (I_C = 2.0 A, I_B = 200 mA) (I_C = 1.0 A, I_B = 100 mA)		$V_{CE(sat)}$	 — —	 0.5 0.3	Vdc
Base-Emitter On Voltage (I_C = 1.0 A, V_{CE} = 2.0 V)		$V_{BE(on)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 1.0 A, I_B = 100 mA)		$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	75	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — MPS650, MPS651
TYPICAL DC CURRENT GAIN
NPN

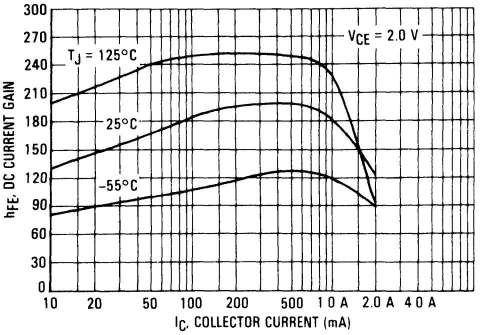


FIGURE 2 — MPS750, MPS751
TYPICAL DC CURRENT GAIN
PNP

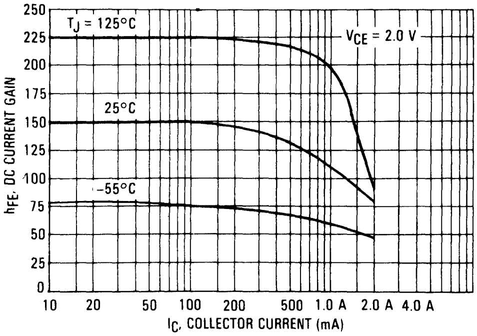


FIGURE 3 — MPS650, MPS651
ON VOLTAGES
NPN

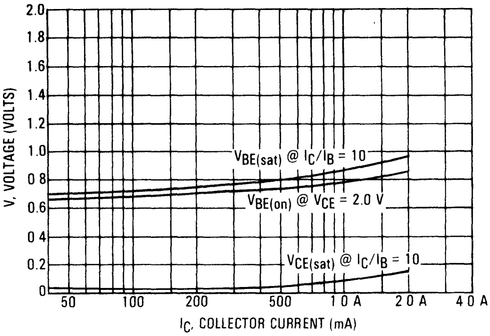


FIGURE 4 — MPS750, MPS751
ON VOLTAGES
PNP

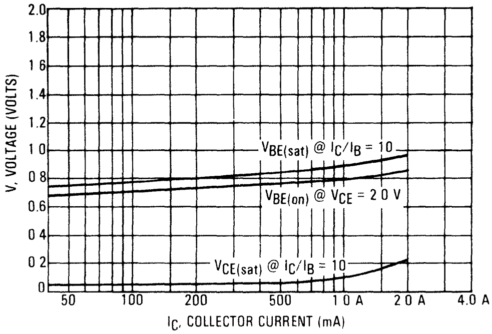


FIGURE 5 — MPS650, MPS651
COLLECTOR SATURATION REGION
NPN

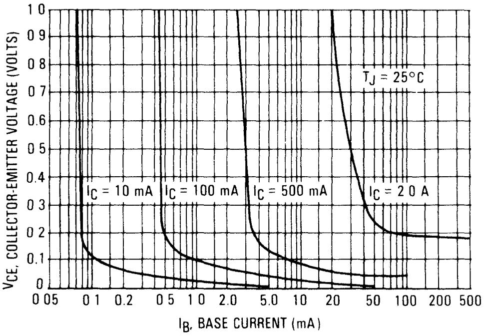


FIGURE 6 — MPS750, MPS751
COLLECTOR SATURATION REGION
PNP

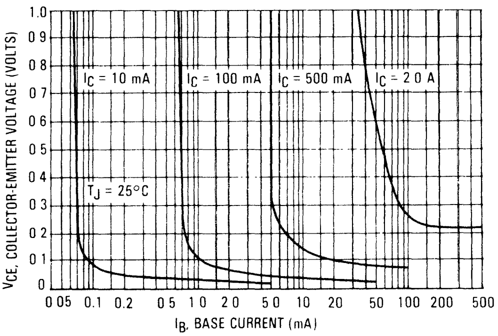


FIGURE 7 — MPS650, MPS651 SOA, SAFE OPERATING AREA

NPN

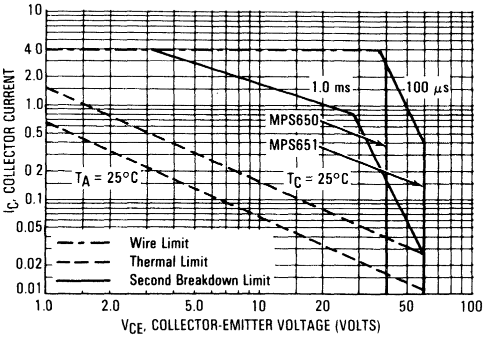
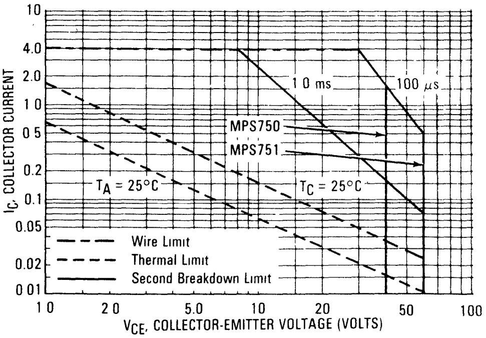


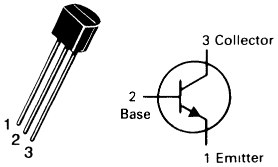
FIGURE 8 — MPS750, MPS751 SOA, SAFE OPERATING AREA

PNP



MPS918
MPS3563

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS918	MPS3563	Unit
Collector-Emitter Voltage	V_{CEO}	15	12	Vdc
Collector-Base Voltage	V_{CBO}	30	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	2.0	Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.85 6.8		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	147	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	357	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 3.0 mAdc, I_B = 0)	 MPS918 MPS3563	$V_{(BR)CEO}$	 15 12	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0) (I_C = 100 μAdc, I_E = 0)	 MPS918 MPS3563	$V_{(BR)CBO}$	 30 30	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	 MPS918 MPS3563	$V_{(BR)EBO}$	 3.0 2.0	 — —	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	 MPS918 MPS3563	I_{CBO}	 — —	 10 50	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 8.0 mAdc, V_{CE} = 10 Vdc)	 MPS918 MPS3563	h_{FE}	 20 20	 — 200	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	 MPS918	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	 MPS918	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	 MPS918 MPS3563	f_T	 600 600	 — 1500	MHz
Output Capacitance (V_{CB} = 0 Vdc, I_E = 0, f = 140 kHz) (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz) (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	 MPS918 MPS918 MPS3563	C_{obo}	 — — —	 3.0 1.7 1.7	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 140 kHz)	 MPS918	C_{ibo}	—	2.0	pF
Small-Signal Current Gain (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	 MPS3563	h_{fe}	20	250	—
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400 ohms, f = 60 MHz)	 MPS918	NF	—	6.0	dB

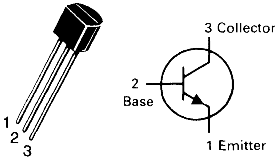
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

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

Characteristic		Symbol	Min	Max	Unit
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (I_C = 6.0 mAdc, V_{CB} = 12 Vdc, f = 200 MHz) (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 200 MHz) ($G_{fd} + G_{re} < -20$ dB)	 MPS918 MPS3563	G_{pe}	 15 14	 — —	dB
Power Output (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, f = 500 MHz)	 MPS918	P_{out}	30	—	mW
Oscillator Collector Efficiency (I_C = 8.0 mAdc, V_{CB} = 15 Vdc, P_{out} = 30 mW, f = 500 MHz)	 MPS918	η	25	—	%

MPS930A

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3903 for additional graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 5.0$ Vdc, $I_B = 0$)	I_{CEO}	—	5.6	nAdc
Collector Cutoff Current ($V_{CB} = 45$ Vdc, $I_E = 0$)	I_{CBO}	—	5.0	nAdc
Collector Cutoff Current ($V_{CE} = 45$ Vdc, $V_{BE} = 0$) ($V_{CE} = 45$ Vdc, $V_{BE} = 0$, $T_A = 125°C$)	I_{CES}	— —	5.0 5.0	nAdc μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	5.0	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 1.0$ μAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 10$ μAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 10$ μAdc, $V_{CE} = 5.0$ Vdc, $T_A = -55°C$) ($I_C = 500$ μAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	 60 100 30 150 —	 — 300 — — 600	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)	$V_{BE(sat)}$	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 500$ μAdc, $V_{CE} = 5.0$ Vdc, f = 30 MHz)	f_T	45	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Impedance ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{ib}	25	32	Ohms
Voltage Feedback Ratio ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{rb}	—	600	$X\ 10^{-6}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{fe}	150	600	—
Output Admittance ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{ob}	—	1.0	μmho
Noise Figure ($I_C = 10$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ kohms, f = 10 Hz to 15.7 kHz)	NF	—	3.0	dB

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

TYPICAL CHARACTERISTICS

FIGURE 1 – DC CURRENT GAIN

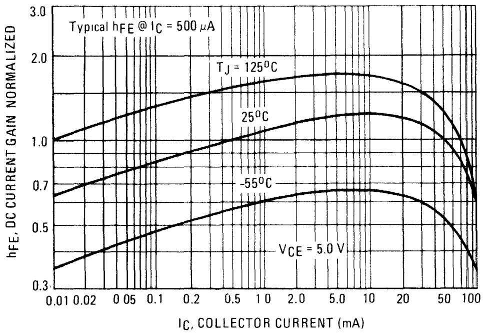


FIGURE 2 – "ON" VOLTAGES

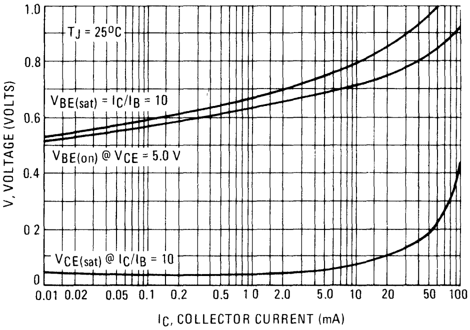


FIGURE 3 – COLLECTOR SATURATION REGION

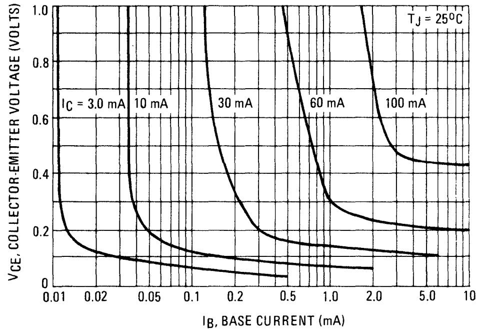


FIGURE 4 – TEMPERATURE COEFFICIENTS

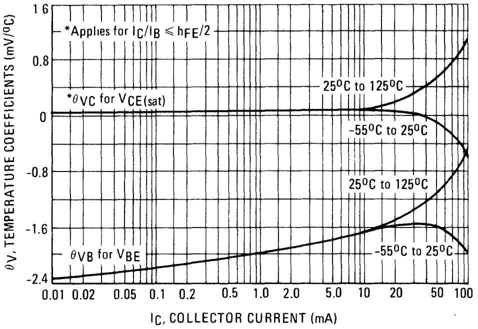


FIGURE 5 – CURRENT-GAIN – BANDWIDTH PRODUCT

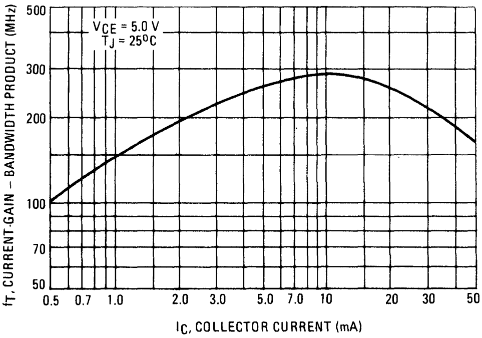
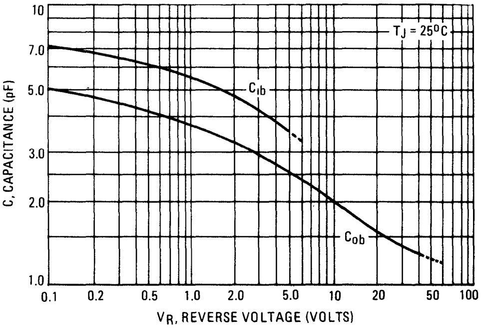
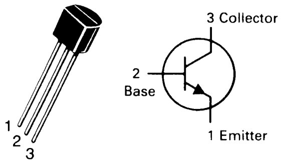


FIGURE 6 – CAPACITANCES



MPS2222, A*

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS2222	MPS2222A	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MPS2222		30	—	
	MPS2222A		40	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	MPS2222		60	—	
	MPS2222A		75	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	MPS2222		5.0	—	
	MPS2222A		6.0	—	
Collector Cutoff Current		I_{CEX}	—	10	nAdc
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MPS2222A				
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MPS2222		—	0.01	
(V_{CB} = 60 Vdc, I_E = 0)	MPS2222A		—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MPS2222		—	10	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 125°C)	MPS2222A		—	10	
Emitter Cutoff Current		I_{EBO}	—	10	nAdc
(V_{EB} = 3.0 Vdc, I_C = 0)	MPS2222A				
Base Cutoff Current		I_{BL}	—	20	nAdc
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MPS2222A				
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	MPS2222A only		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)			100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)(1)			50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	MPS2222		30	—	
	MPS2222A		40	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MPS2222		—	0.4	
	MPS2222A		—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)	MPS2222		—	1.6	
	MPS2222A		—	1.0	

*Also available as a PN2222,A.

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

Characteristic		Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	MPS2222		—	1.3	
	MPS2222A		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)	MPS2222		—	2.6	
	MPS2222A		—	2.0	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2)		f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MPS2222		250	—	
	MPS2222A		300	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MPS2222		—	30	
	MPS2222A		—	25	
Input Impedance		h_{ie}			kΩ
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		0.25	1.25	
Voltage Feedback Ratio		h_{re}			$X 10^{-4}$
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		—	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		—	4.0	
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		75	375	
Output Admittance		h_{oe}			µmhos
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS2222A		25	200	
Collector Base Time Constant		$rb'C_c$	—	150	ps
(I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	MPS2222A				
Noise Figure		NF	—	4.0	dB
(I_C = 100 µAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	MPS2222A				

SWITCHING CHARACTERISTICS MPS2222A only

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 1)	t_d	—	10	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_s	—	225	ns
Fall Time		t_f	—	60	ns

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 – TURN-ON TIME

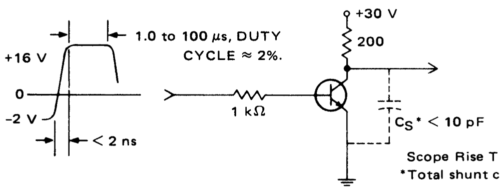
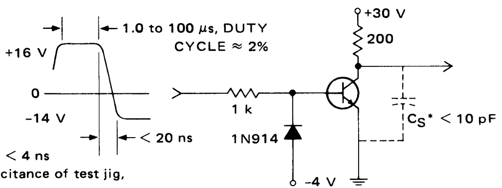


FIGURE 2 – TURN-OFF TIME



Scope Rise Time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

FIGURE 3 – DC CURRENT GAIN

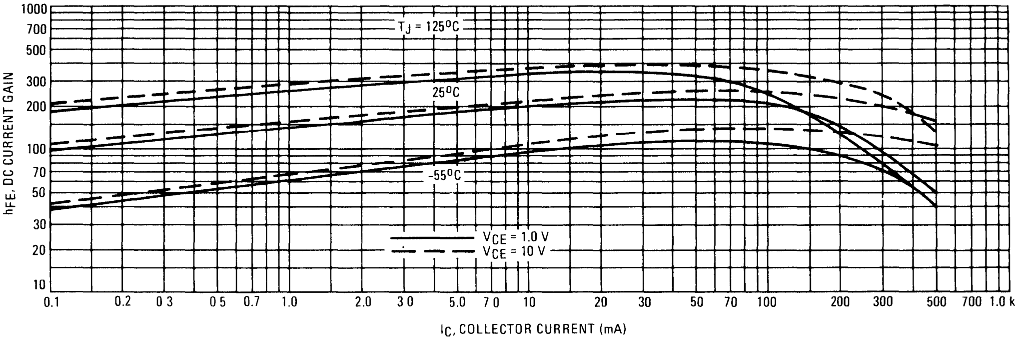


FIGURE 4 – COLLECTOR SATURATION REGION

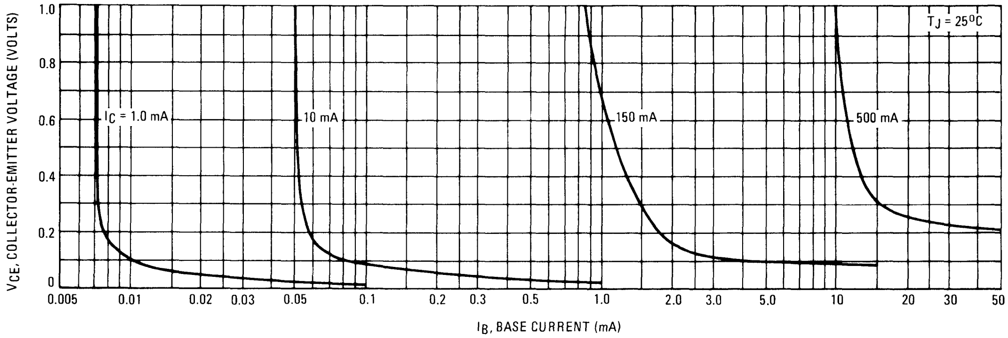


FIGURE 5 – TURN-ON TIME

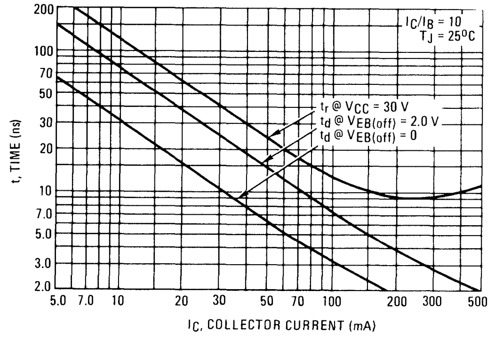


FIGURE 6 – TURN-OFF TIME

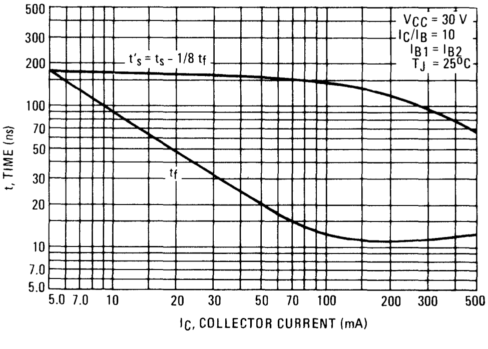


FIGURE 7 – FREQUENCY EFFECTS

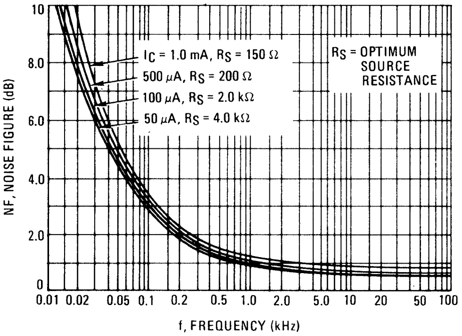


FIGURE 8 – SOURCE RESISTANCE EFFECTS

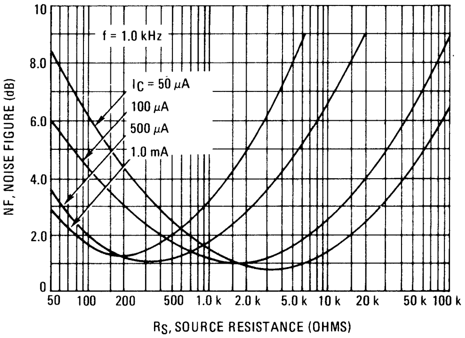


FIGURE 9 – CAPACITANCES

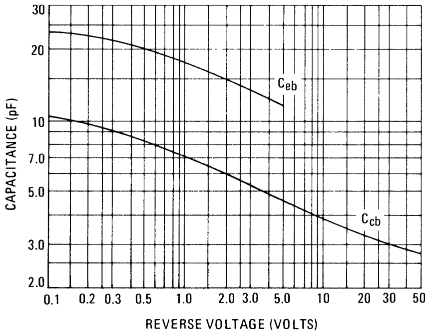


FIGURE 10 – CURRENT-GAIN BANDWIDTH PRODUCT

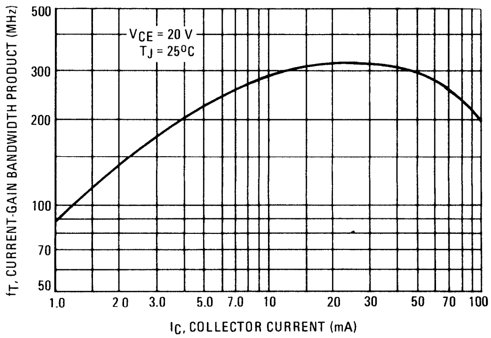


FIGURE 11 – "ON" VOLTAGES

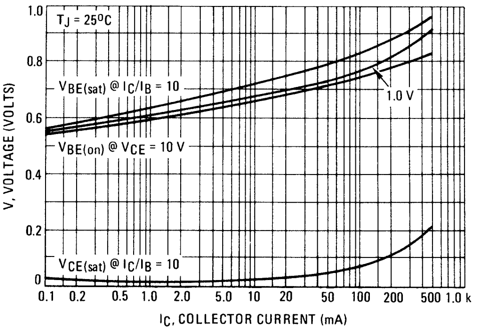
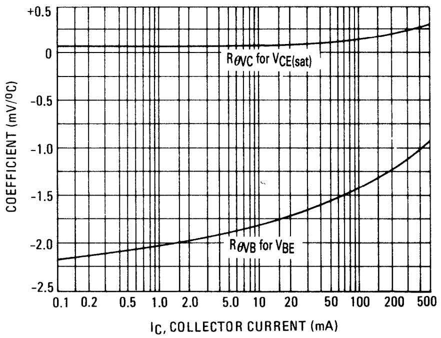
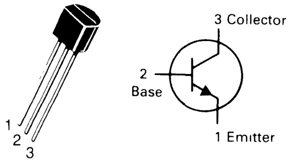


FIGURE 12 – TEMPERATURE COEFFICIENTS



MPS2369

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10$ μAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) ($V_{CB} = 20$ Vdc, $I_E = 0$, $T_A = 125°C$)	I_{CBO}	 — —	 — —	 0.4 30	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 2.0$ Vdc)	h_{FE}	 40 20	 — —	 120 —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	0.7	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	—	4.0	pF
Small Signal Current Gain ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	h_{fe}	5.0	—	—	—
SWITCHING CHARACTERISTICS					
Storage Time ($I_{B1} = I_{B2} = I_C = 10$ mAdc) (Figure 3)	t_s	—	5.0	13	ns
Turn-On Time ($V_{CC} = 3.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc) (Figure 1)	t_{on}	—	8.0	12	ns
Turn-Off Time ($V_{CC} = 3.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc, $I_{B2} = 1.5$ mAdc) (Figure 2)	t_{off}	—	10	18	ns

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

FIGURE 1 — t_{on} CIRCUIT

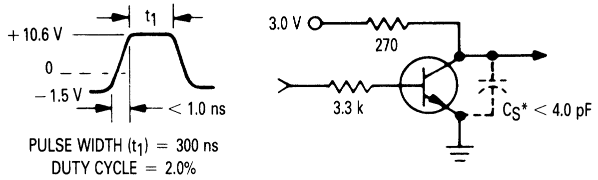


FIGURE 2 — t_{off} CIRCUIT

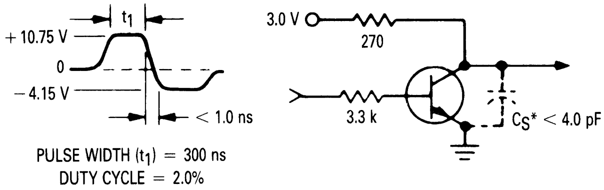
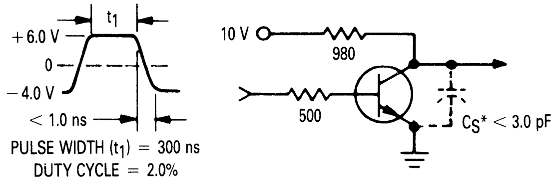


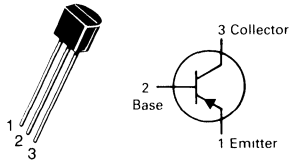
FIGURE 3 — STORAGE TEST CIRCUIT



*TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS.

MPS2907, A

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS2907	MPS2907A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MPS2907		40	—	
	MPS2907A		60	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc)		I_{CEX}	—	50	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MPS2907		—	0.020	
	MPS2907A		—	0.010	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	MPS2907		—	20	
	MPS2907A		—	10	
Base Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc)		I_B	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MPS2907		35	—	
	MPS2907A		75	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MPS2907		50	—	
	MPS2907A		100	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MPS2907		75	—	
	MPS2907A		100	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)	MPS2907, MPS2907A		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	MPS2907		30	—	
	MPS2907A		50	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.6	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	2.6	

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1),(2) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
SWITCHING CHARACTERISTICS					
Turn-On Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figures 1 and 5)	t_{on}	—	45	ns
Delay Time		t_d	—	10	ns
Rise Time		t_r	—	40	ns
Turn-Off Time	(V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_{off}	—	100	ns
Storage Time		t_s	—	80	ns
Fall Time		t_f	—	30	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 – DELAY AND RISE TIME TEST CIRCUIT

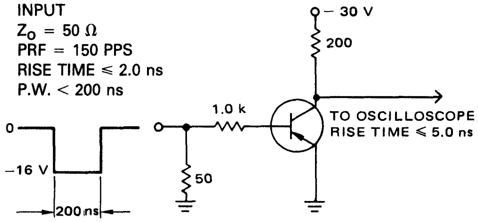
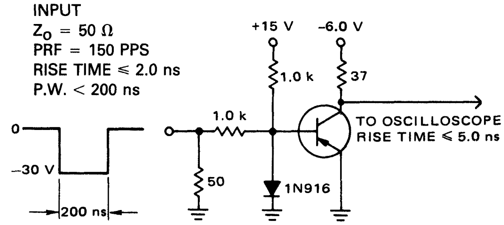


FIGURE 2 – STORAGE AND FALL TIME TEST CIRCUIT



TYPICAL CHARACTERISTICS

FIGURE 3 – DC CURRENT GAIN

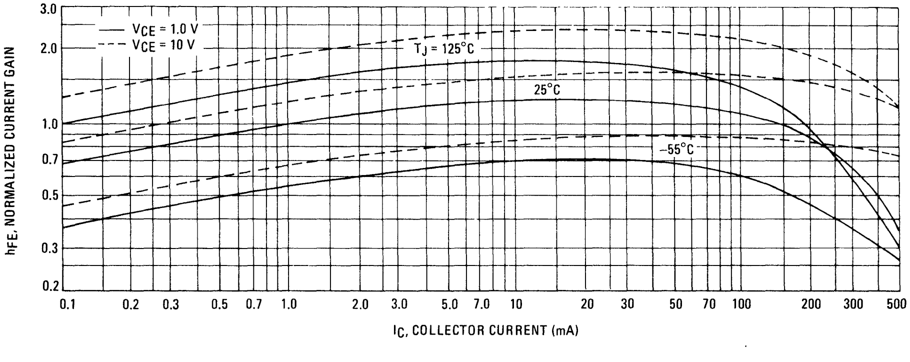


FIGURE 4 – COLLECTOR SATURATION REGION

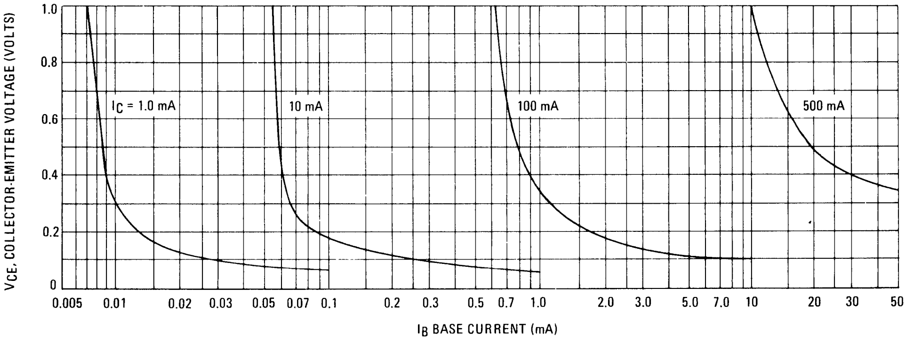


FIGURE 5 – TURN-ON TIME

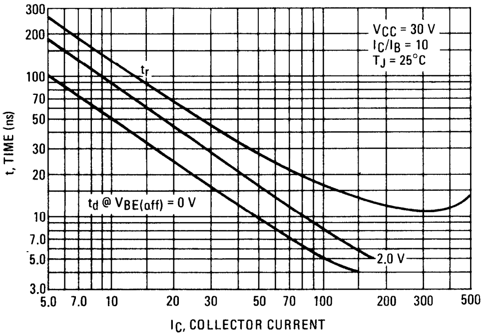
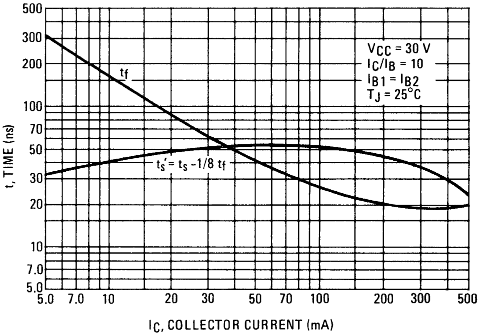


FIGURE 6 – TURN-OFF TIME



TYPICAL SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

V_{CE} = 10 Vdc, T_A = 25°C

FIGURE 7 – FREQUENCY EFFECTS

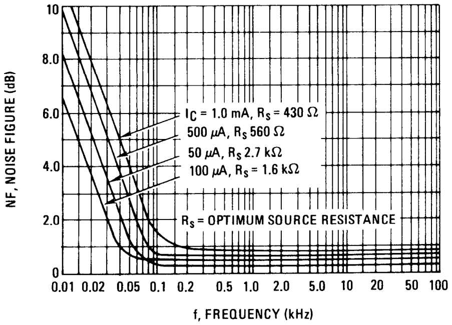


FIGURE 8 – SOURCE RESISTANCE EFFECTS

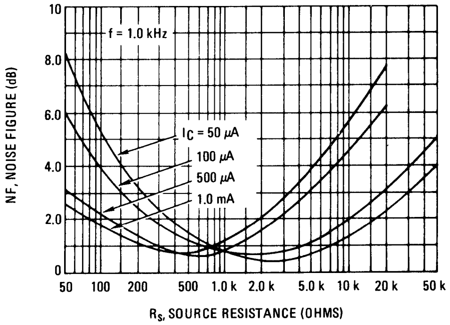


FIGURE 9 — CAPACITANCES

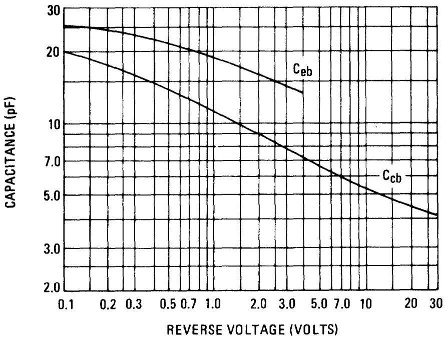


FIGURE 10 — CURRENT-GAIN — BANDWIDTH PRODUCT

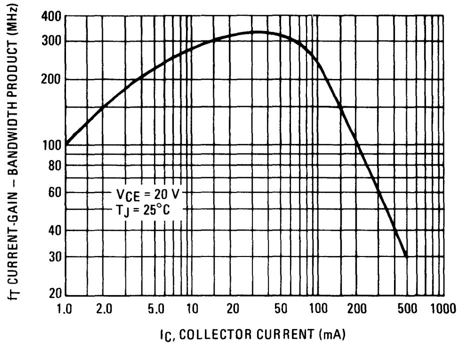


FIGURE 11 — "ON" VOLTAGE

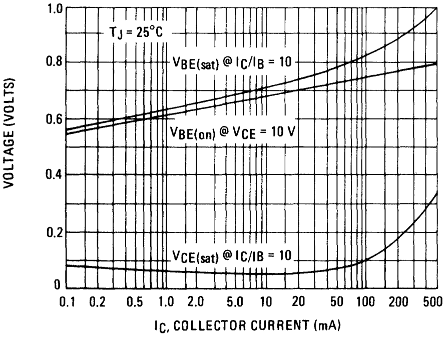
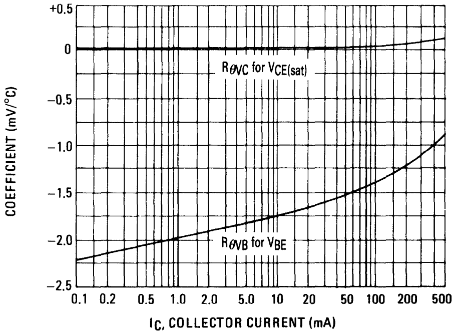
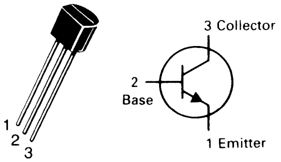


FIGURE 12 — TEMPERATURE COEFFICIENTS



MPS3403

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to MPS8098 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	500	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

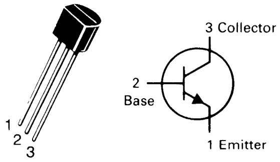
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mA)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μA)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μA)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 18$ V) ($V_{CB} = 18$ V, $T_A = 100°C$)	I_{CBO}	 — —	 100 15	 nA μA
Emitter Cutoff Current ($V_{BE} = 5.0$ V)	I_{EBO}	—	100	nA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 2.0$ mA, $V_{CE} = 4.5$ V)	h_{FE}	180	540	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 3.0$ mA)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage ($I_C = 50$ mA, $I_B = 3.0$ mA)	$V_{BE(sat)}$	0.6	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Small-Signal Current Gain ($I_C = 2.0$ mA, $V_{CE} = 4.5$ V, f = 1.0 kHz) ($I_C = 2.0$ mA, $V_{CE} = 4.5$ V, f = 1.0 kHz)	h_{fe}	 75 180	 — —	—

MPS3563 For Specifications, See MPS918 Data

MPS3566

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N4400 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_A = 60°C	P_D	450	mW
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

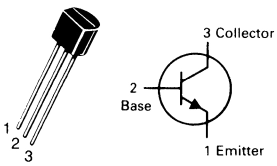
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 30 mA)	$V_{(BR)CEO(sus)}$	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V) (V_{CB} = 20 V, T_A = 75°C)	I_{CBO}	 — —	 50 5.0	 nA μA
Emitter Cutoff Current (V_{BE} = 5.0 V)	I_{EBO}	—	10	μA
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 mA, V_{CE} = 10 V) (I_C = 2.0 mA, V_{CE} = 10 V)	h_{FE}	 150 80	 600 —	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter On Voltage(1) (I_C = 100 mA, V_{CE} = 1.0 V)	$V_{BE(on)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)	C_{obo}	—	25	pF
Small-Signal Current Gain (I_C = 30 mA, V_{CE} = 10 V, f = 20 MHz)	h_{fe}	2.0	35	—

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

MPS3567
thru
MPS3569

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N4400 for graphs for MPS3567, 3569.*

MAXIMUM RATINGS

Rating	Symbol	MPS3567 MPS3569	MPS3568	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	80		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

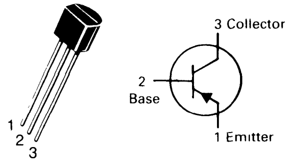
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1) (I_C = 30 mAdc, I_B = 0)	 MPS3567, MPS3569 MPS3568	$V_{CEO(sus)}$	 40 60	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0) (V_{CB} = 40 Vdc, I_E = 0, T_A = 75°C)		I_{CBO}	 — —	 50 5.0	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	25	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 1.0 Vdc)	 MPS3567, MPS3568 MPS3569	h_{FE}	 40 100	 — —	—
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	MPS3567, MPS3568 MPS3569		40 100	120 300	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)		$V_{BE(sat)}$	—	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 V, f = 1.0 MHz)		C_{obo}	—	20	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	80	pF

*Refer to MPS8098 for graphs for MPS3568.
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPS3638, A

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTORS

PNP SILICON

Refer to 2N4402 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Emitter Voltage	V_{CES}	25	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	40	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc, V_{BE} = 0$)	$V_{(BR)CES}$	25	—	Vdc
Collector-Emitter Sustaining Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc, I_E = 0$)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc, I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$) ($V_{CE} = 15$ Vdc, $V_{BE} = 0$, $T_A = -65°C$)	I_{CES}	 — —	 0.035 2.0	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ V, $I_C = 0$)	I_{EBO}	—	35	nA
Base Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$)	I_B	—	0.035	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) MPS3638A	h_{FE}	 80	 —	—
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) MPS3638 MPS3638A		20 100	— —	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) MPS3638 MPS3638A		30 100	— —	
($I_C = 300$ mAdc, $V_{CE} = 2.0$ Vdc) MPS3638 MPS3638A		20 20	— —	
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 2.5$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{CE(sat)}$	 — —	 0.25 1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 2.5$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{BE(sat)}$	 — 0.80	 1.1 2.0	Vdc

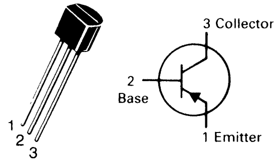
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (V_{CE} = 3.0 Vdc, I_C = 50 mAdc, f = 100 MHz)	MPS3638 MPS3638A	f_T	100 150	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MPS3638 MPS3638A	C_{obo}	— —	20 10	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MPS3638 MPS3638A	C_{ibo}	— —	65 25	pF
Input Impedance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{ie}	—	2000	Ohms
Voltage Feedback Ratio (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS3638 MPS3638A	h_{re}	— —	26 15	X 10^{-4}
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MPS3638 MPS3638A	h_{fe}	25 100	— —	—
Output Admittance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	—	1.2	mmhos
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 10 Vdc, I_C = 300 mAdc, I_{B1} = 30 mAdc)	t_d	—	20	ns
Rise Time		t_r	—	70	ns
Storage Time	(V_{CC} = 10 Vdc, I_C = 300 mAdc, I_{B1} = 30 mAdc, I_{B2} = 30 mAdc)	t_s	—	140	ns
Fall Time		t_f	—	70	ns
Turn-On Time	(I_C = 300 mAdc, I_{B1} = 30 mAdc)	t_{on}	—	75	ns
Turn-Off Time	(I_C = 300 mAdc, I_{B1} = 30 mAdc, I_{B2} = 30 mAdc)	t_{off}	—	170	ns

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

MPS3640

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	80	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

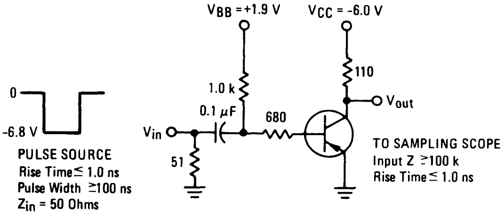
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	12	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = 65°C)	I_{CES}	— —	0.01 1.0	μAdc
Base Current (V_{CE} = 6.0 Vdc, V_{BE} = 0)	I_B	—	10	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 0.3 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30 20	120 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = 65°C)	$V_{CE(sat)}$	— — —	0.2 0.6 0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	0.75 0.75 —	0.95 1.0 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	500	—	MHz
Output Capacitance (V_{CB} = = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	3.5	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	3.5	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 Vdc, I_{B1} = 5.0 mAdc)	t_d	—	10	ns
Rise Time	t_r	—	30	ns
Storage Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, I_{B1} = I_{B2} = 5.0 mAdc)	t_s	—	20	ns
Fall Time	t_f	—	12	ns
Turn-On Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 Vdc, I_{B1} = 5.0 mAdc) (V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 0.5 mAdc)	t_{on}	 — —	 25 60	ns
Turn-Off Time (V_{CC} = 6.0 Vdc, I_C = 50 mAdc, $V_{BE(off)}$ = 1.9 V, I_{B1} = I_{B2} = 5.0 mAdc) (V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 0.5 mAdc)	t_{off}	 — —	 35 75	ns

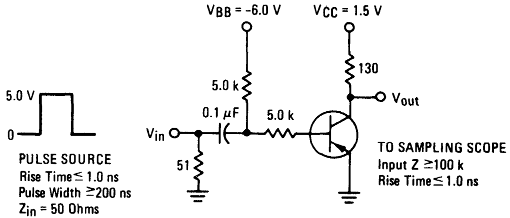
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1



NOTES: Collector Current = 50 mA, Turn-On and Turn-Off Time Base Currents = 5.0 mA.

FIGURE 2



NOTES: Collector Current = 10 mA, Turn-On and Turn-Off Time Base Currents = 0.5 mA.

FIGURE 3 – DC CURRENT GAIN

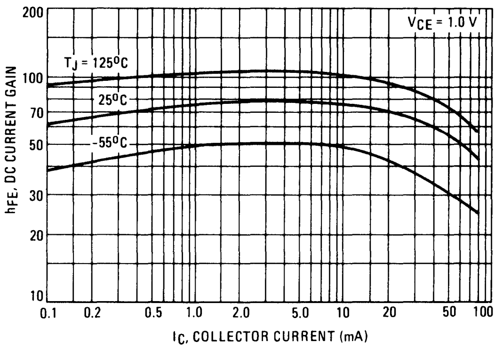


FIGURE 4 – "ON" VOLTAGES

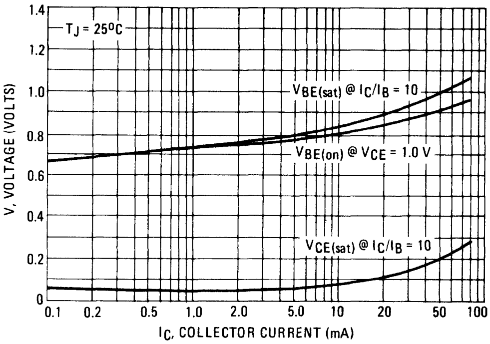


FIGURE 5 – COLLECTOR SATURATION REGION

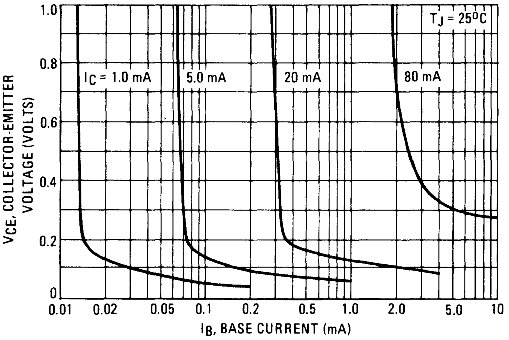


FIGURE 6 – TEMPERATURE COEFFICIENTS

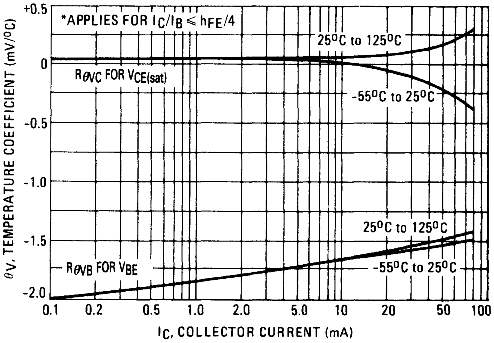


FIGURE 7 – CURRENT-GAIN–BANDWIDTH PRODUCT

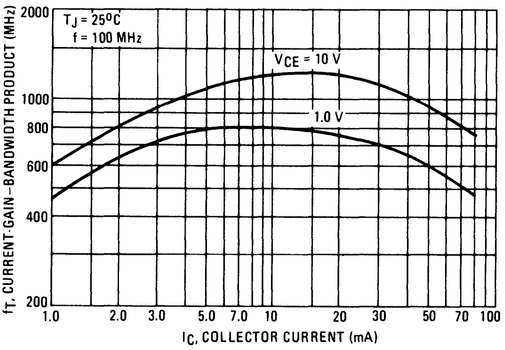
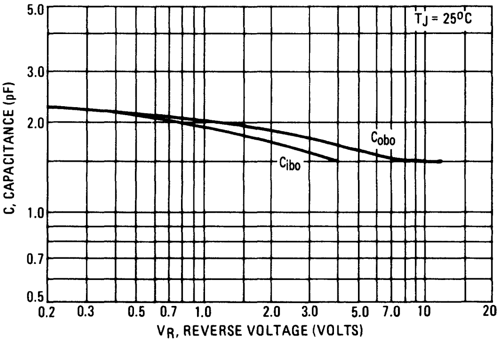
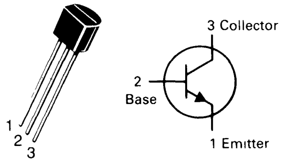


FIGURE 8 – CAPACITANCE



MPS3646

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N4264 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous — 10 μs Pulse	I_C	300 500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 0) (V_{CE} = 20 Vdc, V_{BE} = 0, T_A = 65°C)	I_{CES}	— —	0.5 3.0	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 30 mAdc, V_{CE} = 0.4 Vdc) (I_C = 100 mAdc, V_{CE} = 0.5 Vdc) (I_C = 300 mA, V_{CE} = 1.0 Vdc)	h_{FE}	30 25 15	120 — —	—
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 300 mAdc, I_B = 30 mAdc) (I_C = 30 mA, I_B = 3.0 mA, T_A = 65°C)	$V_{CE(sat)}$	— — — —	0.2 0.28 0.5 0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 300 mAdc, I_B = 30 mA)	$V_{BE(sat)}$	0.73 — —	0.95 1.2 1.7	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	350	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	9.0	pF
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 10 Vdc, $V_{BE(off)}$ = 3.0 Vdc, I_C = 300 mAdc, I_{B1} = 30 mAdc) (Figure 1)	t_{on}	—	18	ns
Delay Time	t_d	—	10	ns
Rise Time	t_r	—	15	ns
Turn-Off Time (V_{CC} = 10 Vdc, I_C = 300 mAdc, I_{B1} = I_{B2} = 30 mAdc) (Figure 1)	t_{off}	—	28	ns
Fall Time	t_f	—	15	ns
Storage Time (V_{CC} = 10 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 10 mAdc) (Figure 2)	t_s	—	18	ns

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

FIGURE 1 – SWITCHING TIME TEST CIRCUIT

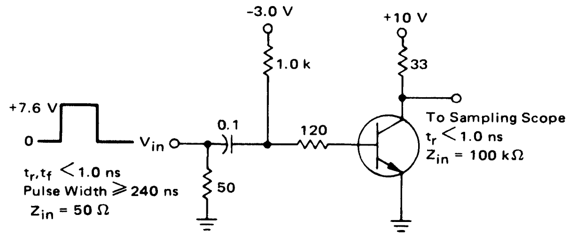
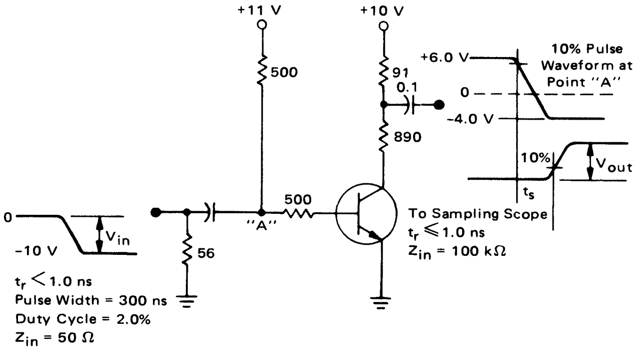
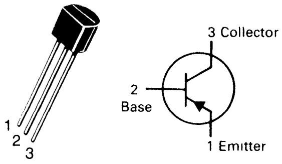


FIGURE 2 – CHARGE STORAGE TIME TEST CIRCUIT



MPS3702
MPS3703

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N4402 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPS3702	MPS3703	Unit
Collector-Emitter Voltage	V_{CEO}	25	30	Vdc
Collector-Base Voltage	V_{CBO}	40	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.2	°C/W

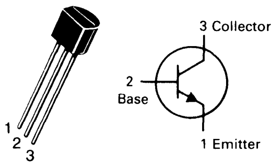
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	MPS3702 MPS3703	$V_{(BR)CEO}$	25 30	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPS3702 MPS3703	$V_{(BR)CBO}$	40 50	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MPS3702 MPS3703	h_{FE}	60 30	300 150	—
Collector-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage(1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	0.6	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	100	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz)		C_{obo}	—	12	pF

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MPS3704
MPS3705

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N4400 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.2	°C/W

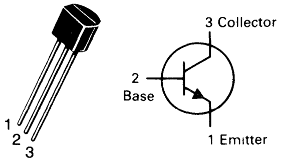
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_E = 0)		$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 50 mAdc, V_{CE} = 2.0 Vdc)	MPS3704 MPS3705	h_{FE}	100 50	300 150	—
Collector-Emitter Saturation Voltage(1) (I_C = 100 mAdc, I_B = 5.0 mAdc)	MPS3704 MPS3705	$V_{CE(sat)}$	— —	0.6 0.8	Vdc
Base-Emitter On Voltage(1) (I_C = 100 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(on)}$	0.5	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 2.0 V, f = 20 MHz)		f_T	100	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	12	pF

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MPS3866

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

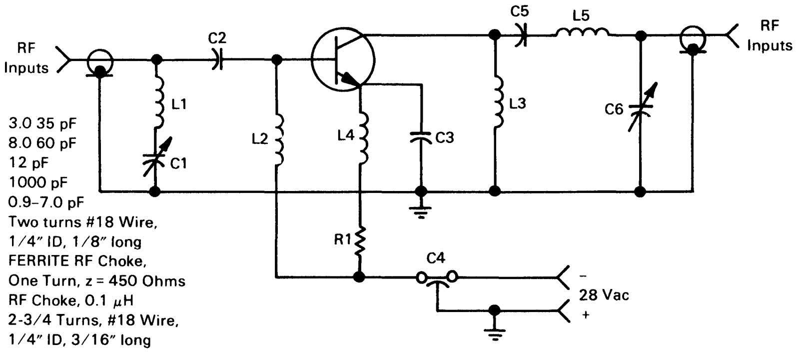
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 5.0$ mAdc, $R_{BE} = 10\ \Omega$)	$V_{CER(sus)}$	55	—	Vdc
Collector-Emitter Sustaining Voltage ($I_C = 5.0$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current ($V_{CE} = 28$ Vdc, $I_B = 0$)	I_{CEO}	—	0.02	mAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = -1.5$ Vdc (Rev.), $T_C = 150°C$) ($V_{CE} = 55$ Vdc, $V_{BE} = -1.5$ Vdc (Rev.)	I_{CEX}	 — —	 5.0 0.1	mAdc
Emitter Cutoff Current ($V_{BE} = 3.5$ Vdc, $I_C = 0$)	I_{EBO}	—	0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 360$ mAdc, $V_{CE} = 5.0$ Vdc)(1) ($I_C = 50$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	 5.0 10	 — 200	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 20$ mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc, f = 200 MHz)	f_T	500	—	MHz
Output Capacitance ($V_{CB} = 28$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	3.0	pF
FUNCTIONAL TEST				
Amplifier Power Gain ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, f = 400 MHz)	G_{pe}	10	—	dB
Collector Efficiency ($V_{CC} = 28$ Vdc, $P_{out} = 1.0$ W, f = 400 MHz)	η	45	—	%

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

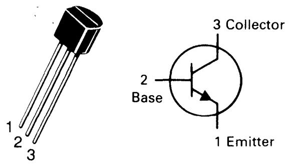
FIGURE 1 — 400 MHz TEST CIRCUIT SCHEMATIC



C1: 3.0 35 pF
C2, C5: 8.0 60 pF
C3: 12 pF
C4: 1000 pF
C6: 0.9–7.0 pF
L1. Two turns #18 Wire, 1/4″ ID, 1/8″ long
L2: FERRITE RF Choke, One Turn, z = 450 Ohms
L3, L4: RF Choke, 0.1 μH
L5: 2-3/4 Turns, #18 Wire, 1/4″ ID, 3/16″ long
R1: 5.6 Ohms

MPS3903
MPS3904

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ $T_A = 60°C$	P_D	450	mW
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{EB(off)} = 3.0$ Vdc)		I_{CEX}	—	50	nAdc
Base Cutoff Current ($V_{CE} = 30$ Vdc, $V_{EB(off)} = 3.0$ Vdc)		I_{BL}	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	MPS3903		20	—	
	MPS3904		40	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	MPS3903		35	—	
	MPS3904		70	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	MPS3903		50	150	
	MPS3904		100	300	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	MPS3903		30	—	
	MPS3904		60	—	
$I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	MPS3903		15	—	
	MPS3904		30	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			—	0.2	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)			—	0.3	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			0.65	0.85	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)			—	1.1	

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

Characteristic			Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		MPS3903	f_T	150	—	MHz
		MPS3904		200	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)			C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)			C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		MPS3903	h_{ie}	0.5	8.0	kΩ
		MPS3904		1.0	10	
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		MPS3903	h_{re}	0.1	5.0	X 10^{-4}
		MPS3904		0.5	8.0	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		MPS3903	h_{fe}	50	200	—
		MPS3904		100	400	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)			h_{oe}	1.0	40	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 10 Hz to 15.7 kHz)		MPS3903	NF	—	6.0	dB
		MPS3904		—	5.0	
SWITCHING CHARACTERISTICS						
Delay Time	(V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	—	35	ns
Rise Time			t_r	—	50	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	MPS3903	t_s	—	800	ns
		MPS3904		—	900	
Fall Time			t_f	—	90	ns

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

EQUIVALENT SWITCHING TIME TEST CIRCUITS

FIGURE 1 – TURN-ON TIME

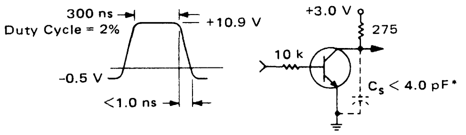
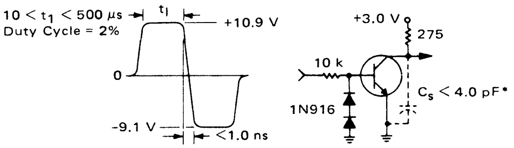


FIGURE 2 – TURN-OFF TIME



*Total shunt capacitance of test jig and connectors

TYPICAL NOISE CHARACTERISTICS
(V_{CE} = 5.0 Vdc, T_A = 25°C)

FIGURE 3 – NOISE VOLTAGE

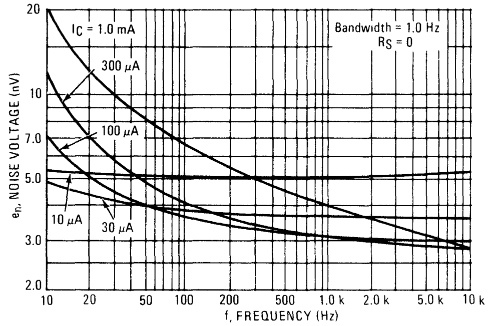
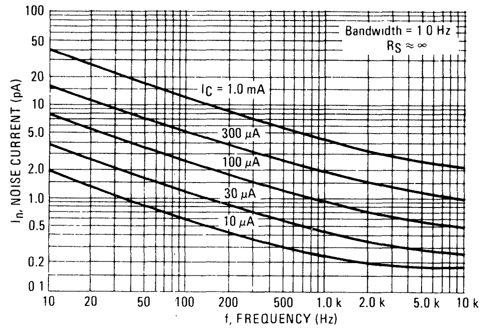


FIGURE 4 – NOISE CURRENT



NOISE FIGURE CONTOURS
(V_{CE} = 5.0 Vdc, T_A = 25°C)

FIGURE 5 – NARROW BAND, 100 Hz

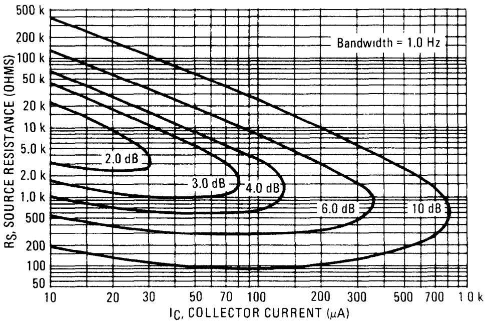


FIGURE 6 – NARROW BAND, 1.0 kHz

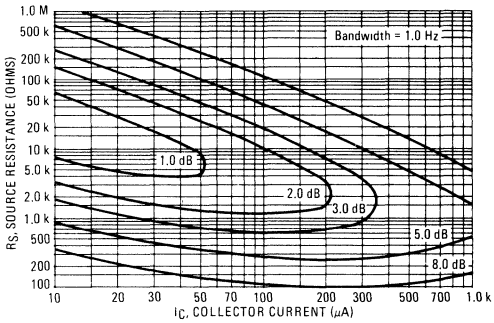
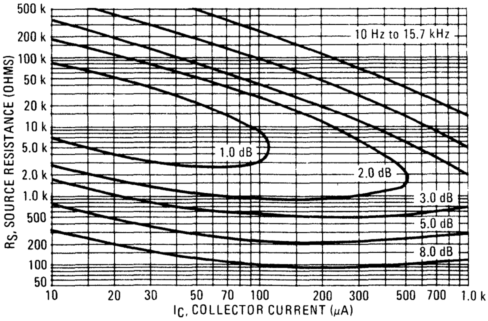


FIGURE 7 – WIDEBAND



Noise Figure is Defined as:

$$NF = 20\log_{10}\left(\frac{e_n^{\,2} + 4KTR_S + I_n^{\,2}R_S^{\,2}}{4KTR_S}\right)^{1/2}$$

e_n = Noise Voltage of the Transistor referred to the input. (Figure 3)
I_n = Noise Current of the transistor referred to the input (Figure 4)
K = Boltzman's Constant (1.38 x 10^{-23} j/°K)
T = Temperature of the Source Resistance (°K)
R_S = Source Resistance (Ohms)

TYPICAL STATIC CHARACTERISTICS

FIGURE 8 — DC CURRENT GAIN

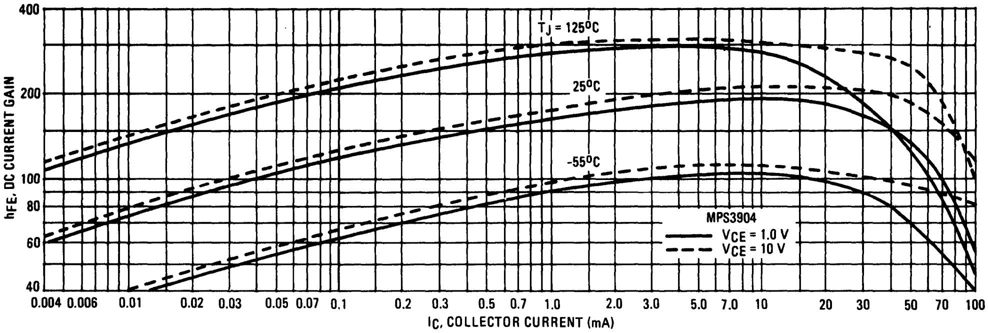


FIGURE 9 — COLLECTOR SATURATION REGION

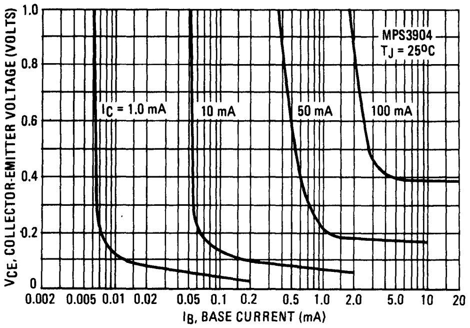


FIGURE 10 — COLLECTOR CHARACTERISTICS

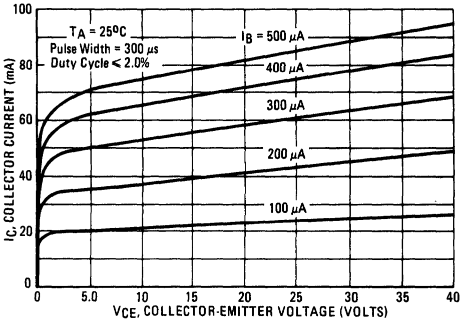


FIGURE 11 — "ON" VOLTAGES

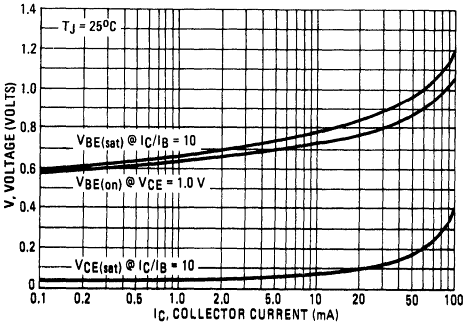
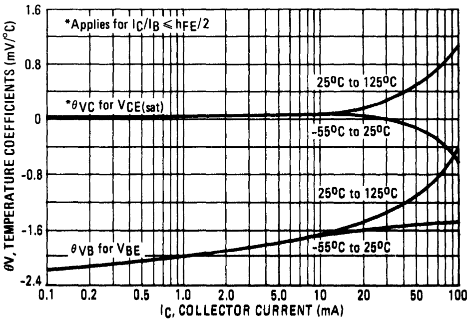


FIGURE 12 — TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 13 – TURN-ON TIME

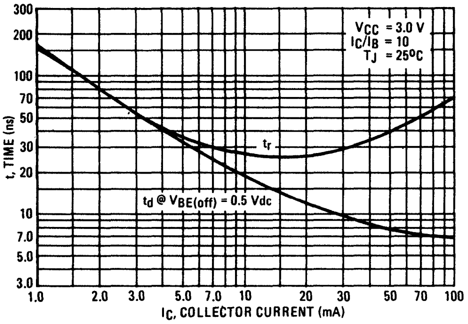


FIGURE 14 – TURN-OFF TIME

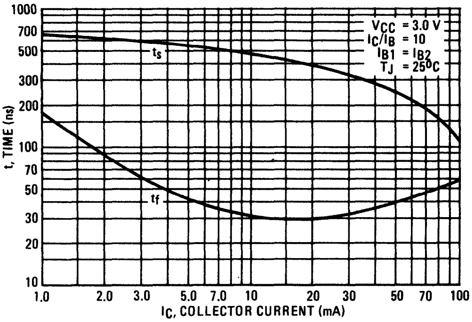


FIGURE 15 – CURRENT-GAIN – BANDWIDTH PRODUCT

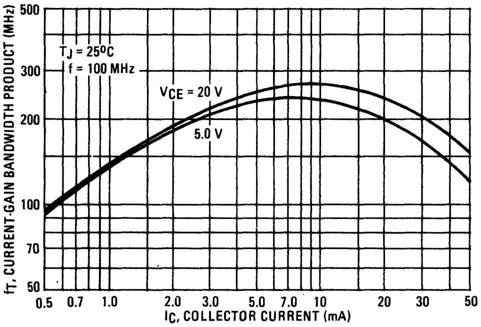


FIGURE 16 – CAPACITANCE

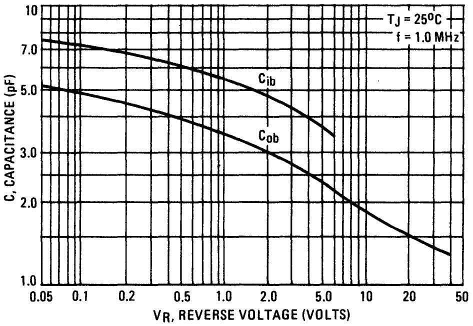


FIGURE 17 – INPUT IMPEDANCE

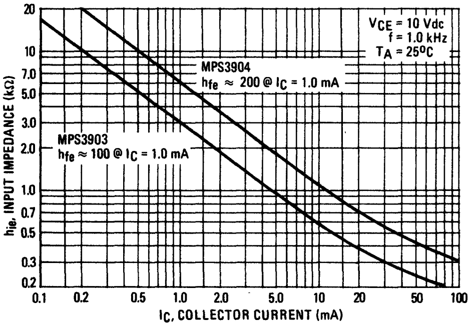


FIGURE 18 – OUTPUT ADMITTANCE

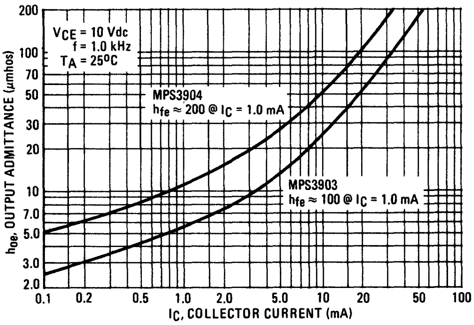


FIGURE 19 – THERMAL RESPONSE

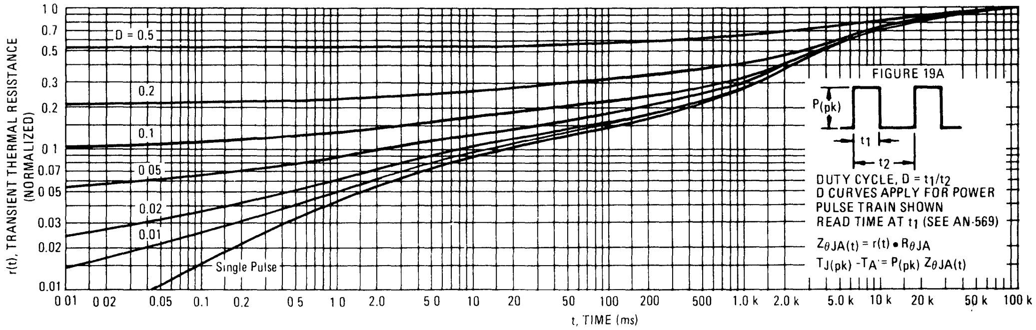


FIGURE 19A

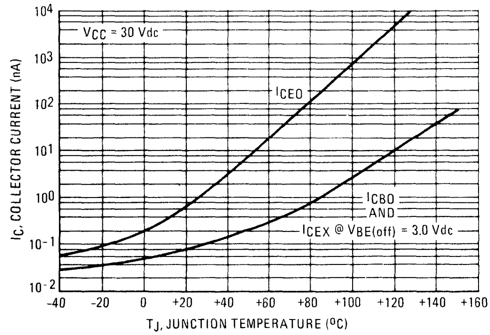
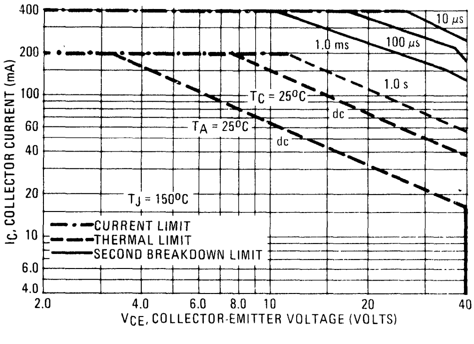


FIGURE 20



DESIGN NOTE: USE OF THERMAL RESPONSE DATA

A train of periodical power pulses can be represented by the model as shown in Figure 19A. Using the model and the device thermal response the normalized effective transient thermal resistance of Figure 19 was calculated for various duty cycles.

To find $Z_{\theta JA(t)}$, multiply the value obtained from Figure 19 by the steady state value $R_{\theta JA}$.

Example:

The MPS3903 is dissipating 2.0 watts peak under the following conditions:

$t_1 = 1.0$ ms, $t_2 = 5.0$ ms. $(D = 0.2)$

Using Figure 19 at a pulse width of 1.0 ms and D = 0.2, the reading of r(t) is 0.22.

The peak rise in junction temperature is therefore

$\Delta T = r(t) \times P_{(pk)} \times R_{\theta JA} = 0.22 \times 2.0 \times 200 = 88°C.$

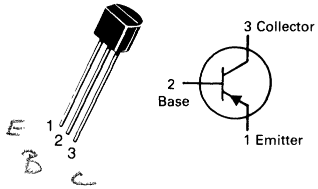
For more information, see AN-569.

The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 20 is based upon $T_{J(pk)} = 150°C$; T_C or T_A is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 150°C$. $T_{J(pk)}$ may be calculated from the data in Figure 19. At high case or ambient temperatures, thermal limitations will reduce the power than can be handled to values less than the limitations imposed by second breakdown.

MPS3906

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ $T_A = 60°C$	P_D	450	mW
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE(off)} = 3.0$ Vdc)	I_{CEX}	—	50	nAdc
Base Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE(off)} = 3.0$ Vdc)	I_{BL}	—	50	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 60 80 100 60 30	 — — 300 — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	 — —	 0.25 0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	 0.65 —	 0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ V, f = 100 MHz)	f_T	250	—	MHz

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

Characteristic	Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.5	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	2.0	12	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	1.0	10	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	100	400	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	3.0	60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)	NF	—	4.0	dB

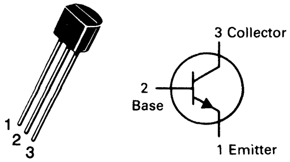
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	50	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	—	600	ns
Fall Time		t_f	—	90	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MPS4123
MPS4124

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS4123	MPS4124	Unit
Collector-Emitter Voltage	V_{CE}	30	25	Vdc
Collector-Base Voltage	V_{CB}	40	30	Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

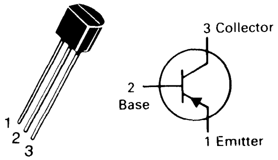
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	MPS4123 MPS4124	$V_{(BR)CEO}$	30 25	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	MPS4123 MPS4124	$V_{(BR)CBO}$	40 30	— —	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 10 μA)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 V, I_C = 0)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 2.0 mA, V_{CE} = 1.0 V)	MPS4123		50	150	
	MPS4124		120	360	
(I_C = 50 mA, V_{CE} = 1.0 V)	MPS4123		25	—	
	MPS4124		60	—	
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz)	MPS4123 MPS4124	f_T	100 170	— —	MHz
Output Capacitance (V_{CB} = 5.0 V, I_E = 0, f = 100 kHz)		C_{ob}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 100 kHz)	MPS4123 MPS4124	C_{ib}	— —	14 13.5	pF
Small-Signal Current Gain (I_C = 2.0 mA, V_{CE} = 1.0 V, f = 1.0 kHz)	MPS4123 MPS4124	h_{fe}	50 120	200 480	—
Noise Figure		NF			dB
(I_C = 100 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ,	MPS4123		—	6.0	
Noise Bandwidth = 10 Hz to 15.7 kHz)	MPS4124		—	5.0	

MPS4125
MPS4126

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS4125	MPS4126	Unit
Collector-Emitter Voltage	V_{CE}	30	25	Vdc
Collector-Base Voltage	V_{CB}	30	25	Vdc
Emitter-Base Voltage	V_{EB}	4.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

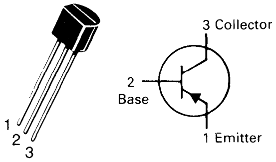
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mA, I_B = 0)	MPS4125 MPS4126	$V_{(BR)CEO}$	30 25	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	MPS4125 MPS4126	$V_{(BR)CBO}$	30 25	— —	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 10 μA)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 V, I_C = 0)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mA, V_{CE} = 1.0 V) (I_C = 50 mA, V_{CE} = 1.0 V)	 MPS4125 MPS4126 MPS4125 MPS4126	h_{FE}	 50 120 25 60	 150 360 — —	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz)	MPS4125 MPS4126	f_T	150 170	— —	MHz
Output Capacitance (V_{CB} = 5.0 V, I_E = 0, f = 100 kHz)		C_{ob}	—	4.5	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 100 kHz)	MPS4125 MPS4126	C_{ib}	— —	12 11.5	pF
Small-Signal Current Gain (I_C = 2.0 mA, V_{CE} = 1.0 V, f = 1.0 kHz)	MPS4125 MPS4126	h_{fe}	50 120	200 480	—
Noise Figure (I_C = 100 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ, Noise Bandwidth = 10 Hz to 15.7 kHz)	 MPS4125 MPS4126	NF	 — —	 5.0 4.0	dB

MPS4249
MPS4250

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS4250	MPS4249 MPS4250A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Emitter Voltage	V_{CES}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	40	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	5.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	1.5 12	mW mW/°C
Total Device Dissipation @ $T_C = 100°C$ Derate above 100°C	P_D			
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +125		°C
Junction Temperature	T_J	125		°C
Lead Temperature (10 seconds)	T_L	260		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$			Vdc
($I_C = 10\ \mu A$)	MPS4249		60	—	
($I_C = 5.0$ mA)	MPS4250		40	—	
Collector-Emitter Sustaining Voltage(1)		$V_{(BR)CEO(sus)}$			Vdc
($I_C = 5.0$)	MPS4250		40	—	
($I_C = 5.0$)	MPS4249		60	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 10\ \mu A$)	MPS4250		40	—	
($I_C = 10\ \mu A$)	MPS4249		60	—	
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu A$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			nA
($V_{CB} = 40$ V)	MPS4249		—	10	
($V_{CB} = 50$ V)	MPS4250		—	10	
($V_{CB} = 40$ V, $T_A = 65°C$)	MPS4249, MPS4250		—	3.0	
Emitter Cutoff Current ($V_{BE} = 3.0$ V)		I_{EBO}	—	20	nA
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 100\ \mu A$, $V_{CE} = 5.0$ V)	MPS4249		100	300	
($I_C = 1.0$ mA, $V_{CE} = 5.0$ V)	MPS4249		100	—	
($I_C = 1.0$ mA, $V_{CE} = 5.0$ V)	MPS4250		250	—	
($I_C = 10$ mA, $V_{CE} = 5.0$ V)	MPS4249		100	—	
($I_C = 10$ mA, $V_{CE} = 5.0$ V)	MPS4250		250	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mA, $I_B = 0.5$ mA)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mA, $I_B = 0.5$ mA)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance ($V_{CB} = 5.0$ V, f = 1.0 MHz)		C_{obo}	—	6.0	pF

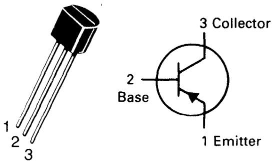
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Input Capacitance (V_{BE} = 0.5 V, f = 1.0 MHz)		C_{ibo}	—	16	pF
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	MPS4249		100	500	
(I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz)	MPS4250,A		250	800	
(I_C = 0.5 mA, V_{CE} = 5.0 V, f = 20 MHz)	MPS4249,50		2.0	—	
Noise Figure		NF			dB
(I_C = 20 μA, V_{CE} = 5.0 V, R_S = 10 kΩ, f = 1.0 kHz, P_{BW} = 150 Hz)	MPS4250,A		—	2.0	
(I_C = 20 μA, V_{CE} = 5.0 V, R_S = 10 kΩ, f = 1.0 kHz, P_{BW} = 150 Hz)	MPS4249		—	3.0	
(I_C = 250 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ, f = 1.0 kHz, P_{BW} = 150 Hz)	MPS4250,A		—	2.0	
(I_C = 250 μA, V_{CE} = 5.0 V, R_S = 1.0 kΩ, f = 1.0 kHz, P_{BW} = 150 Hz)	MPS4249		—	3.0	

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MPS4258

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current — Continuous	I_C	80	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 12	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

Refer to MPS3640 for graphs.

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

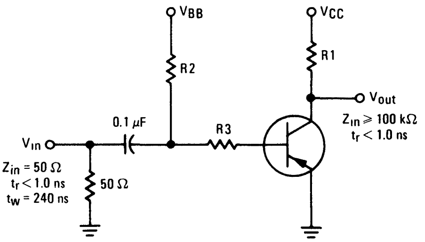
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	12	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 3.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.5	—	Vdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = +65°C)	I_{CES}	 — —	 0.01 5.0	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 0.5 Vdc) (I_C = 10 mAdc, V_{CE} = 3.0 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	 15 30 30	 — 120 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 — —	 0.15 0.5	Vdc
Base-Emitter On Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 0.75 —	 0.95 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	700	—	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	3.5	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	3.0	pF

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Turn-On Time	(V_{CC} = 1.5 Vdc, $V_{BE(off)}$ = 0, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	15	ns
Delay Time		t_d	—	10	ns
Rise Time		t_r	—	15	ns
Turn-Off Time	(V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_{off}	—	20	ns
Storage Time		t_s	—	20	ns
Fall Time		t_f	—	10	ns
Storage Time (I_C ≈ 10 mAdc, I_{B1} ≈ 10 mAdc, I_{B2} ≈ 10 mAdc)		t_s	—	20	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

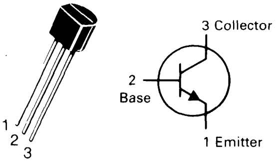
FIGURE 1 — SWITCHING TIME TEST CIRCUIT



	V_{in} Volts	V_{BB} Volts	V_{CC} Volts	R1 Ohms	R2 Ohms	R3 Ohms	I_C mA	I_{B1} mA	I_{B2} mA
t_{on}	-5.8	GND	-1.5	130	2.2 k	5 k	10	1.0	–
t_{off}	+9.8	-8.0	-1.5	130	2.2 k	5 k	10	1.0	1.0
t_s	+9.0	-10	-3.0	270	510	390	10	10	10

MPS5179

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH FREQUENCY TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

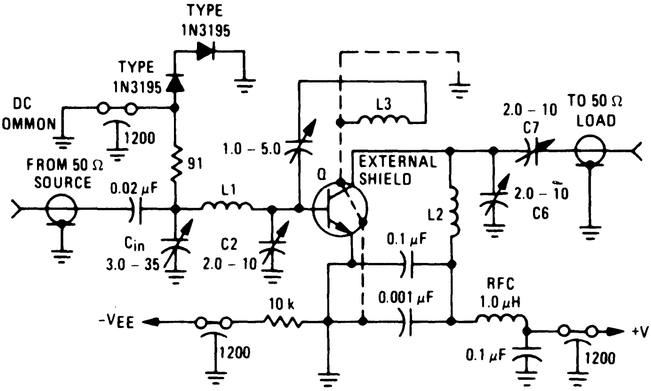
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

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

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

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

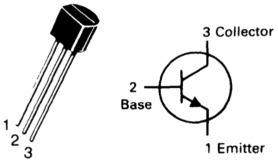
FIGURE 1 – 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



L1 1-3/4 Turns, #18 AWG, 0.5" L, 0.5" Diameter
L2 2 Turns, #16 AWG, 0.5" L, 0.5" Diameter
L3 2 Turns, #13 AWG, 0.25" L, 0.5" Diameter (Position 1/4" from L2)

MPS6507

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

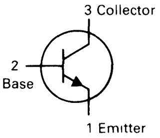
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

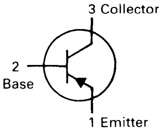
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$) ($V_{CB} = 15$ Vdc, $I_E = 0$, $T_A = 60°C$)	I_{CBO}	 — —	 — —	 50 1.0	 nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain(2) ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	25	75	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	700	800	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	1.25	2.5	pF
Small-Signal Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 10$ Vdc, f = 44 MHz)	h_{fe}	20	—	—	—

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

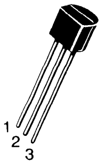
NPN
MPS6520
MPS6521



PNP
MPS6523



CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

Refer to MPS3903 for NPN graphs.*

MAXIMUM RATINGS

Rating	Symbol	NPN	PNP	Unit
Collector-Emitter Voltage MPS6520, MPS6521 MPS6523	V_{CEO}	 25 —	 — 25	Vdc
Collector-Base Voltage MPS6520, MPS6521 MPS6523	V_{CBO}	 40 —	 — 25	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

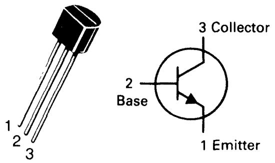
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 0.5 mAdc, I_B = 0) (I_C = 0.5 mAdc, I_B = 0)		$V_{(BR)CEO}$	 25 25	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0) (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	 4.0 4.0	 — —	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0)		I_{CBO}	 — —	 0.05 0.05	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 μAdc, V_{CE} = 10 Vdc)	 MPS6520 MPS6521	h_{FE}	 100 150	 — —	—
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6520 MPS6521		200 300	400 600	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MPS6523		150	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	MPS6523		300	400	
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	 — —	 0.5 0.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz) (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	 — —	 3.5 3.5	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, Power Bandwidth = 15.7 kHz, 3.0 dB points @ 10 Hz and 10 kHz) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, Power Bandwidth = 15.7 kHz, 3.0 dB points @ 10 Hz and 10 kHz)		NF	 — —	 3.0 3.0	dB

*Refer to 2N5086 for PNP graphs.

MPS6530
MPS6531

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N4400 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625	mW
Junction Temperature	T_J, T_{stg}	150	°C

THERMAL CHARACTERISTICS

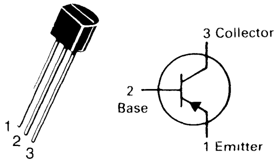
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.2	°C/mW

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_B = 10 μAdc, I_C = 0)			5.0	—	
(I_B = 10 μAdc, I_C = 0)			4.0	—	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 40 Vdc, I_E = 0)			—	0.05	
(V_{CB} = 40 Vdc, I_E = 0, T_A = 60°C)			—	2.0	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	MPS6530		30	—	
	MPS6531		60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	MPS6530		40	120	
	MPS6531		90	270	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MPS6530		25	—	
	MPS6531		50	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 100 mAdc, I_B = 10 mAdc)	MPS6530		—	0.5	
	MPS6531		—	0.3	
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance		C_{obo}			pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)			—	5.0	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)			—	7.0	

MPS6534

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625	mW
Junction Temperature	T_J, T_{stg}	150	°C

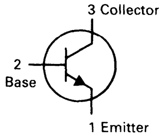
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.2	°C/mW

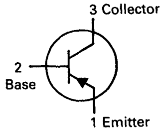
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$			Vdc
(I_B = 10 μAdc, I_C = 0)		5.0	—	
(I_B = 10 μAdc, I_C = 0)		4.0	—	
Collector Cutoff Current	I_{CBO}			μAdc
(V_{CB} = 30 Vdc, I_E = 0)		—	0.05	
(V_{CB} = 30 Vdc, I_E = 0, T_A = 60°C)		—	2.0	
(V_{CB} = 20 Vdc, I_E = 0, T_A = 60°C)		—	—	
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		60	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		90	270	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)		50	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance	C_{obo}			pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		—	5.0	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		—	7.0	

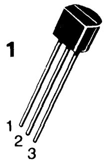
NPN
MPS6560



PNP
MPS6562



CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AUDIO TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/mW

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

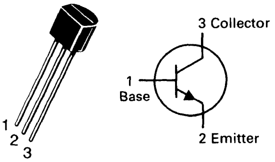
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 25$ Vdc, $I_B = 0$)	I_{CEO}	—	100	nAdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{EB(off)} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(2)				
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 35 50 50	 — — 200	—
Collector-Emitter Saturation Voltage ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)	$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 30 MHz)	f_T	60	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	30	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPS6568A
thru
MPS6570A

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case(1)	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	20	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)		$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_C = 0)		I_{CBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	20	200	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)		$V_{CE(sat)}$	0.1	3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)		$V_{BE(sat)}$	—	0.96	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS6568A		375	800	
	MPS6569A, MPS6570A		300	800	
Collector-Base Capacitance		C_{cb}	—	0.65	pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz, emitter guarded)	MPS6568A/6570A				
Noise Figure		NF			dB
(V_{AGC} = 1.4 Vdc, R_S = 50 ohms, f = 200 MHz)	MPS6568A		—	3.3	
(V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz)	MPS6569A, MPS6570A		—	6.0	
FUNCTIONAL TEST					
Amplifier Power Gain		G_{pe}			dB
(V_{AGC} = 1.4 Vdc, R_S = 50 ohms, f = 200 MHz)	MPS6568A		20	27	
(V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz)	MPS6569A, MPS6570A		22.5	28.5	
Forward AGC Voltage		V_{AGC}			Vdc
(Gain Reduction = 30 dB, R_S = 50 ohms, f = 200 MHz)	MPS6568A		4.0	5.0	
(Gain Reduction = 30 dB, R_S = 50 ohms, f = 45 MHz)	MPS6569A		4.4	5.4	
	MPS6570A		5.2	6.2	

AGC CHARACTERISTICS

V_{CC} = 12 Vdc, R_S = 50 OHMS, SEE FIGURES 9 AND 10

—— f = 45 MHz   – – – f = 200 MHz

FIGURE 1 — POWER GAIN

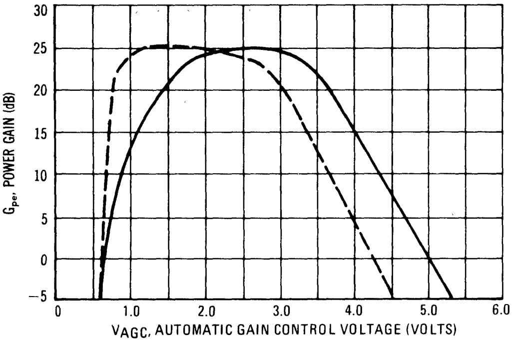


FIGURE 2 — NOISE FIGURE

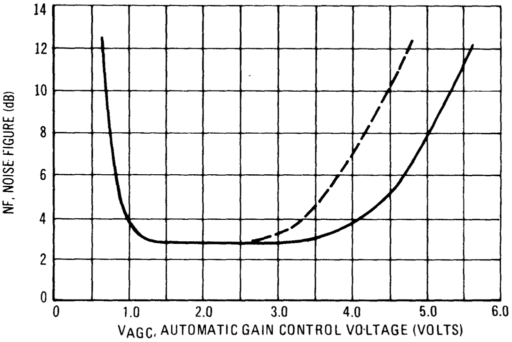
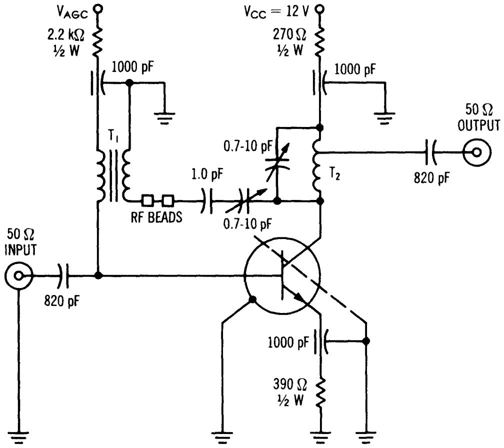
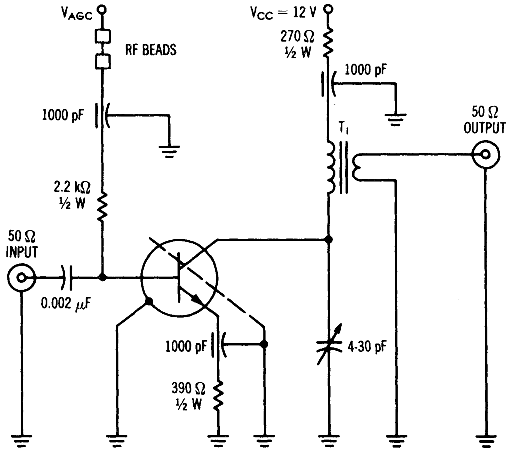


FIGURE 3 — 200 MHz FUNCTIONAL TEST CIRCUIT (NEUTRALIZED)



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

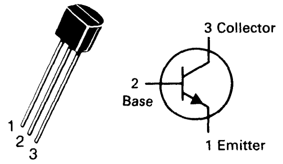
FIGURE 4 — 45 MHz FUNCTIONAL TEST CIRCUIT (UNNEUTRALIZED)



T_1 = TOROID 4:1 RATIO } #22 WIRE
8T-PRI 2T-SEC

MPS6571

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

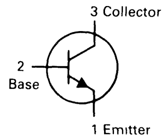
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

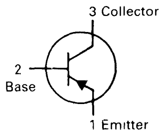
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{EB(off)}$ = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	h_{FE}	250	—	1000	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	—	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	50	175	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	—	4.5	pF
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 100 Hz)	NF	—	1.2	—	dB

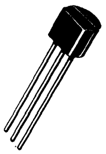
NPN
MPS6601
MPS6602



PNP
MPS6651
MPS6652



CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6601/6651 MPS6602/6652	V_{CEO}	 25 40	Vdc
Collector-Base Voltage MPS6601/6651 MPS6602/6652	V_{CBO}	 25 30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1000	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

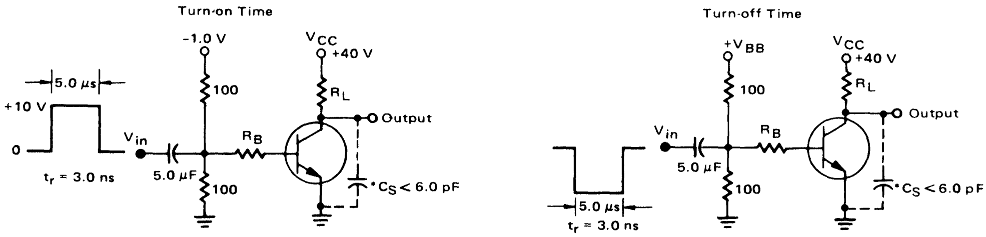
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPS6601/6651 MPS6602/6652	$V_{(BR)CEO}$	 25 40	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPS6601/6651 MPS6602/6652	$V_{(BR)CBO}$	 25 40	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 25$ Vdc, $I_B = 0$) ($V_{CE} = 30$ Vdc, $I_B = 0$)	 MPS6601/6651 MPS6602/6652	I_{CEO}	 — —	 0.1 0.1	μAdc
Collector Cutoff Current ($V_{CB} = 25$ Vdc, $I_E = 0$) ($V_{CB} = 30$ Vdc, $I_E = 0$)	 MPS6601/6651 MPS6602/6652	I_{CBO}	 — —	 0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 50 50 30	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 1000$ mAdc, $I_B = 100$ mAdc)		$V_{CE(sat)}$	—	0.6	Vdc
Base-Emitter On Voltage ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 30 MHz)		f_T	100	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)		C_{obo}	—	30	pF
SWITCHING CHARACTERISTICS					
Delay Time	($V_{CC} = 40$ Vdc, $I_C = 500$ mAdc, $I_{B1} = 50$ mAdc, $t_p \geqslant 300$ ns Duty Cycle)	t_d	—	25	ns
Rise Time		t_r	—	30	ns
Storage Time		t_s	—	250	ns
Fall Time		t_f	—	50	ns

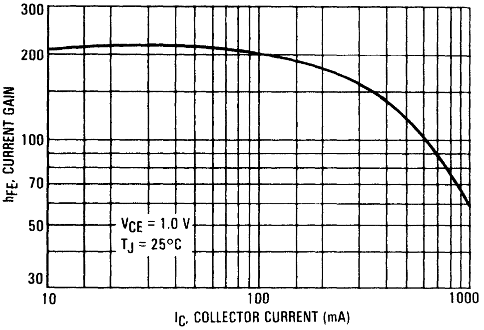
FIGURE 1 – SWITCHING TIME TEST CIRCUITS



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

NPN

FIGURE 2 — MPS6601/6602 DC CURRENT GAIN



PNP

FIGURE 3 — MPS6651/6652 DC CURRENT GAIN

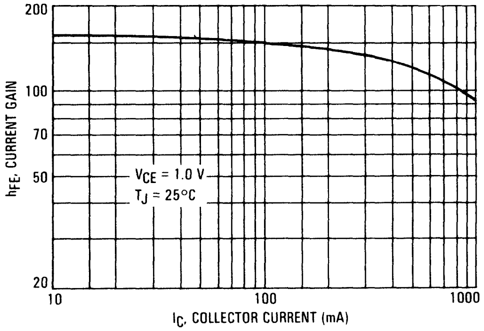


FIGURE 4 — CURRENT GAIN BANDWIDTH PRODUCT

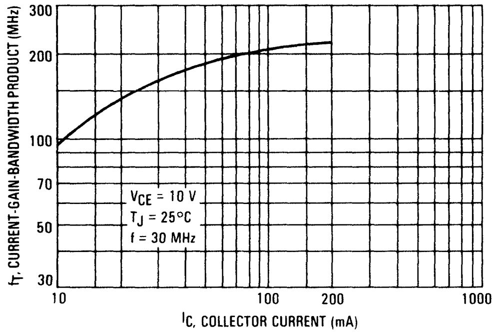


FIGURE 5 — CURRENT GAIN BANDWIDTH PRODUCT

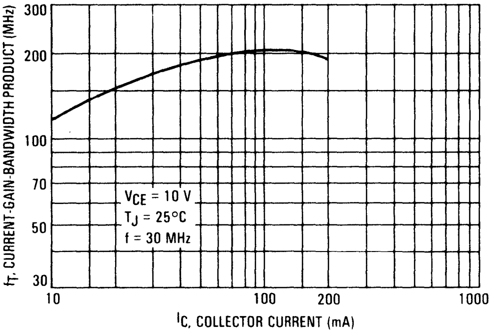


FIGURE 6 — ON VOLTAGES

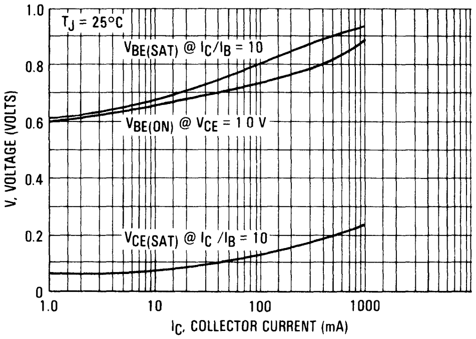
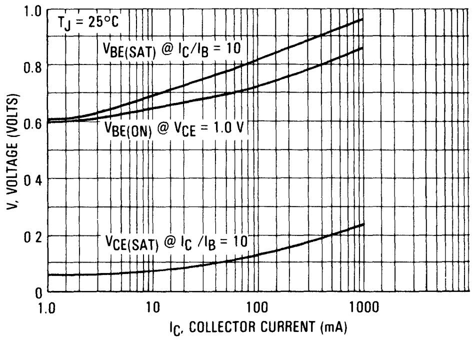
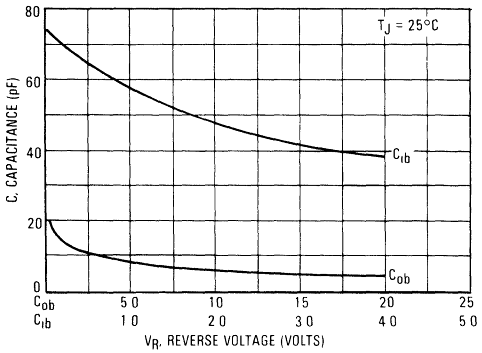


FIGURE 7 — ON VOLTAGES



NPN

FIGURE 8 — CAPACITANCE



PNP

FIGURE 9 — CAPACITANCE

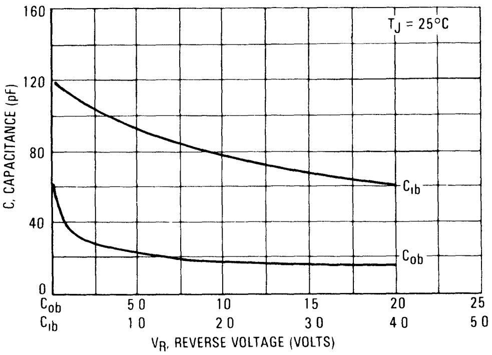


FIGURE 10 — MPS6601/6602 NOISE FIGURE

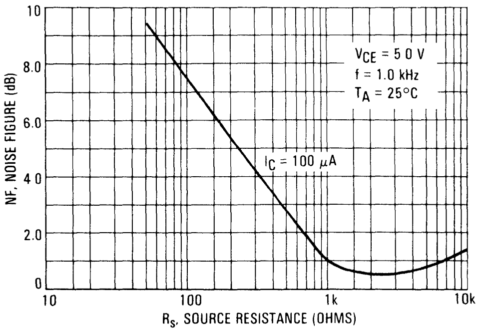
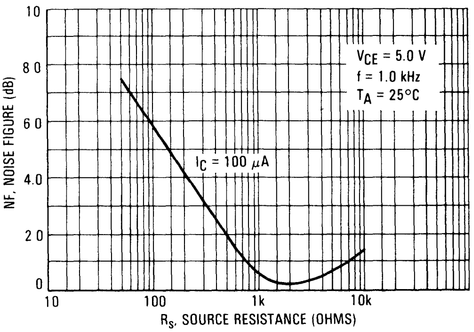


FIGURE 11 — MPS6651/6652 NOISE FIGURE



NPN MPS6601, MPS6602, PNP MPS6651, MPS6652

FIGURE 12 — MPS6601/6602 SWITCHING TIMES

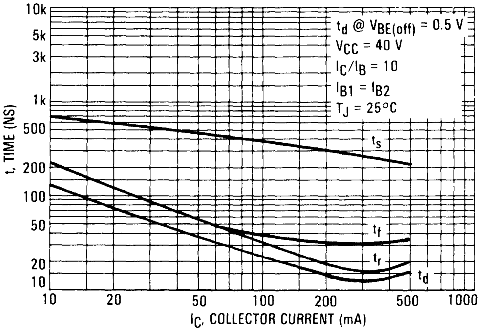
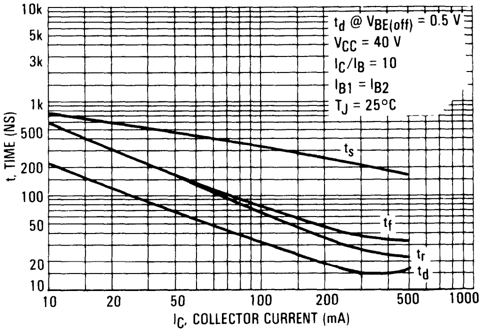
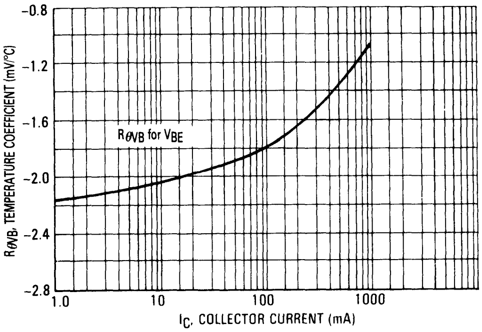


FIGURE 13 — MPS6651/6652 SWITCHING TIMES



NPN

FIGURE 14 — BASE-EMITTER TEMPERATURE COEFFICIENT



PNP

FIGURE 15 — BASE-EMITTER TEMPERATURE COEFFICIENT

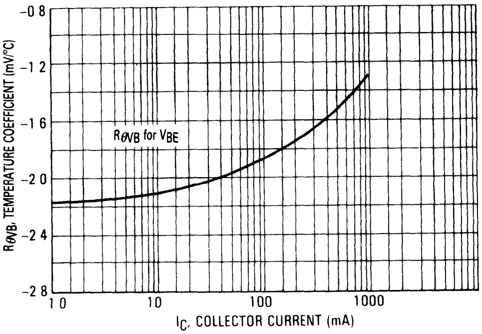


FIGURE 16 — SAFE OPERATING AREA

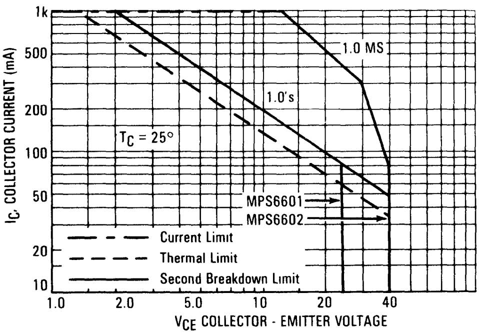


FIGURE 17 — SAFE OPERATING AREA

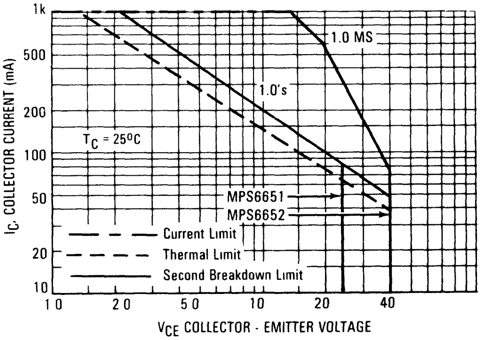


FIGURE 18 — MPS6601/6602 SATURATION REGION

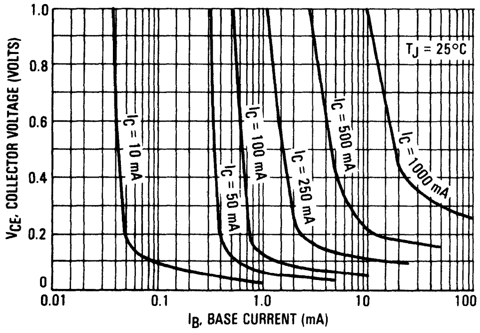


FIGURE 19 — MPS6651/6652 SATURATION REGION

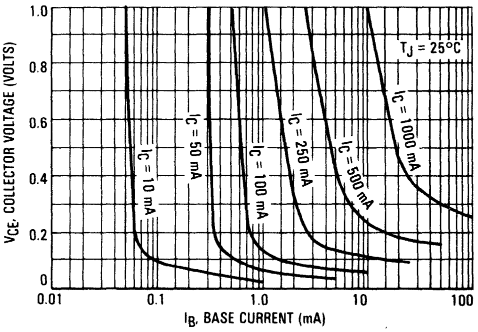
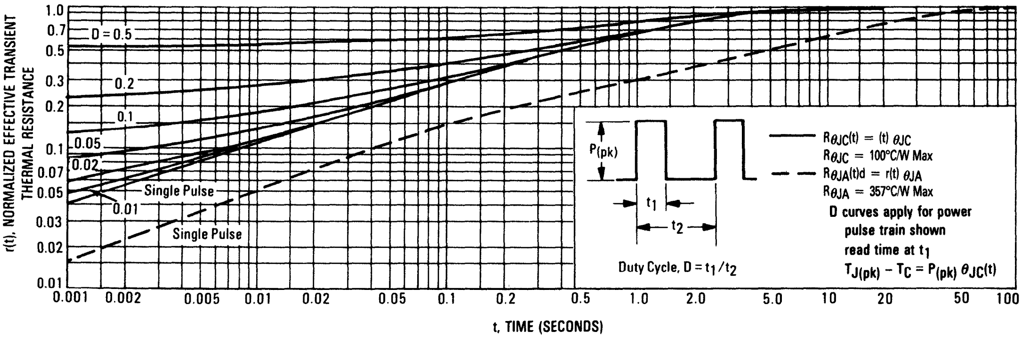
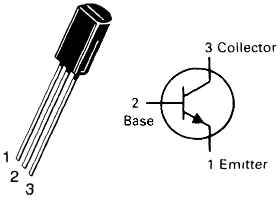


FIGURE 20 — THERMAL RESPONSE



MPS6714
MPS6715

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSW01 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6714 MPS6715	V_{CEO}	 30 40	Vdc
Collector-Base Voltage MPS6714 MPS6715	V_{CBO}	 40 50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

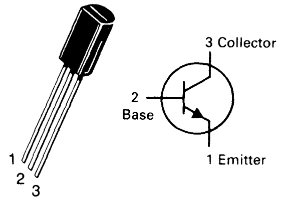
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	 MPS6714 MPS6715	$V_{(BR)CEO}$	 30 40	 —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPS6714 MPS6715	$V_{(BR)CBO}$	 40 50	 —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$) ($V_{CB} = 50$ Vdc, $I_E = 0$)	 MPS6714 MPS6715	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 60 50	 — 250	—
Collector-Emitter Saturation Voltage ($I_C = 1000$ mAdc, $I_B = 100$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	30	pF
Small-Signal Current Gain ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)		h_{fe}	2.5	25	—

(1) Pulse Test: Pulse Width ≤ 30 μs, Duty Cycle ≤ 2.0%.

MPS6716
MPS6717

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MPSW05 for graphs.

2

MAXIMUM RATINGS

Rating	Symbol	MPS6516	MPS6517	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

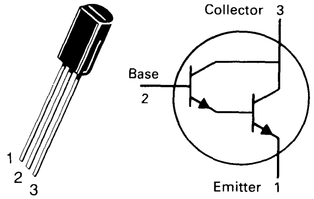
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $_B = 0$)	 MPS6716 MPS6717	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPS6716 MPS6717	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$)	 MPS6716 MPS6717	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	—	10	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 250$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 80 50	 — 250	—
Collector-Emitter Saturation Voltage ($I_C = 250$ mAdc, $I_B = 10$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 250$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	30	pF
Small-Signal Current Gain ($I_C = 200$ mAdc, $V_{CE} = 5.0$ Vdc, f = 20 MHz)		h_{fe}	2.5	25	—

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

MPS6724
MPS6725

CASE 29-03, STYLE 1
(TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPS6724	MPS6725	Unit
Collector-Emitter Voltage	V_{CES}	40	50	Vdc
Collector-Base Voltage	V_{CBO}	50	60	Vdc
Emitter-Base Voltage	V_{EBO}	12		Vdc
Collector Current — Continuous	I_C	1000		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

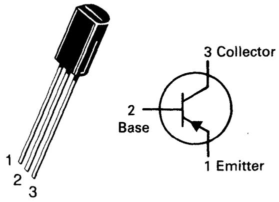
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	 MPS6724 MPS6725	$V_{(BR)CES}$	 40 50	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	 MPS6724 MPS6725	$V_{(BR)CBO}$	 50 60	 — —	 Vdc Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 40 Vdc, I_E = 0)	 MPS6724 MPS6725	I_{CBO}	 — —	 100 100	nAdc
Emitter Cutoff Current (V_{EB} = 10 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc) (I_C = 1000 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	 25,000 4,000	 — 40,000	—
Collector-Emitter Saturation Voltage (I_C = 1000 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 1000 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 200 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	100	1000	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	10	pF

MPS6726
MPS6727

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MPSW51 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPS6726 MPS6727	V_{CEO}	 30 40	Vdc
Collector-Base Voltage MPS6726 MPS6727	V_{CBO}	 40 50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

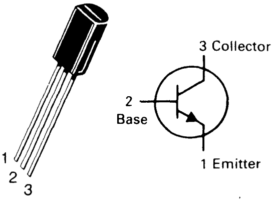
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	 MPS6726 MPS6727	$V_{(BR)CEO}$	 30 40	 —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPS6726 MPS6727	$V_{(BR)CBO}$	 40 50	 —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0)	 MPS6726 MPS6727	I_{CBO}	 —	 0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1000 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	 60 50	 — 250	—
Collector-Emitter Saturation Voltage (I_C = 1000 mAdc, I_B = 100 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 1000 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	30	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		h_{fe}	2.5	25	—

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

MPS6733
thru
MPS6735

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSW42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPS6735	MPS6734	MPS6733	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	200	Vdc
Collector-Base Voltage	V_{CBO}	300	250	200	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current — Continuous	I_C	300			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

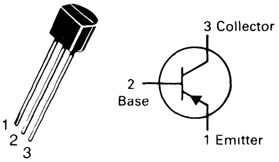
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	MPS6735	$V_{(BR)CEO}$	300	—	Vdc
	MPS6734		250	—	
	MPS6733		200	—	
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	MPS6735	$V_{(BR)CBO}$	300	—	Vdc
	MPS6734		250	—	
	MPS6733		200	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 260 Vdc, I_E = 0)	MPS6735	I_{CBO}	—	0.1	μAdc
(V_{CB} = 200 Vdc, I_E = 0)	MPS6734		—	0.1	
(V_{CB} = 160 Vdc, I_E = 0)	MPS6733		—	0.1	
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25	—	—
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			40	200	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	2.0	Vdc
Base-Emitter On Voltage (I_C = 20 mAdc, V_{CE} = 10 Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		f_T	50	200	MHz
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	3.0	pF

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

MPS8093

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4402 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 60°C$	P_D	450	mW
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

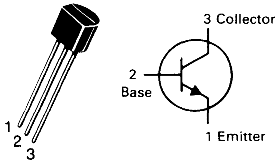
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mAdc)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ V)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ V)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 50$ mAdc, $V_{CE} = 2.0$ Vdc)	h_{FE}	100	300	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage ($I_C = 50$ mAdc, $V_{CE} = 2.0$ V)	$V_{BE(on)}$	0.6	1.0	Vdc

MPS8097

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPSA18 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

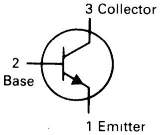
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

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

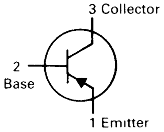
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$)	I_{CBO}	 — —	 30 10	 nAdc μAdc
Emitter Cutoff Current ($V_{BE} = 6.0$ Vdc, $I_C = 0$)	I_{EBO}	—	20	nAdc
ON CHARACTERISTICS(2)				
DC Current Gain ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	250	700	—
Base-Emitter On Voltage ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc)	$V_{BE(on)}$	0.45	0.65	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	1.0	4.0	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{eb}	—	10	pF
Small-Signal Current Gain ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{fe}	250	800	—
Noise Figure ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S =$ kΩ, f = 10 Hz to 15.7 kHz)	NF	—	2.0	dB
Equivalent Short Circuit Noise Voltage ($I_C = 100$ μAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ kΩ, f = 100 Hz, Bw = 1.0 Hz)	e_n	—	32	nV/√Hz

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

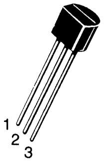
NPN
MPS8099



PNP
MPS8598
MPS8599



CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	MPS8598	MPS8099 MPS8599	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
		MPS8099	MPS8598 MPS8599	
Emitter-Base Voltage	V_{EBO}	6.0	5.0	Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

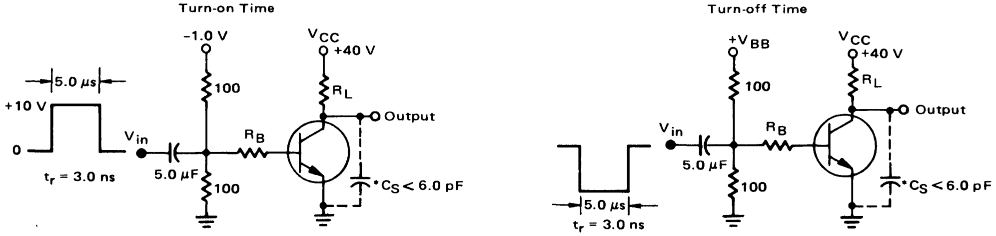
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	 MPS8598 MPS8099, MPS8599	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 MPS8598 MPS8099, MPS8599	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	 MPS8099 MPS8598, MPS8599	$V_{(BR)EBO}$	 6.0 5.0	 — —	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CEO}	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0)	 MPS8598 MPS8099, MPS8599	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0) (V_{EB} = 4.0 Vdc, I_C = 0)	 MPS8099 MPS8598, MPS8599	I_{EBO}	 — —	 0.1 0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	100 100 75	300 — —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 5.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	— —	0.4 0.3	Vdc
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	 MPS8598 MPS8099, MPS8599	$V_{BE(on)}$	 0.5 0.6	 0.7 0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)		f_T	150	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	 MPS8099 MPS8598, MPS8599	C_{obo}	 — —	 6.0 8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	 MPS8099 MPS8598, MPS8599	C_{ibo}	 — —	 25 30	pF

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

FIGURE 1 – SWITCHING TIME TEST CIRCUITS



*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

FIGURE 2 – CURRENT-GAIN – BANDWIDTH PRODUCT

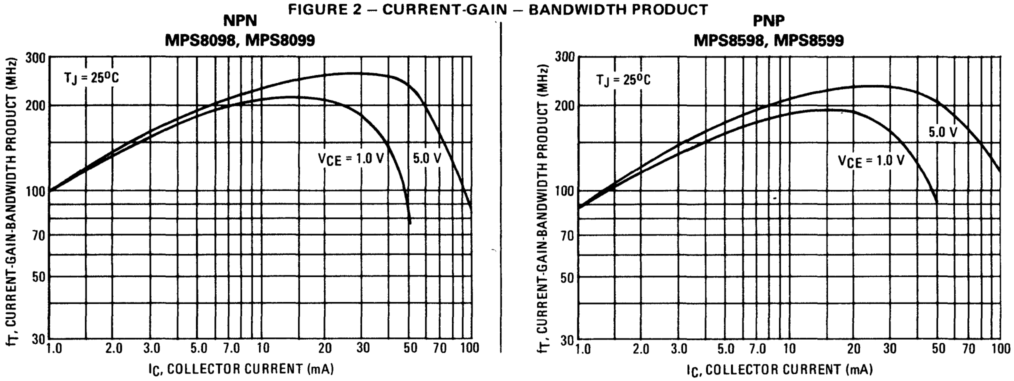


FIGURE 3 – CAPACITANCE

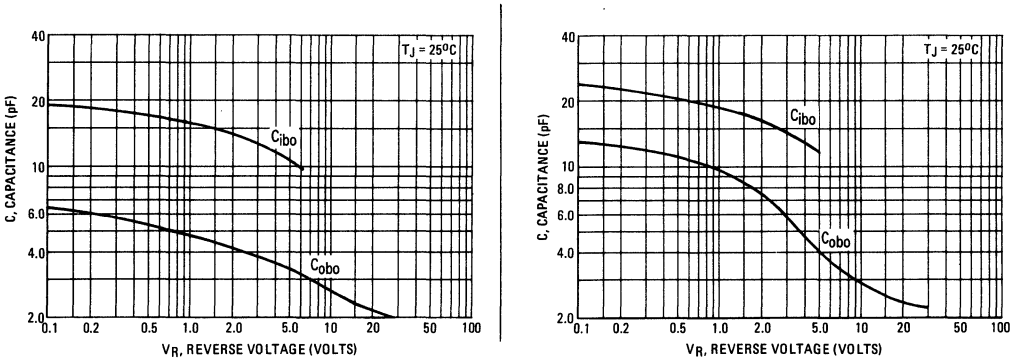


FIGURE 4 – SWITCHING TIMES

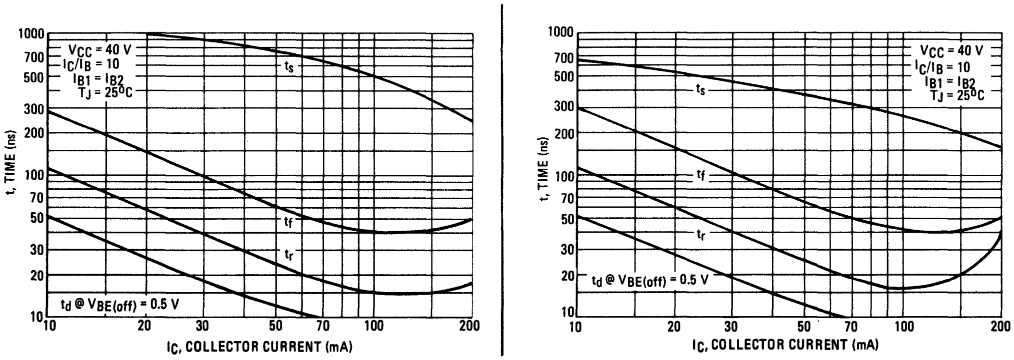


FIGURE 5 — THERMAL RESPONSE

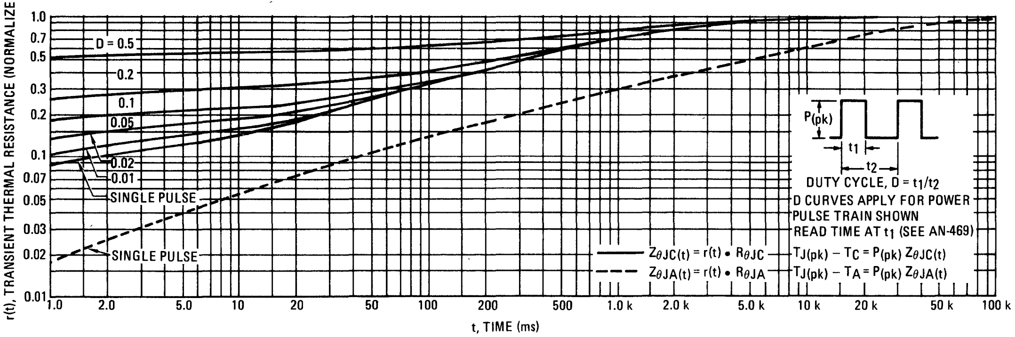


FIGURE 6 — ACTIVE REGION, SAFE OPERATING AREA
MPS8099

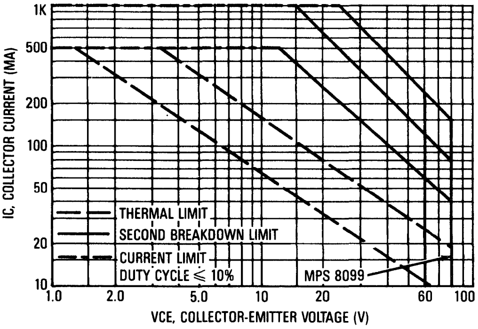
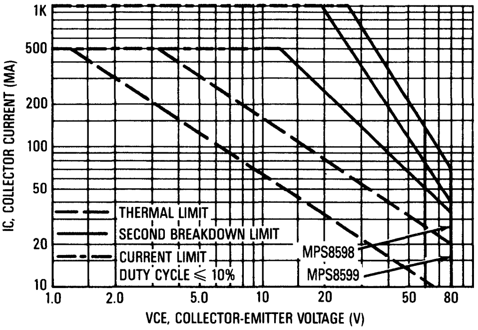


FIGURE 6 — ACTIVE REGION, SAFE OPERATING AREA
MPS8598, MPS8599



MPS8099

FIGURE 7 — DC CURRENT GAIN

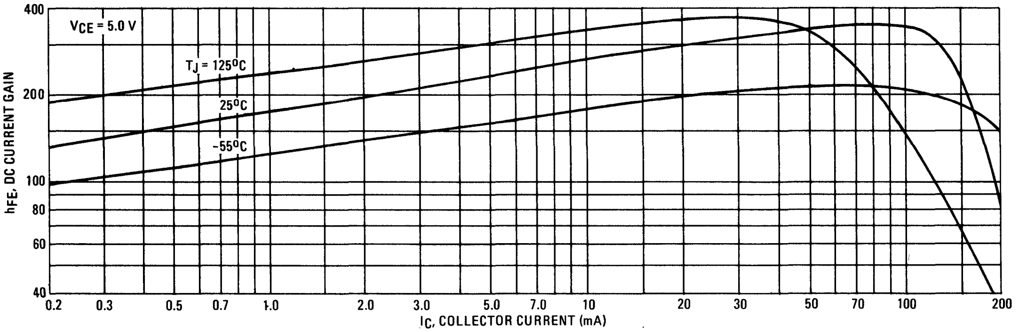


FIGURE 8 – "ON" VOLTAGES

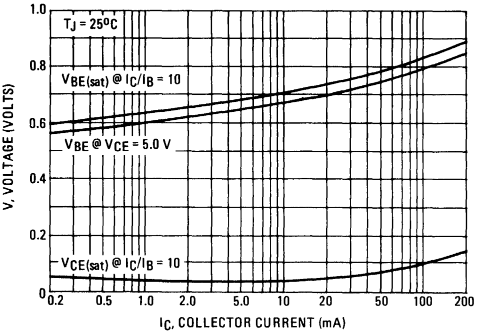


FIGURE 9 – COLLECTOR SATURATION REGION

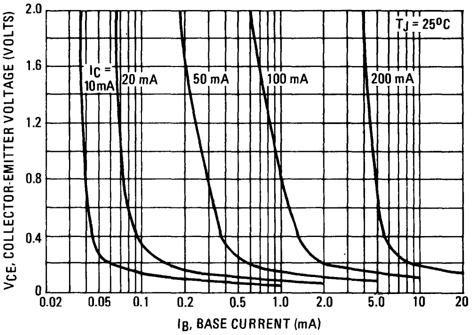
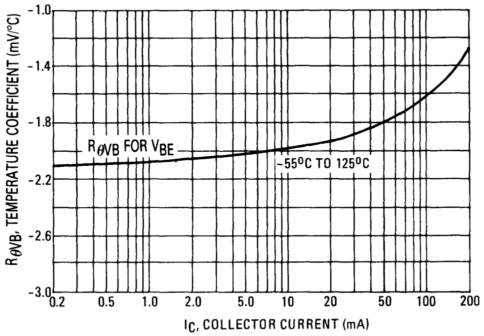


FIGURE 10 – BASE-EMITTER TEMPERATURE COEFFICIENT



MPS8598, MPS8599

FIGURE 11 – DC CURRENT GAIN

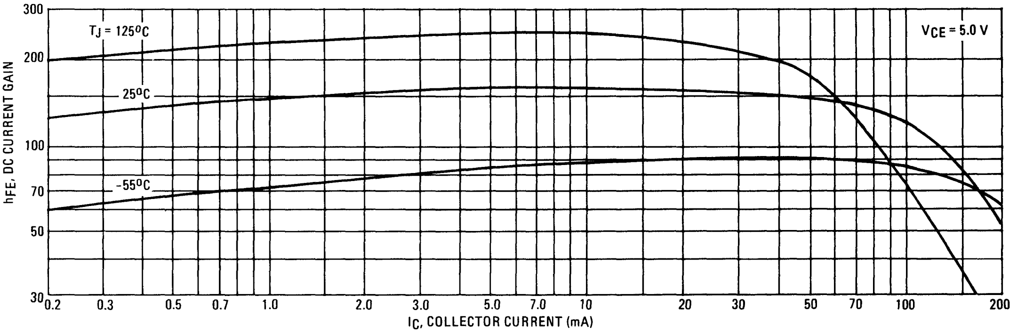


FIGURE 12 – "ON" VOLTAGES

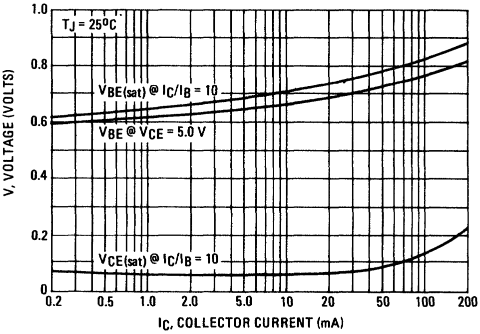


FIGURE 13 – COLLECTOR SATURATION REGION

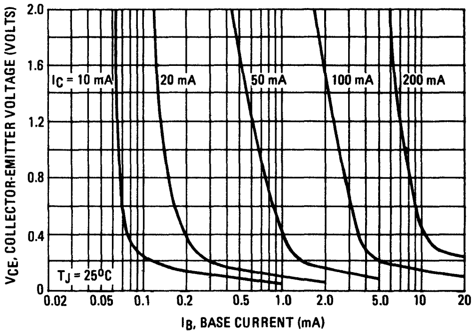
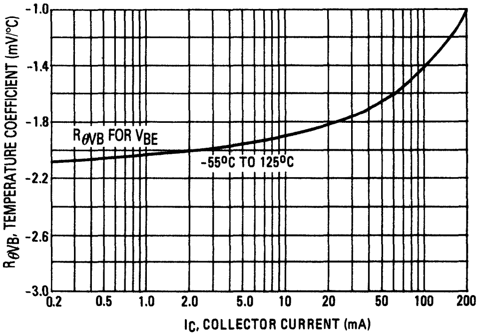
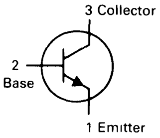


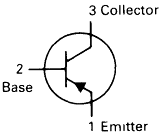
FIGURE 14 – BASE-EMITTER TEMPERATURE COEFFICIENT



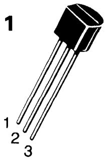
NPN
MPSA05
MPSA06



PNP
MPSA55
MPSA56



CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	MPSA05 MPSA55	MPSA06 MPSA56	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

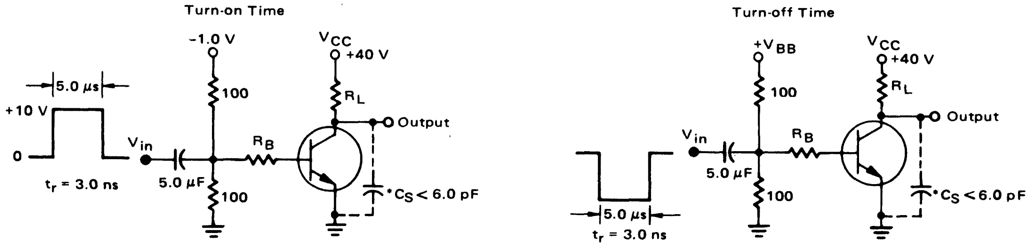
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPSA05, MPSA55		60	—	
	MPSA06, MPSA56		80	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, I_B = 0)		I_{CEO}	—	0.1	μAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 60 Vdc, I_E = 0)	MPSA05, MPSA55		—	0.1	
(V_{CB} = 80 Vdc, I_E = 0)	MPSA06, MPSA56		—	0.1	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			100	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			100	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2)		f_T			MHz
(I_C = 10 mA, V_{CE} = 2.0 V, f = 100 MHz)	MPSA05 MPSA06		100	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	MPSA55 MPSA56		50	—	

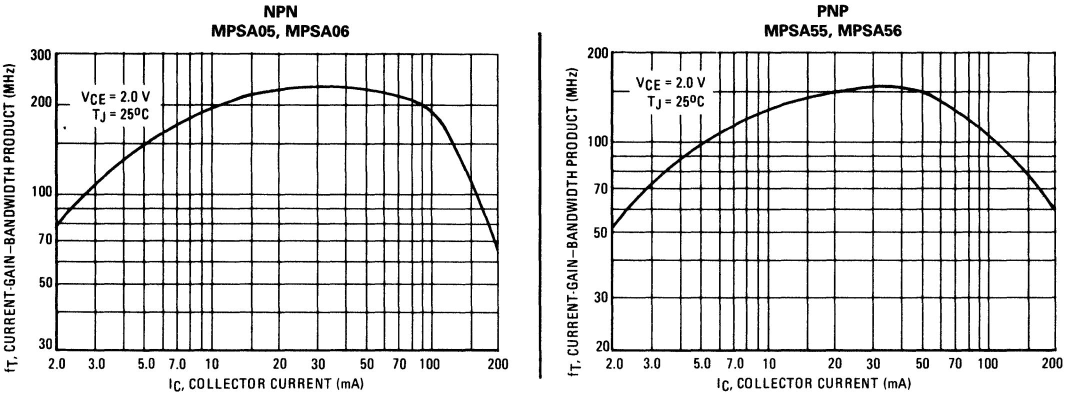
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 – SWITCHING TIME TEST CIRCUITS



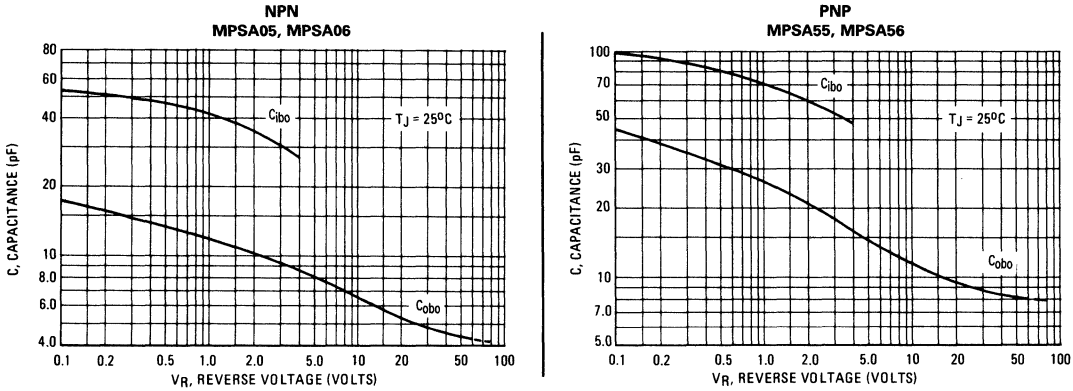
*Total Shunt Capacitance of Test Jig and Connectors
For PNP Test Circuits, Reverse All Voltage Polarities

FIGURE 2 — CURRENT-GAIN — BANDWIDTH PRODUCT


NPN
MPSA05, MPSA06

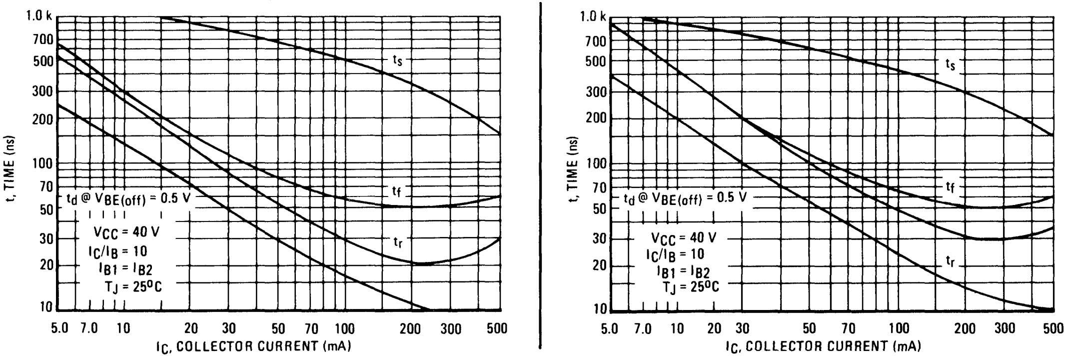
PNP
MPSA55, MPSA56

FIGURE 3 — CAPACITANCE


NPN
MPSA05, MPSA06

PNP
MPSA55, MPSA56

FIGURE 4 — SWITCHING TIME


NPN
MPSA05, MPSA06

PNP
MPSA55, MPSA56

FIGURE 5 — THERMAL RESPONSE
MPSA05, MPSA06, MPSA55, MPSA56

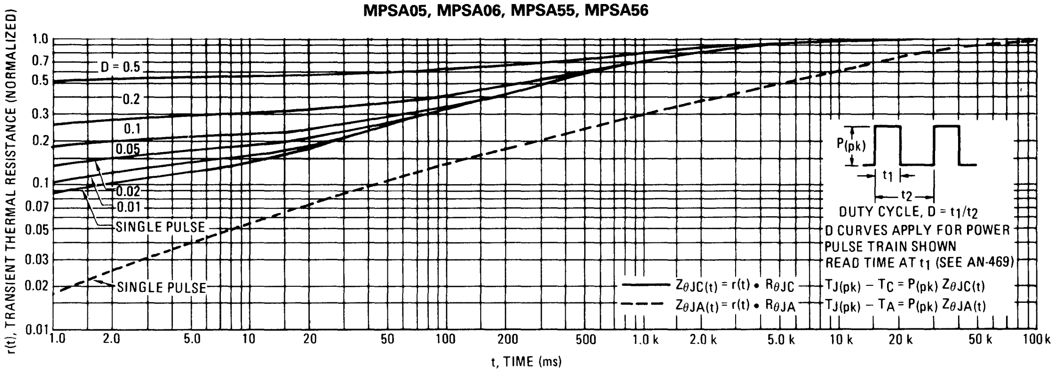
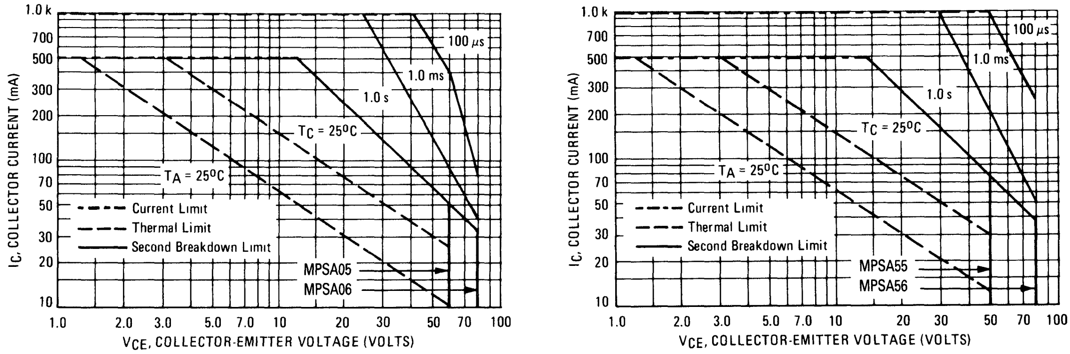


FIGURE 6 — ACTIVE — REGION SAFE OPERATING AREA


NPN
MPSA05, MPSA06

PNP
MPSA55, MPSA56

NPN
MPSA05, MPSA06

FIGURE 7 – DC CURRENT GAIN

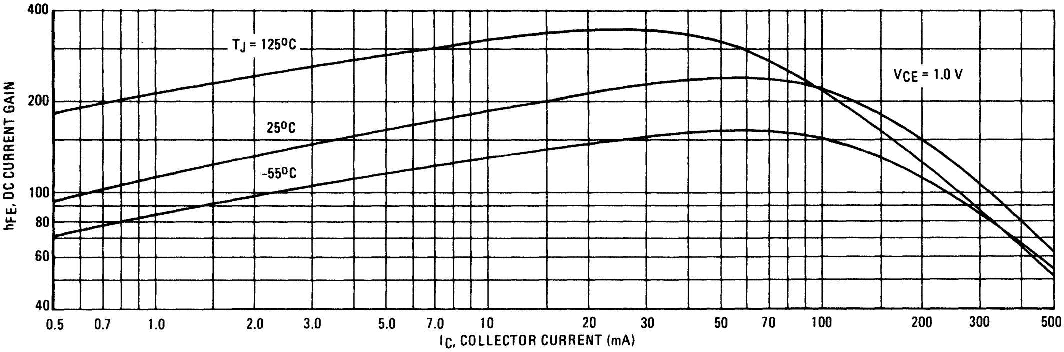


FIGURE 8 – "ON" VOLTAGES

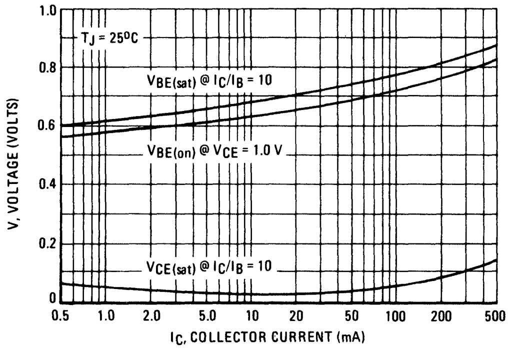


FIGURE 9 – COLLECTOR SATURATION REGION

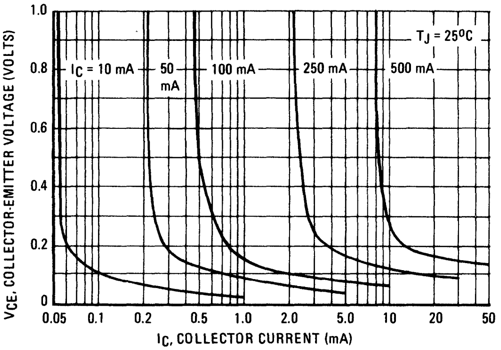
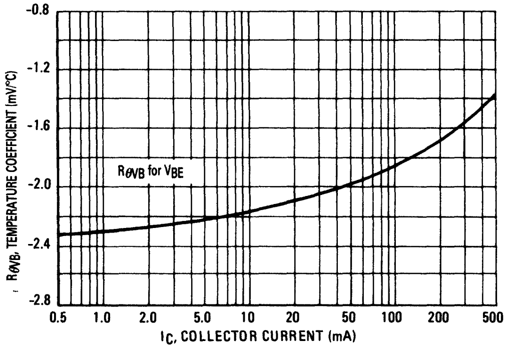


FIGURE 10 – BASE-EMITTER TEMPERATURE COEFFICIENT



PNP
MPSA55, MPSA56

FIGURE 11 — DC CURRENT GAIN

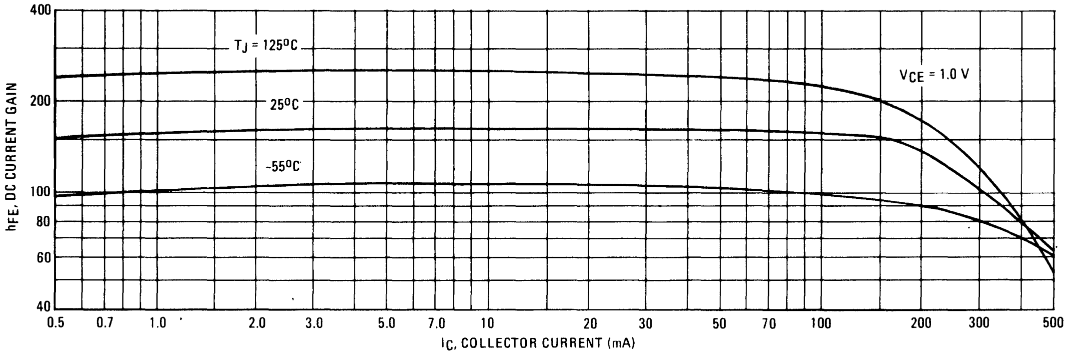


FIGURE 12 — "ON" VOLTAGES

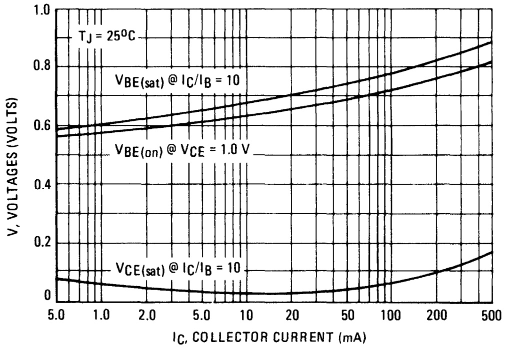


FIGURE 13 — COLLECTOR SATURATION REGION

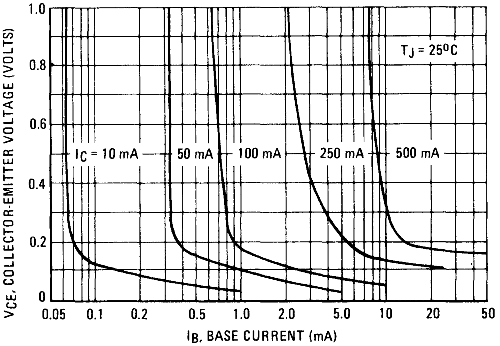
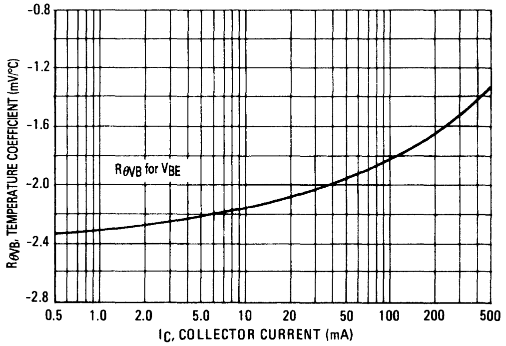
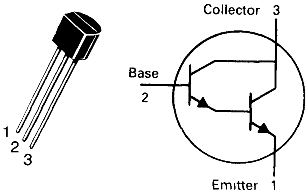


FIGURE 14 — BASE-EMITTER TEMPERATURE COEFFICIENT



MPSA13
MPSA14

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	− 55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

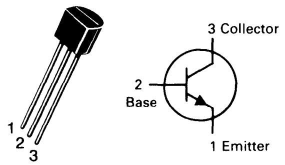
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_B = 0$)		$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 10$ Vdc, $I_C = 0$)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSA13		5000	—	
	MPSA14		10,000	—	
($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSA13		10,000	—	
	MPSA14		20,000	—	
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 0.1$ mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)		V_{BE}	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	125	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

MPSA16
MPSA17

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS-A16	MPS-A17	Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	12	15	Vdc
Collector Current — Continuous	I_C	100		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	MPS-A16 MPS-A17	$V_{(BR)EBO}$	12 15	— —	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)		h_{FE}	200	600	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	MPS-A16 MPS-A17	f_T	100 80	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	pF

FIGURE 1 – DC CURRENT GAIN

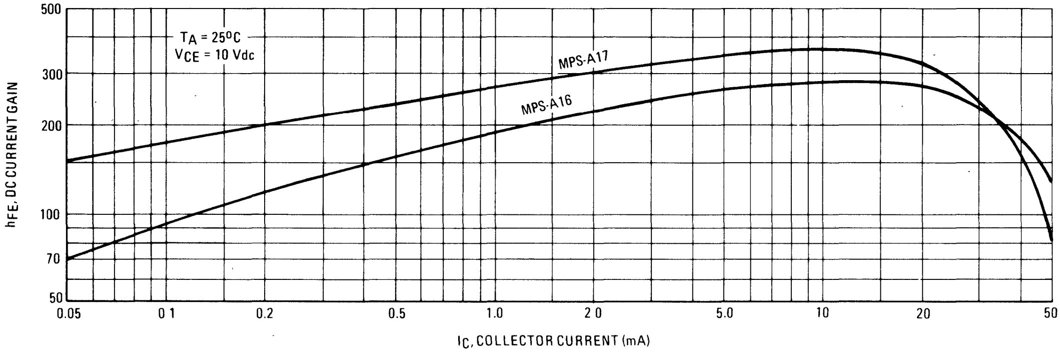


FIGURE 2 – SMALL SIGNAL CURRENT GAIN

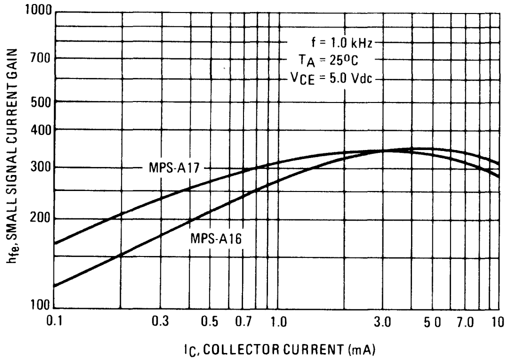


FIGURE 3 – SATURATION AND ON VOLTAGES

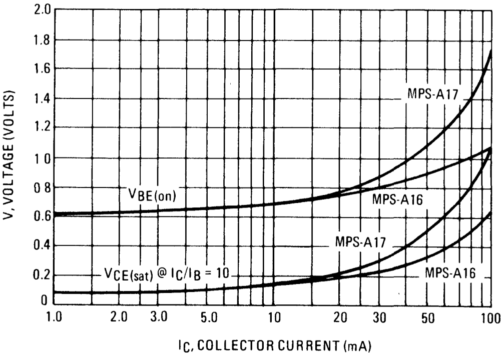


FIGURE 4 – CURRENT-GAIN–BANDWIDTH PRODUCT

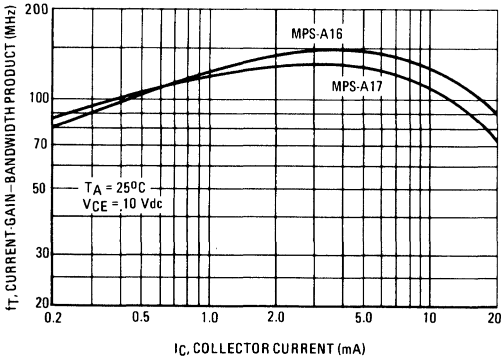
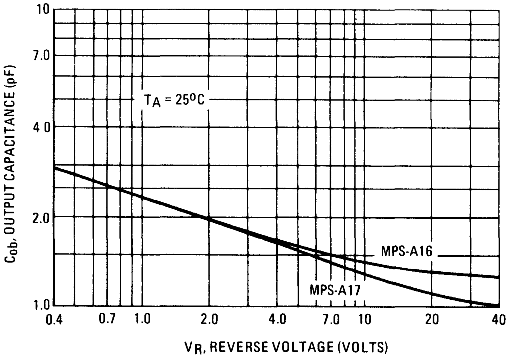
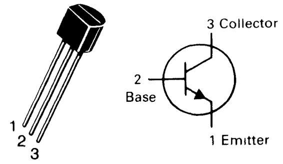


FIGURE 5 – OUTPUT CAPACITANCE



MPSA18

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



LOW NOISE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	6.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

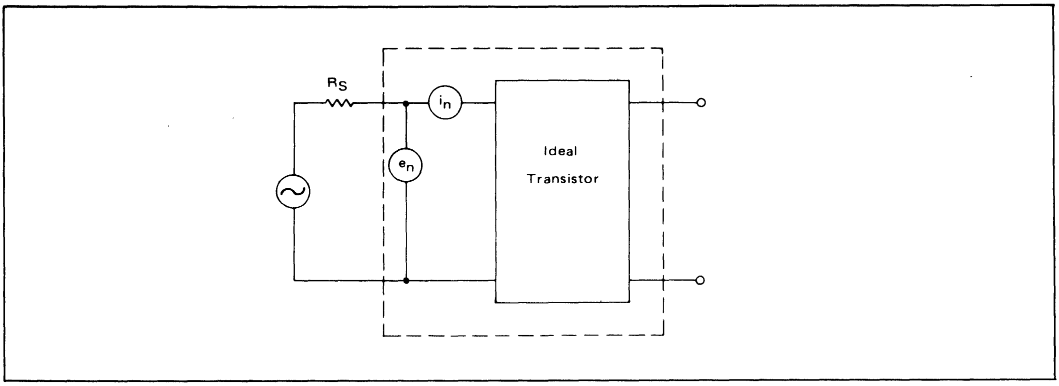
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ µAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	1.0	50	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}				—
($I_C = 10$ µAdc, $V_{CE} = 5.0$ Vdc)		400	580	—	
($I_C = 100$ µAdc, $V_{CE} = 5.0$ Vdc)		500	850	—	
($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)		500	1100	—	
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)		500	1150	1500	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)		—	—	0.2	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		—	0.08	0.3	
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	$V_{BE(on)}$	—	0.6	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)	f_T	100	160	—	MHz
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	1.7	3.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{eb}	—	5.6	6.5	pF
Noise Figure	NF				dB
($I_C = 100$ µAdc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ kΩ, f = 10 Hz to 15.7 kHz)		—	0.5	1.5	
($I_C = 100$ µAdc, $V_{CE} = 5.0$ Vdc, $R_S = 1.0$ kΩ, f = 100 Hz)		—	4.0	—	
Equivalent Short Circuit Noise Voltage ($I_C = 100$ µAdc, $V_{CE} = 5.0$ Vdc, $R_S = 1.0$ kΩ, f = 100 Hz)	V_T	—	6.5	—	nV/√Hz

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

FIGURE 1 – TRANSISTOR NOISE MODEL



NOISE CHARACTERISTICS

(V_{CE} = 5.0 Vdc, T_A = 25°C)

NOISE VOLTAGE

FIGURE 2 – EFFECTS OF FREQUENCY

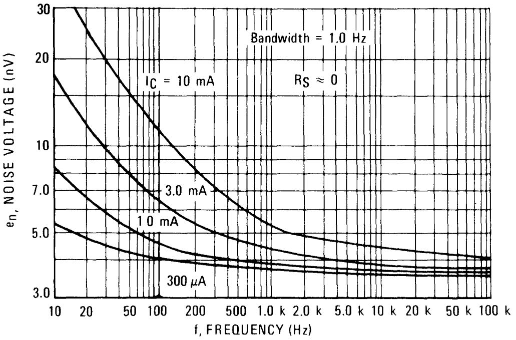


FIGURE 3 – EFFECTS OF COLLECTOR CURRENT

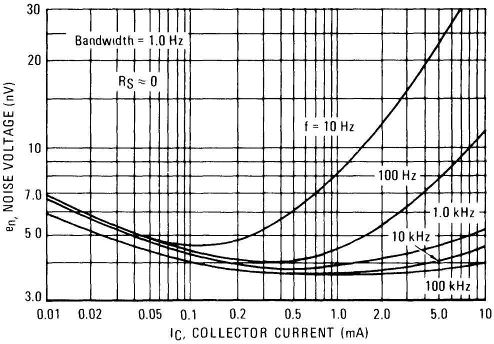


FIGURE 4 – NOISE CURRENT

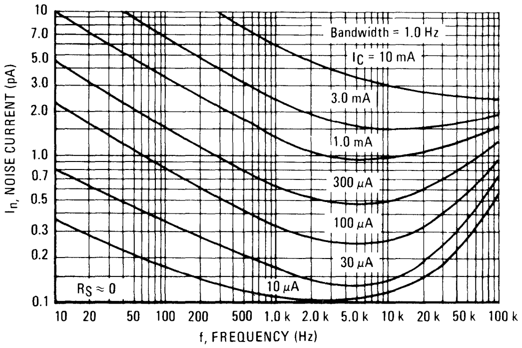
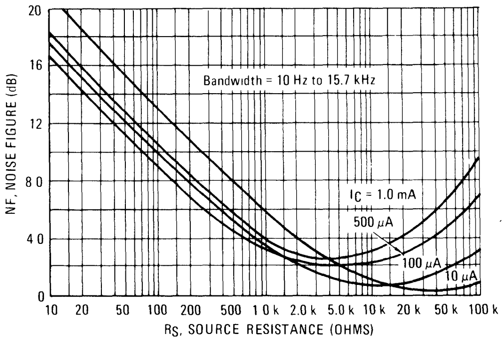


FIGURE 5 – WIDEBAND NOISE FIGURE



100 Hz NOISE DATA

FIGURE 6 – TOTAL NOISE VOLTAGE

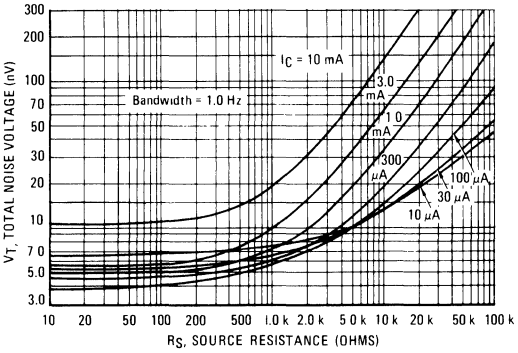


FIGURE 7 – NOISE FIGURE

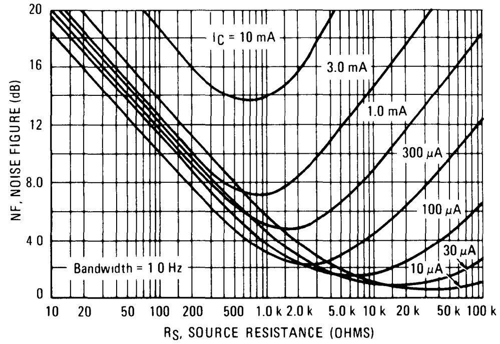


FIGURE 8 — DC CURRENT GAIN

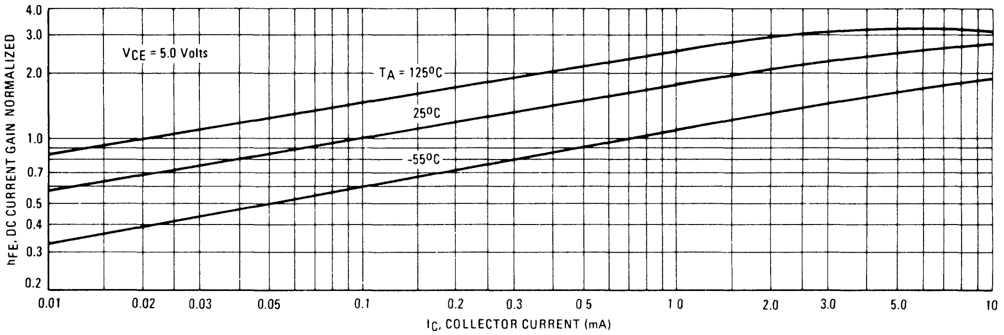


FIGURE 9 – "ON" VOLTAGES

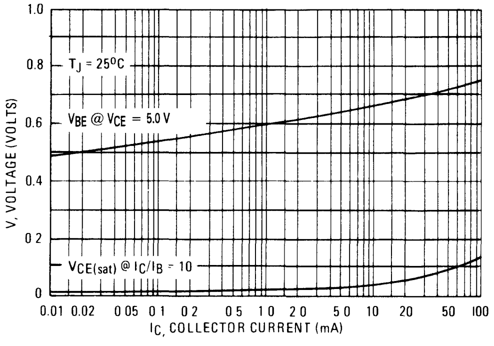


FIGURE 10 – TEMPERATURE COEFFICIENTS

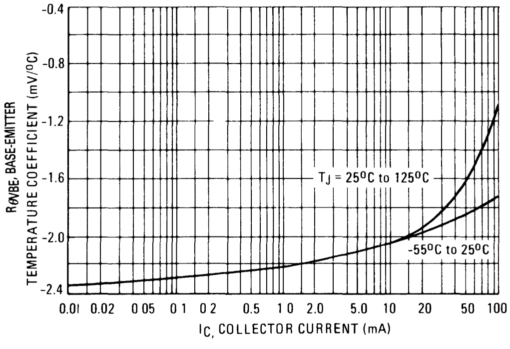


FIGURE 11 — CAPACITANCE

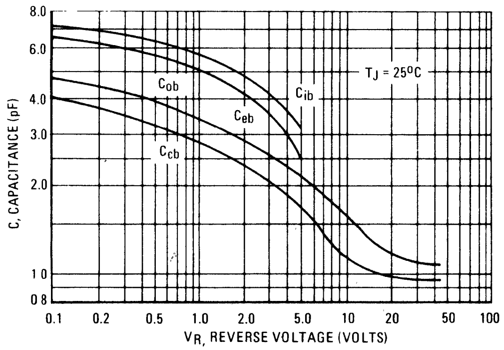
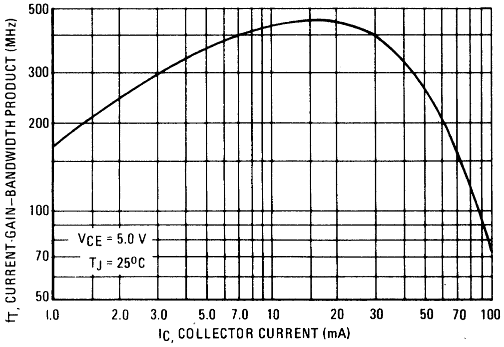
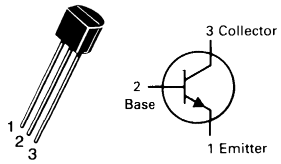


FIGURE 12 — CURRENT-GAIN—BANDWIDTH PRODUCT



MPSA20

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MPS3903 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

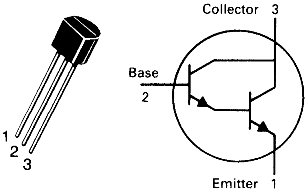
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain(2) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	400	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz	f_T	125	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.0	pF

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPSA27

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPS-A25	MPS-A26	MPS-A27	Unit
Collector-Emitter Voltage	V_{CES}	40	50	60	Vdc
Emitter-Base Voltage	V_{EBO}	10			Vdc
Collector Current — Continuous	I_C	500			mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0			mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0) (V_{CB} = 40 V, I_E = 0) (V_{CB} = 50 V, I_E = 0)	I_{CBO}	—	—	100	nAdc
Collector Cutoff Current (V_{CE} = 30 V, V_{BE} = 0) (V_{CE} = 40 V, V_{BE} = 0) (V_{CE} = 50 V, V_{BE} = 0)	I_{CES}	—	—	500	nAdc
Emitter Cutoff Current (V_{BE} = 10 Vdc)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 10 mA, V_{CE} = 5.0 V) (I_C = 100 mA, V_{CE} = 5.0 V)	h_{FE}	 10,000 10,000	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mA, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	—	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Small Signal Current Gain (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	h_{fe}	1.25	2.4	—	—

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

FIGURE 1 — DC CURRENT GAIN

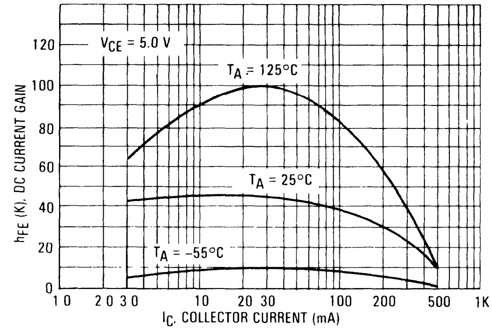


FIGURE 2 — "ON" VOLTAGES

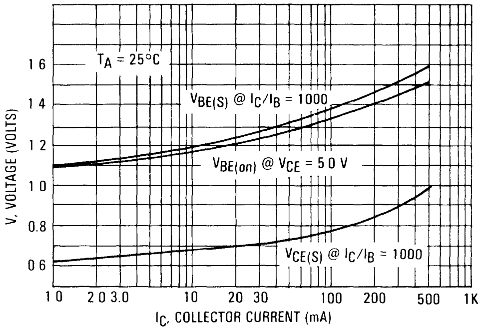


FIGURE 3 — COLLECTOR SATURATION REGION

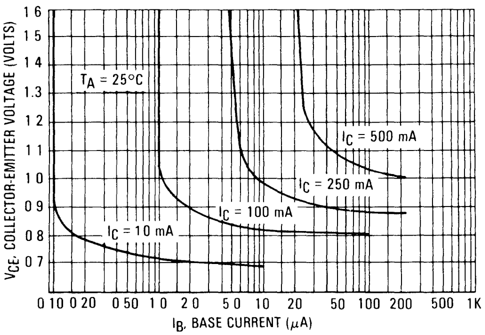


FIGURE 4 — HIGH FREQUENCY CURRENT GAIN

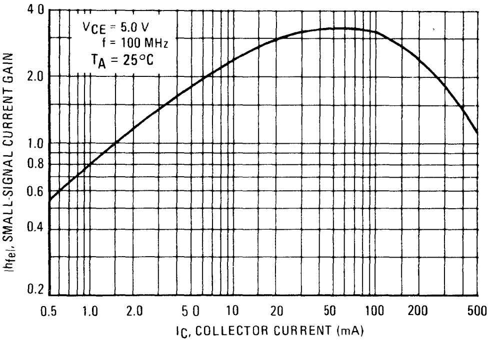
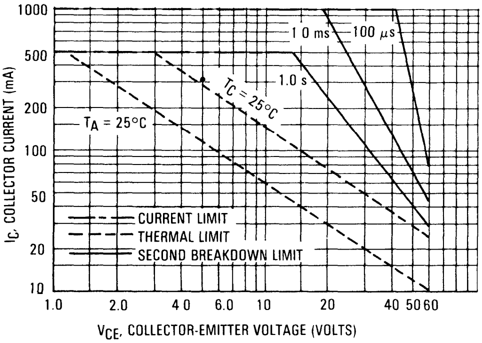
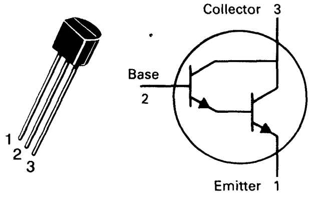


FIGURE 5 — ACTIVE REGION SAFE OPERATING AREA



MPSA28
MPSA29

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA28	MPSA29	Unit
Collector-Emitter Voltage	V_{CES}	80	100	Vdc
Collector-Base Voltage	V_{CBO}	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	12		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 100 μAdc, V_{BE} = 0)	MPSA28		80	—	—	
	MPSA29		100	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	MPSA28		80	—	—	
	MPSA29		100	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	Both Types	$V_{(BR)EBO}$	12	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 60 Vdc, I_E = 0)	MPSA28		—	—	100	
(V_{CB} = 80 Vdc, I_E = 0)	MPSA29		—	—	100	
Collector Cutoff Current		I_{CES}				nAdc
(V_{CE} = 60 Vdc, V_{BE} = 0)	MPSA28		—	—	500	
(V_{CE} = 80 Vdc, V_{BE} = 0)	MPSA29		—	—	500	
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)	Both Types	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	Both Types		10,000	—	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	Both Types		10,000	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 0.01 mAdc)	Both Types		—	0.7	1.2	
(I_C = 100 mAdc, I_B = 0.1 mAdc)	Both Types		—	0.8	1.5	
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	Both Types	$V_{BE(on)}$	—	1.4	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	Both Types	f_T	125	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	Both Types	C_{obo}	—	5.0	8.0	pF

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = h_{fe} \cdot f_{test}$.

FIGURE 1 — DC CURRENT GAIN

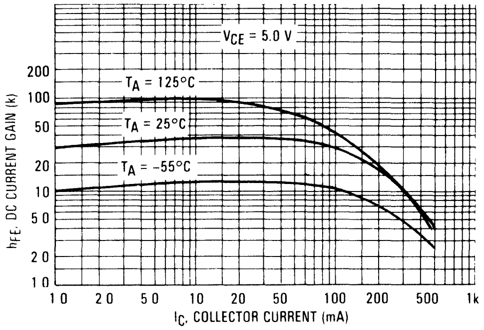


FIGURE 2 — ON VOLTAGES

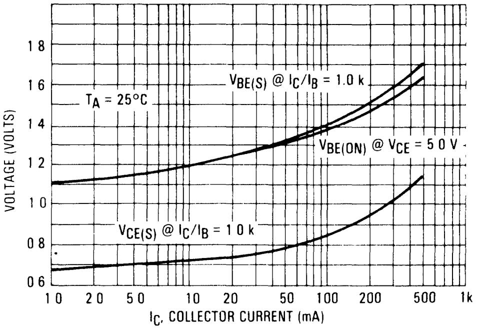


FIGURE 3 — TEMPERATURE COEFFICIENTS

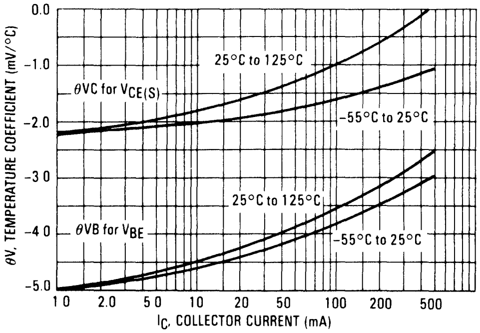


FIGURE 4 — COLLECTOR SATURATION REGION

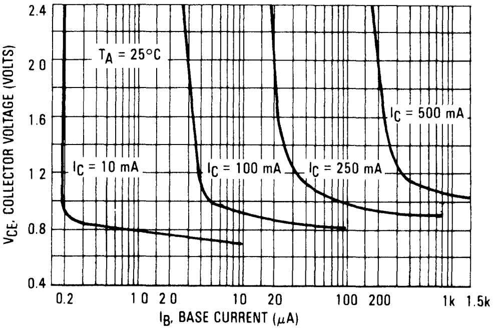


FIGURE 5 — ACTIVE REGION — SAFE OPERATING AREA

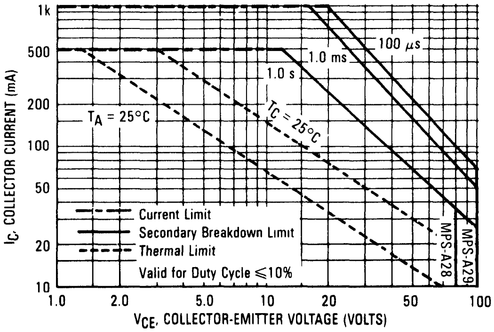
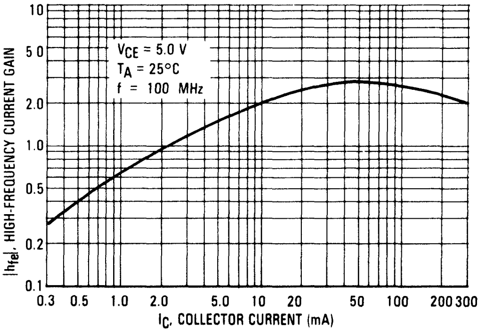
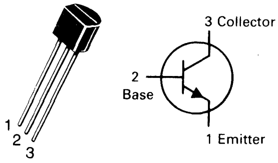


FIGURE 6 — HIGH FREQUENCY CURRENT GAIN



MPSA42
MPSA43

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA42	MPSA43	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	6.0	Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
($I_C = 1.0$ mAdc, $I_B = 0$)	MPSA42		300	—	
	MPSA43		200	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100\ \mu$Adc, $I_E = 0$)	MPSA42		300	—	
	MPSA43		200	—	
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 200$ Vdc, $I_E = 0$)	MPSA42		—	0.1	
($V_{CB} = 160$ Vdc, $I_E = 0$)	MPSA43		—	0.1	
Emitter Cutoff Current		I_{EBO}			μAdc
($V_{BE} = 6.0$ Vdc, $I_C = 0$)	MPSA42		—	0.1	
($V_{BE} = 4.0$ Vdc, $I_C = 0$)	MPSA43		—	0.1	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)			25	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)			40	—	
($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)			40	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)	MPSA42		—	0.5	
	MPSA43		—	0.4	
Base-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	50	—	MHz
Collector-Base Capacitance		C_{cb}			pF
($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)	MPSA42		—	3.0	
	MPSA43		—	4.0	

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

FIGURE 1 — DC CURRENT GAIN

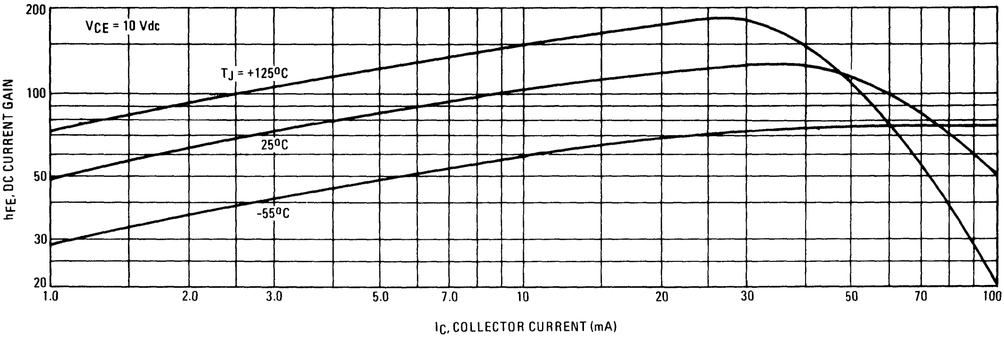


FIGURE 2 — CAPACITANCES

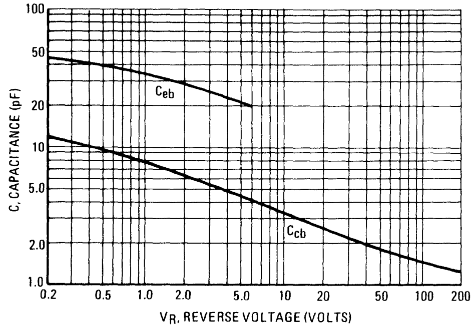


FIGURE 3 — CURRENT-GAIN—BANDWIDTH PRODUCT

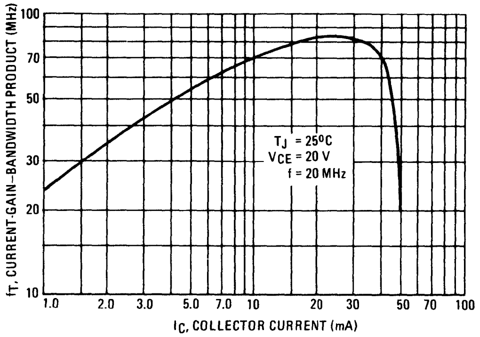


FIGURE 4 — "ON" VOLTAGES

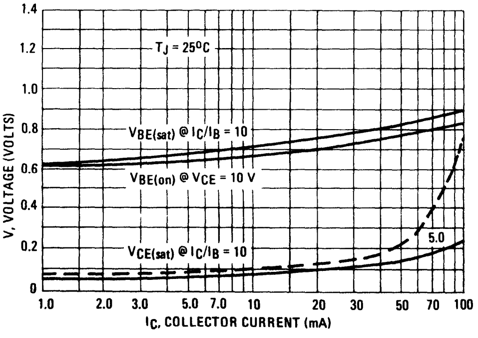
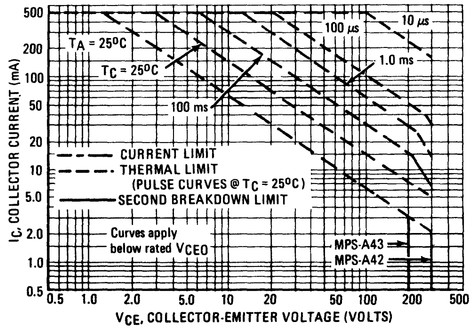
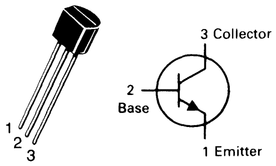


FIGURE 5 — MAXIMUM FORWARD BIAS SAFE OPERATING AREA



MPSA44
MPSA45

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA44	MPSA45	Unit
Collector-Emitter Voltage	V_{CEO}	400	350	Vdc
Collector-Base Voltage	V_{CBO}	500	400	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	6.0	Vdc
Collector Current — Continuous	I_C	300		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 1.0 mAdc, I_B = 0)	MPSA44		400	—	
	MPSA45		350	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$			Vdc
(I_C = 100 μAdc, V_{BE} = 0)	MPSA44		500	—	
	MPSA45		400	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	MPSA44		500	—	
	MPSA45		400	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 400 Vdc, I_E = 0)	MPSA44		—	0.1	
(V_{CB} = 320 Vdc, I_E = 0)	MPSA45		—	0.1	
Collector Cutoff Current		I_{CES}			nAdc
(V_{CE} = 400 Vdc, V_{BE} = 0)	MPSA44		—	500	
(V_{CE} = 320 Vdc, V_{BE} = 0)	MPSA45		—	500	
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain(1)	(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	—	—
	(I_C = 10 mAdc, V_{CE} = 10 Vdc)		50	200	
	(I_C = 50 mAdc, V_{CE} = 10 Vdc)		45	—	
	(I_C = 100 mAdc, V_{CE} = 10 Vdc)		40	—	
Collector-Emitter Saturation Voltage(1)	(I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
	(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.5	
	(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.75	
Base-Emitter Saturation Voltage	(I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance	(V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	7.0	pF
Input Capacitance	(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	13	pF
Small-Signal Current Gain	(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)	h_{fe}	2.0	—	—

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

FIGURE 1 — DC CURRENT GAIN

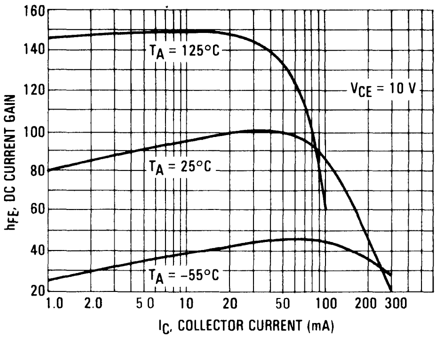


FIGURE 2 — COLLECTOR SATURATION REGION

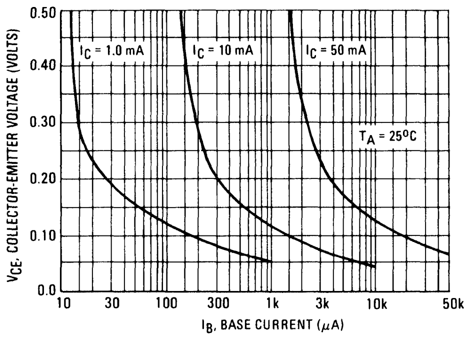


FIGURE 3 — ON VOLTAGES

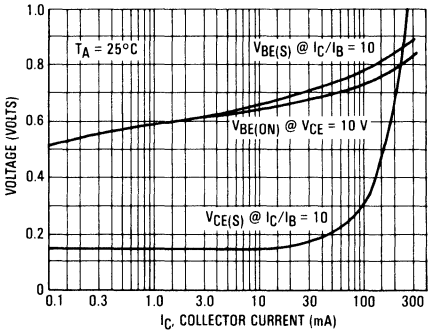


FIGURE 4 — ACTIVE REGION — SAFE OPERATING AREA

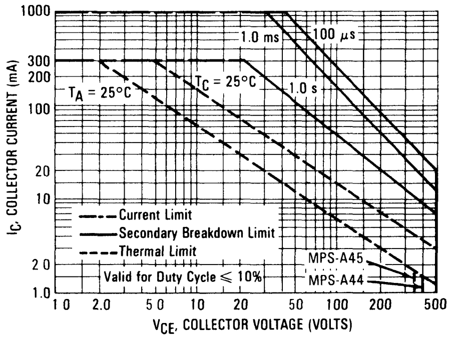


FIGURE 5 — CAPACITANCE

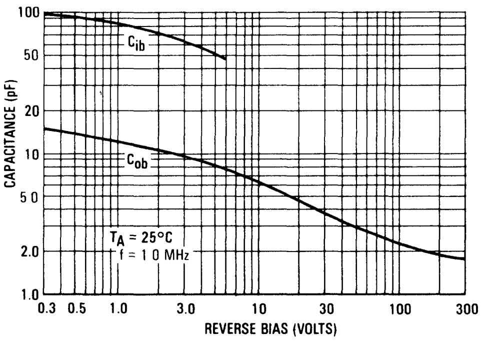


FIGURE 6 — HIGH FREQUENCY CURRENT GAIN

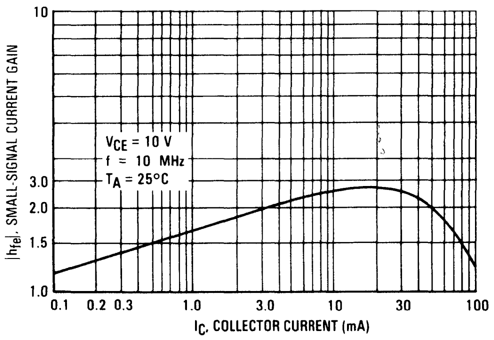


FIGURE 7 — TURN-ON SWITCHING TIMES AND TEST CIRCUIT

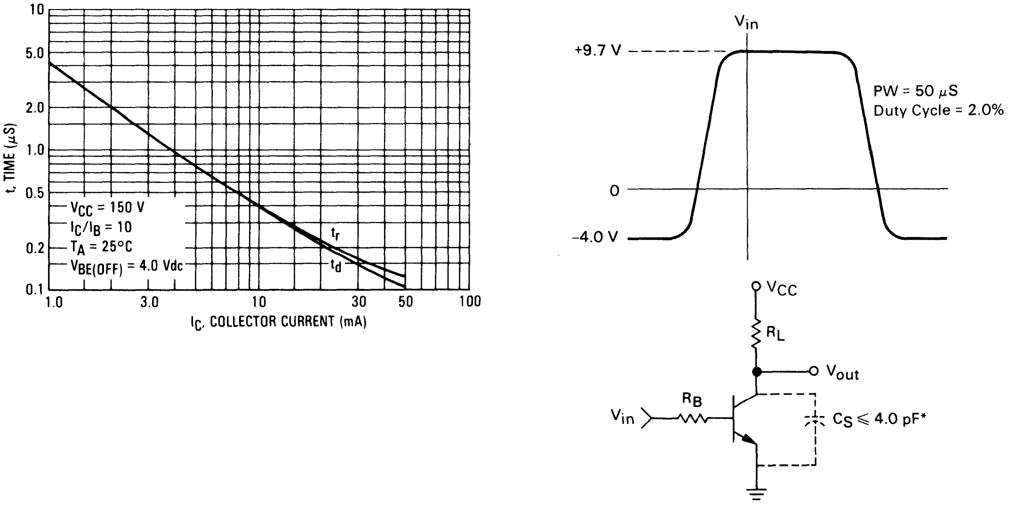
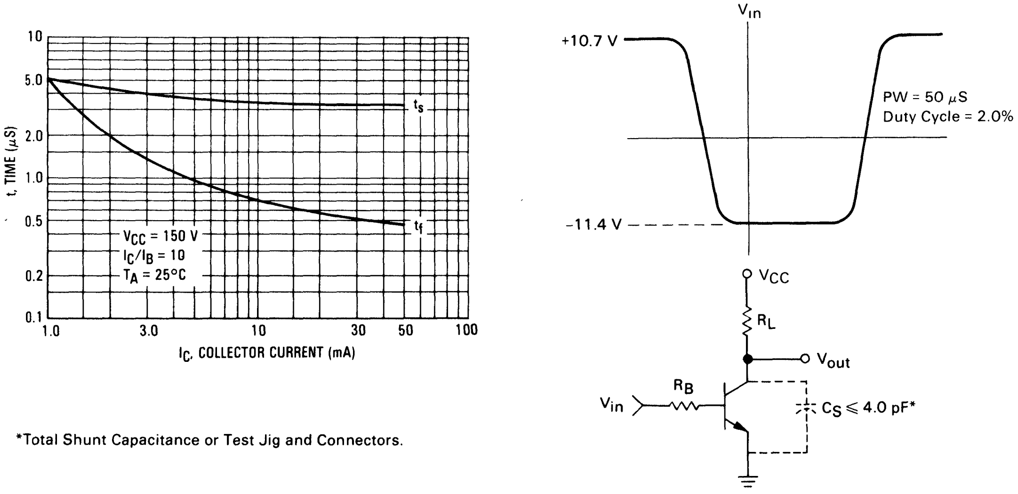


FIGURE 8 — TURN-OFF SWITCHING TIMES AND TEST CIRCUIT



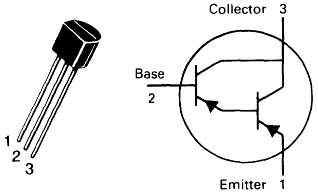
*Total Shunt Capacitance or Test Jig and Connectors.

MPSA55, MPSA56

For Specifications,
See MPSA05, MPSA06 Data

MPSA62
thru
MPSA64

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

PNP SILICON

Refer to MPSA75 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPSA62	MPSA63 MPSA64	Unit
Collector-Emitter Voltage	V_{CES}	20	30	Vdc
Collector-Base Voltage	V_{CBO}	20	30	Vdc
Emitter-Base Voltage	V_{EBO}	10		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

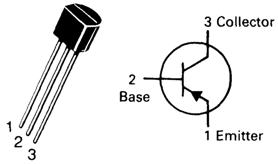
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$			Vdc
(I_C = 100 μAdc, V_{BE} = 0)	MPSA62		20	—	
	MPSA63, MPSA64		30	—	
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 15 Vdc, I_E = 0)	MPSA62		—	100	
(V_{CB} = 30 Vdc, I_E = 0)	MPSA63, MPSA64		—	100	
Emitter Cutoff Current (V_{BE} = 10 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPSA63		5000	—	
	MPSA64		10,000	—	
	MPSA62		20,000	—	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPSA63		10,000	—	
	MPSA64		20,000	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 0.01 mAdc)	MPSA62		—	1.0	
(I_C = 100 mAdc, I_B = 0.1 mAdc)	MPSA63, MPSA64		—	1.5	
Base-Emitter On Voltage		$V_{BE(on)}$			Vdc
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MPSA62		—	1.4	
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	MPSA63, MPSA64		—	2.0	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	MPSA63, MPSA64	f_T	125	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

MPSA70

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N5086 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

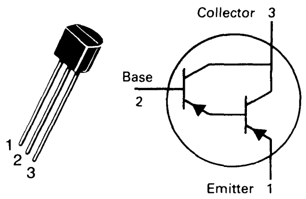
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

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

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

MPSA75
MPSA77

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



DARLINGTON TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA75	MPSA77	Unit
Collector-Emitter Voltage	V_{CES}	40	60	Vdc
Emitter-Base Voltage	V_{EBO}	10		Vdc
Collector Current — Continuous	I_C	500		Adc
Total Device Dissipation	P_D			
@ T_A = 25°C		625		mW
Derate above 25°C		5.0		mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage	$V_{(BR)CES}$				Vdc
(I_C = 100 μAdc, V_{BE} = 0) MPSA75		40	—	—	
MPSA77		60	—	—	
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0) MPSA75		40	—	—	
MPSA77		60	—	—	
Collector Cutoff Current	I_{CBO}				nAdc
(V_{CB} = 30 V, I_E = 0)		—	—	100	
(V_{CB} = 40 V, I_E = 0)		—	—	—	
(V_{CB} = 50 V, I_E = 0)		—	—	—	
Collector Cutoff Current	I_{CES}				nAdc
(V_{CE} = 30 V, V_{BE} = 0)		—	—	500	
(V_{CE} = 40 V, V_{BE} = 0)		—	—	—	
(V_{CE} = 50 V, V_{BE} = 0)		—	—	—	
Emitter Cutoff Current (V_{BE} = 10 Vdc)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 10 mA, V_{CE} = 5.0 V)		10,000	—	—	
(I_C = 100 mA, V_{CE} = 5.0 V)		10,000	—	—	
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 100 mA, V_{CE} = 5.0 Vdc)	V_{BE}	—	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — High Frequency (I_C = 10 mA, V_{CE} = 5.0 V, f = 100 MHz)	$\|h_{fe}\|$	1.25	2.4	—	—

MPSA75, MPSA77

FIGURE 1 — DC CURRENT GAIN

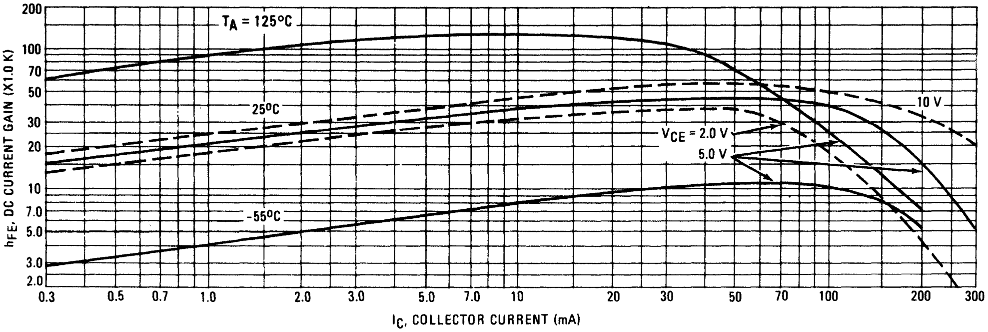


FIGURE 2 — "ON" VOLTAGE

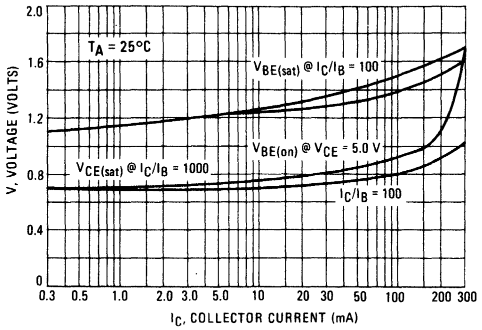


FIGURE 3 — COLLECTOR SATURATION REGION

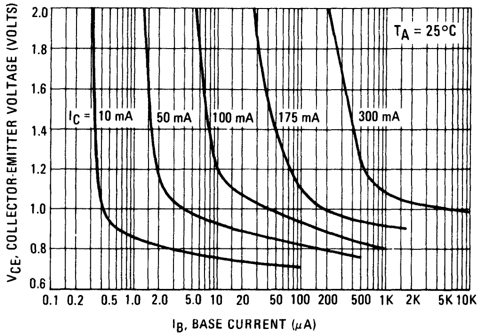


FIGURE 4 — HIGH FREQUENCY CURRENT GAIN

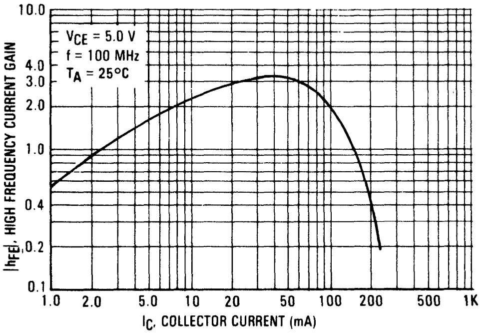
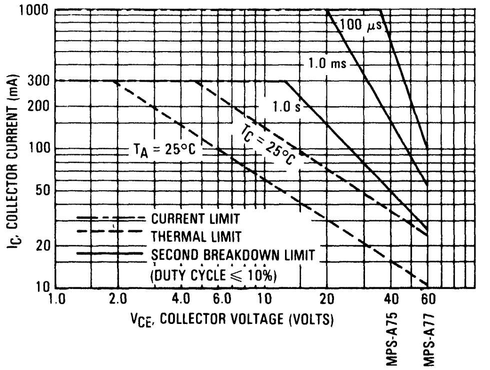
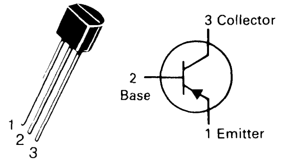


FIGURE 5 — ACTIVE REGION, SAFE OPERATING AREA



MPSA92
MPSA93

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSA92	MPSA93	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$	P_D	625		mW
Derate above 25°C		5.0		mW/°C
Total Device Dissipation @ $T_C = 25°C$	P_D	1.5		Watts
Derate above 25°C		12		mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
($I_C = 1.0$ mAdc, $I_B = 0$)	MPSA92		300	—	
	MPSA93		200	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100\ \mu$Adc, $I_E = 0$)	MPSA92		300	—	
	MPSA93		200	—	
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 200$ Vdc, $I_E = 0$)	MPSA92		—	0.25	
($V_{CB} = 160$ Vdc, $I_E = 0$)	MPSA93		—	0.25	
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	Both Types		25	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	Both Types		40	—	
($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	MPSA92		25	—	
	MPSA93		25	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)	MPSA92		—	0.5	
	MPSA93		—	0.4	
Base-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	50	—	MHz
Collector-Base Capacitance		C_{cb}			pF
($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)	MPSA92		—	6.0	
	MPSA93		—	8.0	

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

FIGURE 1 — DC CURRENT GAIN

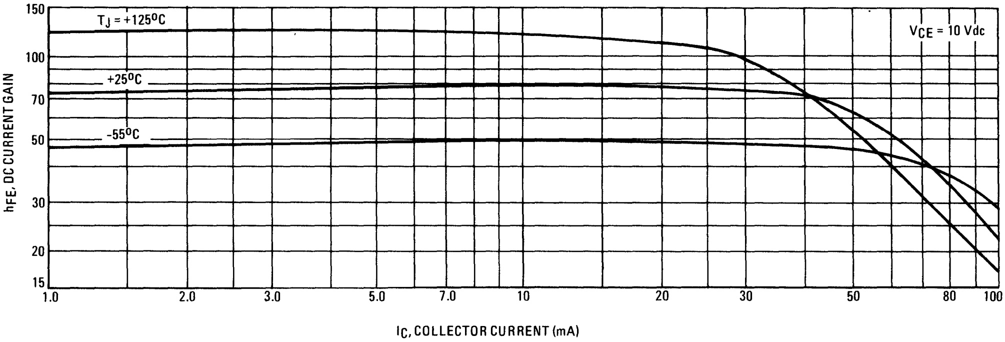


FIGURE 2 — CAPACITANCES

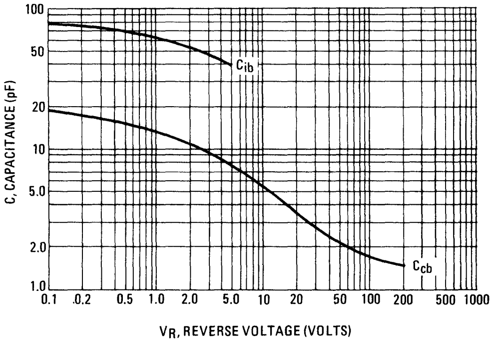


FIGURE 3 — CURRENT-GAIN—BANDWIDTH PRODUCT

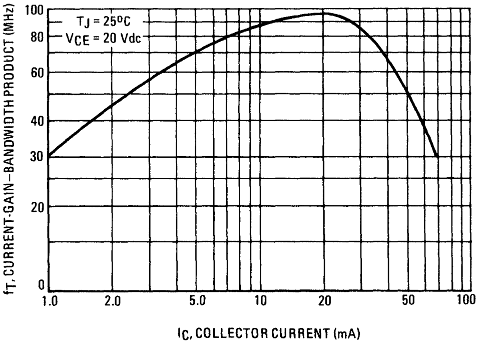


FIGURE 4 — "ON" VOLTAGES

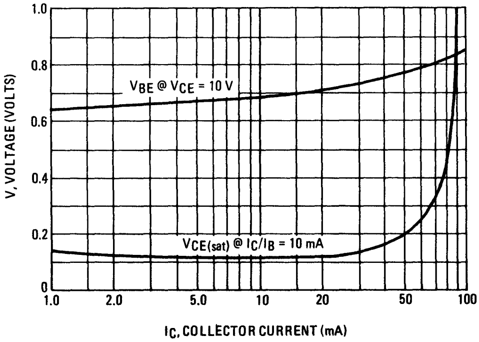
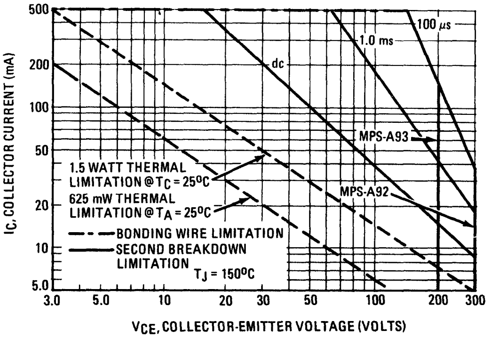
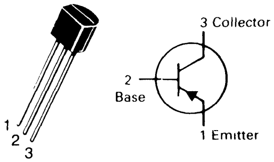


FIGURE 5 — ACTIVE-REGION SAFE OPERATING AREA



MPSD55

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N4400 for MPSD05 graphs.*

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient(1)	$R_{\theta JA}$	200	°C/W

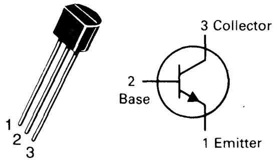
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	25	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc)	I_{CEO}	—	1.0	μAdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$)	I_{CBO}	—	1.0	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(2)				
DC Current Gain	h_{FE}			—
($I_C = 50$ mAdc, $V_{CE} = 5.0$ Vdc)		50	—	
($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)		80	—	
($I_C = 500$ mAdc, $V_{CE} = 5.0$ Vdc)		30	—	
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	100	—	MHz

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Refer to 2N4402 for MPSD55 graphs.

MPSH04

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

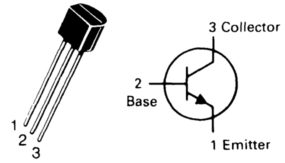
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	80	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	80	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.5$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	30	— —	120	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Crrent-Gain — Bandwidth Product ($I_C = 1.5$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	80	—	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, f = 1.0 MHz)	C_{cb}	—	—	1.6	pF
Output Admittance ($I_C = 1.5$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{oe}	—	—	5.0	μmhos
Noise Figure ($I_C = 1.5$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 50$ ohms, f = 1.0 MHz) MPSH04	NF	—	—	2.0	dB

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPSH07

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



FM/VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	—	—
Base-Emitter On Voltage (I_C = 3.0 mAdc, V_{CE} = 10 Vdc)	$V_{BE(on)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 3.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	—	MHz
Collector-Emitter Capacitance (V_{CE} = 10 Vdc, I_B = 0, f = 1.0 MHz, base guarded)	C_{ce} (C_{rb})	—	0.3	pF
Noise Figure (I_C = 3.0 mAdc, V_{CB} = 10 Vdc, R_S = 50 Ohms, f = 100 MHz)	NF	—	3.2	dB
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (I_C = 3.0 mAdc, V_{CB} = 10 Vdc, R_S = 50 Ohms, f = 100 MHz) (I_C = 3.0 mAdc, V_{CB} = 10 Vdc, R_S = 50 Ohms, f = 200 MHz)	G_{pb}	 18 14	 — —	dB
Forward AGC Current (Gain Reduction = 30 dB, R_S = 50 Ohms, f = 100 MHz)	I_{AGC}	6.5	8.5	mAdc

MPSH07

AGC CHARACTERISTICS

V_{CC} = 10 Vdc, R_S = 50 Ohms, See Figure 9

—— f = 100 MHz – – – f = 200 MHz

FIGURE 1 – POWER GAIN

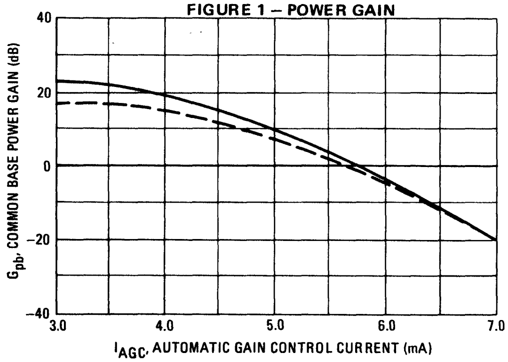
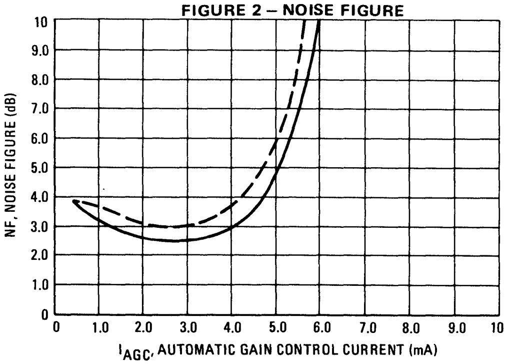


FIGURE 2 – NOISE FIGURE



COMMON-BASE y PARAMETERS

V_{CB} = 10 Vdc, T_A = 25°C

—— f = 100 MHz – – – f = 200 MHz

FIGURE 3 – INPUT ADMITTANCE

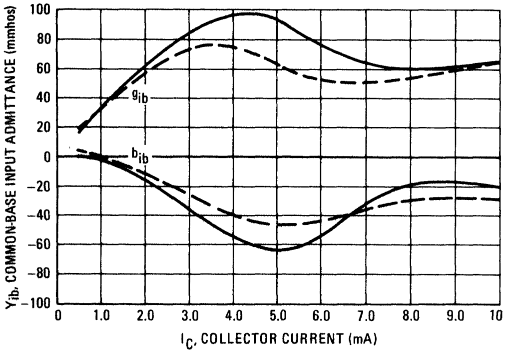


FIGURE 4 – REVERSE TRANSFER ADMITTANCE

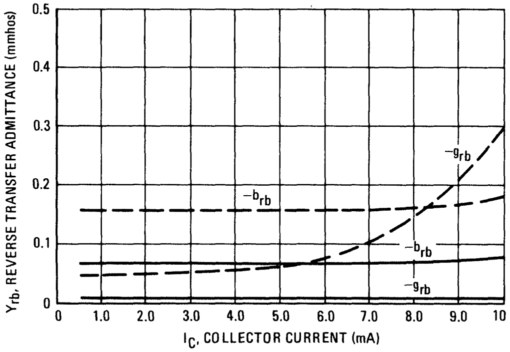


FIGURE 5 – FORWARD TRANSFER ADMITTANCE

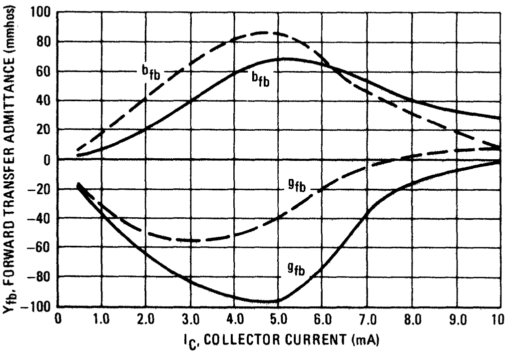


FIGURE 6 – OUTPUT ADMITTANCE

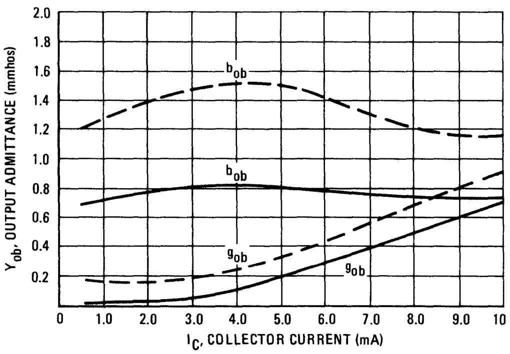


FIGURE 7 – COLLECTOR-BASE TIME CONSTANT

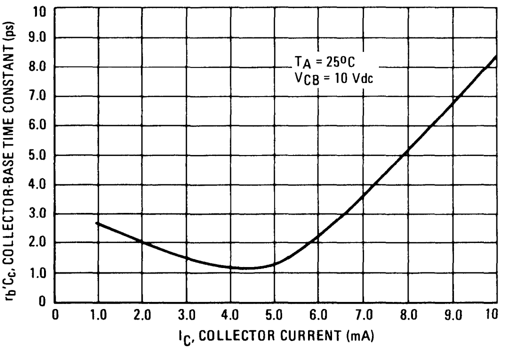


FIGURE 8 – CURRENT-GAIN BANDWIDTH PRODUCT

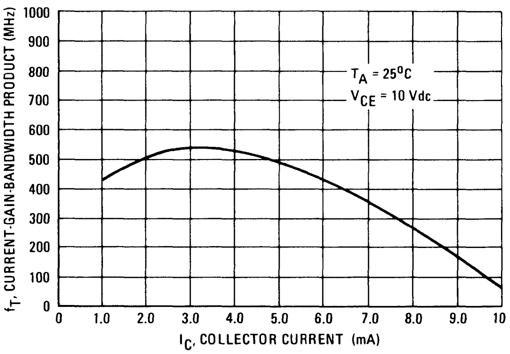
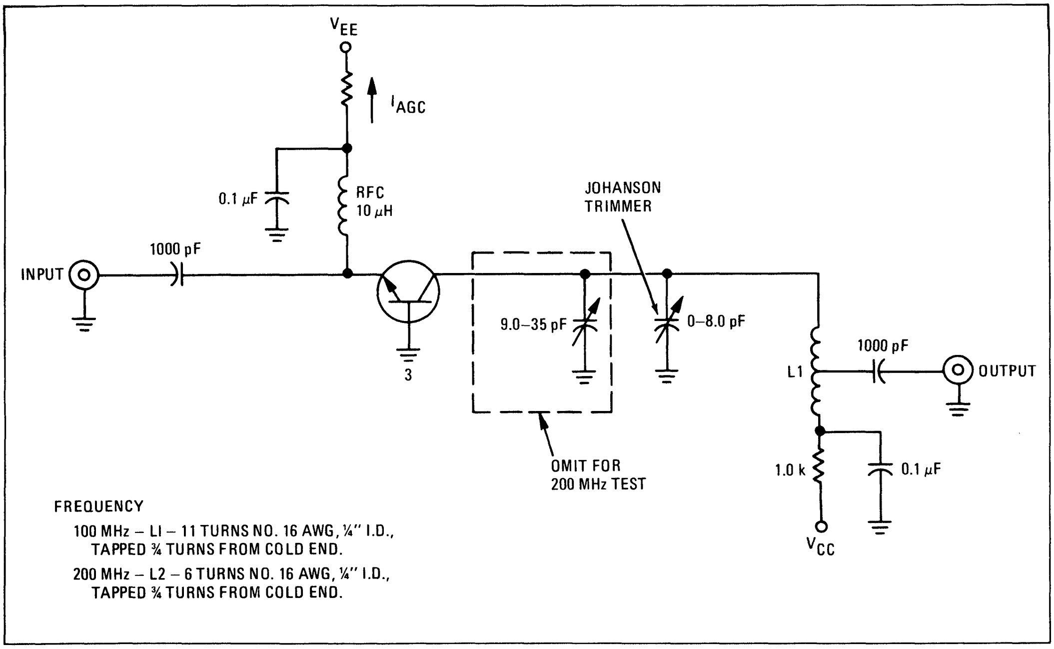


FIGURE 9 – 100-MHz AND 200-MHz COMMON-BASE AMPLIFIER



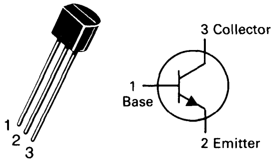
FREQUENCY

100 MHz – LI – 11 TURNS NO. 16 AWG, ¼" I.D., TAPPED ¾ TURNS FROM COLD END.

200 MHz – L2 – 6 TURNS NO. 16 AWG, ¼" I.D., TAPPED ¾ TURNS FROM COLD END.

MPSH10
MPSH11

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF/UHF TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	25	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	60	—	—
Collector-Emitter Saturation Voltage ($I_C = 4.0$ mAdc, $I_B = 0.4$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc)	V_{BE}	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	650	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	0.7	pF
Common-Base Feedback Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz) MPS-H10 MPS-H11	C_{rb}	0.35 0.6	0.65 0.9	pF
Collector Base Time Constant ($I_C = 4.0$ mAdc, $V_{CB} = 10$ Vdc, f = 31.8 MHz)	$r_b'C_c$	—	9.0	ps

COMMON-BASE y PARAMETERS versus FREQUENCY

(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{ib}, INPUT ADMITTANCE

FIGURE 1 – RECTANGULAR FORM

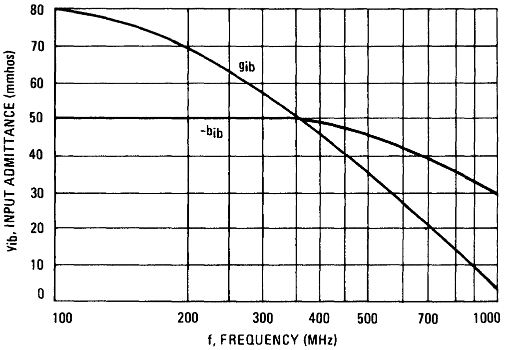
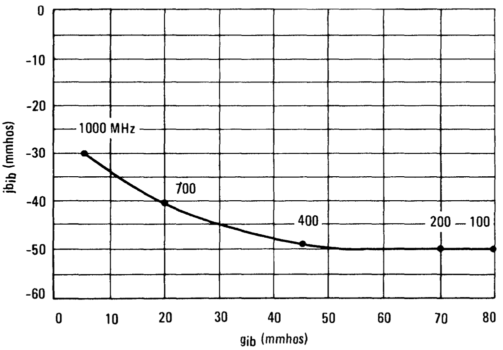


FIGURE 2 – POLAR FORM



COMMON-BASE y PARAMETERS versus FREQUENCY

(V_{CB} = 10 Vdc, I_C = 4.0 mAdc, T_A = 25°C)

y_{fb}, FORWARD TRANSFER ADMITTANCE

FIGURE 3 – RECTANGULAR FORM

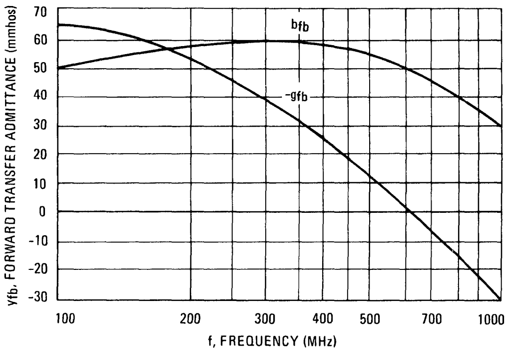
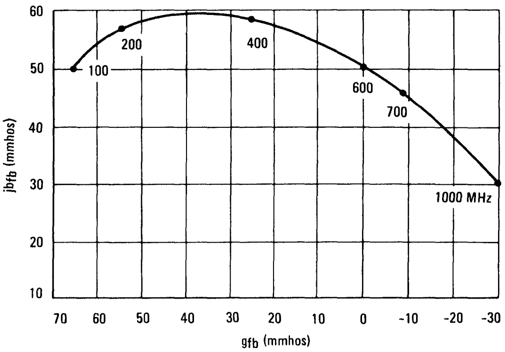


FIGURE 4 – POLAR FORM



y_{rb}, REVERSE TRANSFER ADMITTANCE

FIGURE 5 – RECTANGULAR FORM

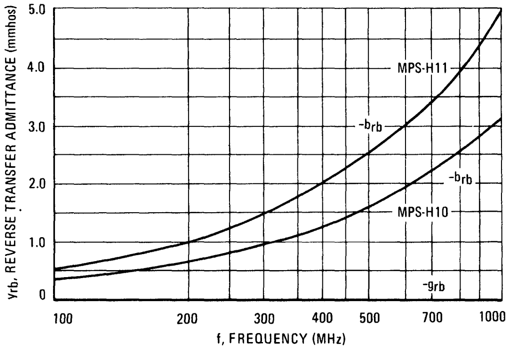
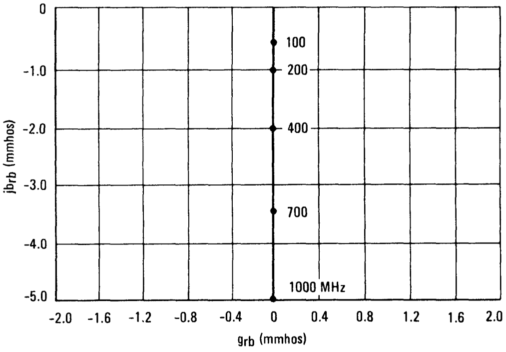


FIGURE 6 – POLAR FORM



y_{ob}, OUTPUT ADMITTANCE

FIGURE 7 – RECTANGULAR FORM

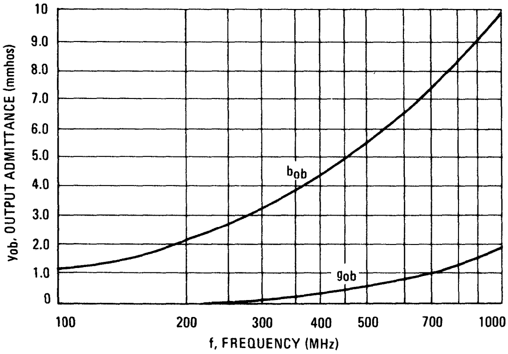
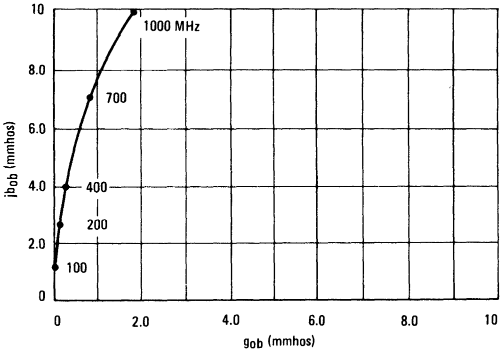
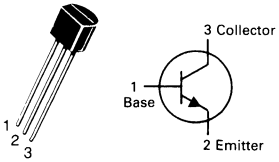


FIGURE 8 – POLAR FORM



MPSH17

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



CATV TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

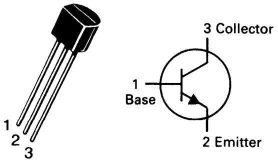
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient (Printed Circuit Board Mounting)	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	25	—	250	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	800	—	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, f = 1.0 MHz)	C_{cb}	0.3	—	0.9	pF
Small-Signal Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30	—	—	—
Noise Figure ($I_C = 5.0$ mAdc, $V_{CC} = 12$ Vdc, $R_S = 50$ ohms, f = 200 MHz)	NF	—	—	6.0	dB
FUNCTIONAL TEST					
Amplifier Power Gain ($I_C = 5.0$ mAdc, $V_{CC} = 12$ Vdc, $R_S = 50$ ohms, f = 200 MHz)	G_{pe}	—	24	—	dB

MPSH20

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	100	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.81	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	25	—	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	400	620	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	0.5	0.65	pF
Collector Base Time Constant ($I_E = 4.0$ mAdc, $V_{CB} = 10$ Vdc, f = 31.8 MHz)	$rb'C_c$	—	10	—	ps
Conversion Gain (213 to 45 MHz) ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, Oscillator Injection = 200 mVdc)	G_C	18	23	—	dB

CONVERSION GAIN CHARACTERISTICS

(TEST CIRCUIT FIGURE 9)

FIGURE 1 – VARIATION WITH COLLECTOR CURRENT

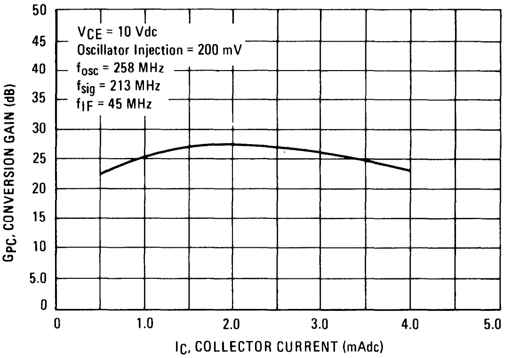
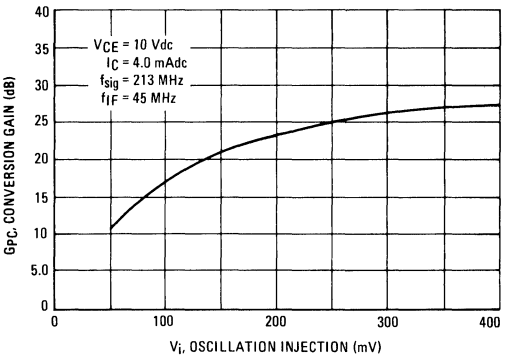


FIGURE 2 – VARIATION WITH INJECTION LEVEL



COMMON-EMITTER y PARAMETERS

(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 3 – INPUT ADMITTANCE

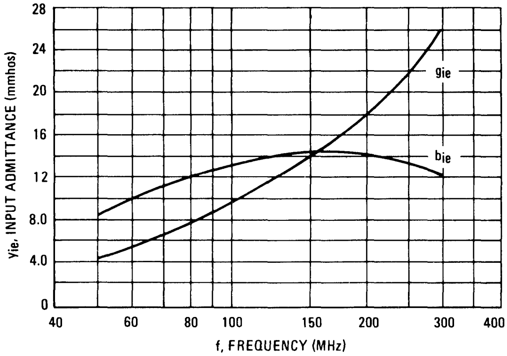
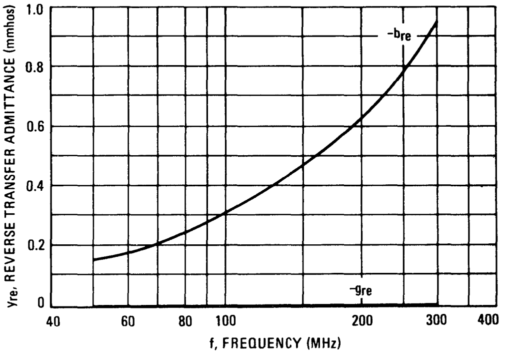


FIGURE 4 – REVERSE TRANSFER ADMITTANCE



COMMON-EMITTER y PARAMETERS

(I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 5 – FORWARD TRANSFER ADMITTANCE

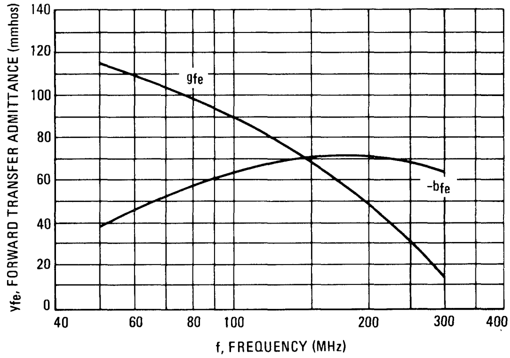


FIGURE 6 – OUTPUT ADMITTANCE

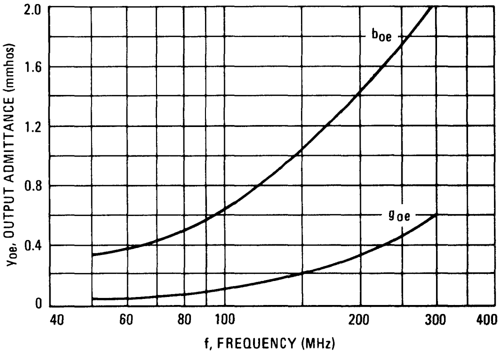


FIGURE 7 — CURRENT-GAIN—BANDWIDTH PRODUCT

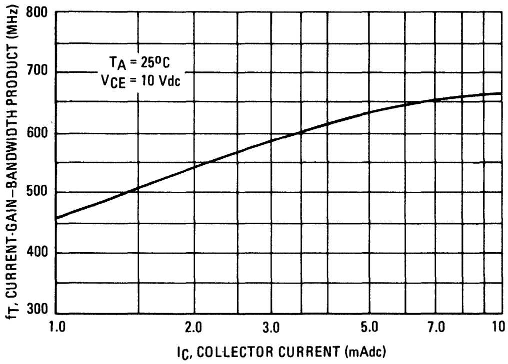


FIGURE 8 — CAPACITANCES

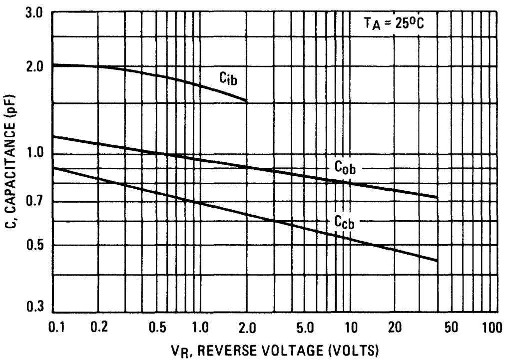
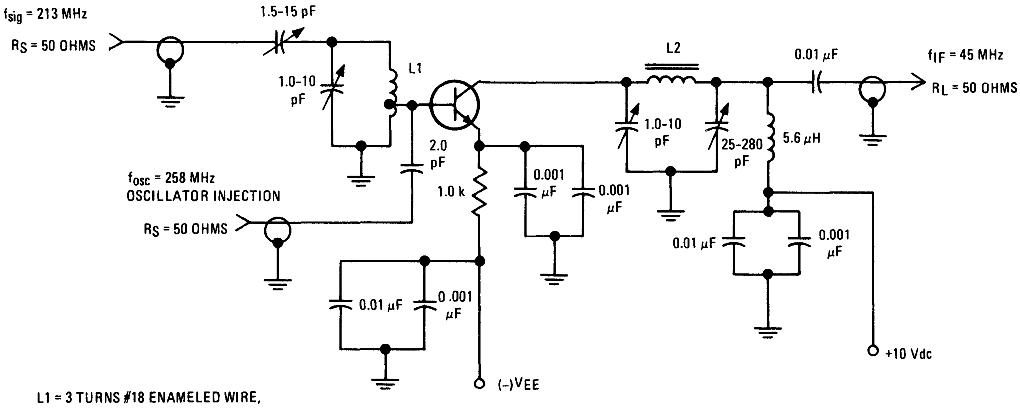


FIGURE 9 — MIXER TEST CIRCUIT

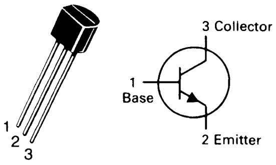


L1 = 3 TURNS #18 ENAMELED WIRE,
1/4" I.D., AIR WOUND, WINDING LENGTH 1/2";
BASE TAPPED 1 TURN FROM GROUND.

L2 = 10 TURNS #26 INSULATED WIRE, WOUND
ON 1/4" I.D. COIL FORM, ARNOLD PART
NO. A1-10 IRON POWDER CORE.

MPSH24

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



VHF TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 8.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 8.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	620	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.25	0.36	pF
Conversion Gain	G_C				dB
(213 MHz to 45 MHz) (I_C = 8.0 mAdc, V_{CC} = 20 Vdc, Oscillator Injection = 150 mVrms)		19	24	—	
(60 MHz to 45 MHz) (I_C = 8.0 mAdc, V_{CC} = 20 Vdc, Oscillator Injection = 150 mVrms)		24	29	—	

CONVERSION GAIN CHARACTERISTICS

(TEST CIRCUIT FIGURE 7)

(V_{CC} = 20 Vdc, R_S = R_L = 50 Ohms, f_{if} = 44 MHz, B.W. = 6.0 MHz)

FIGURE 1 – CONVERSION GAIN versus COLLECTOR CURRENT

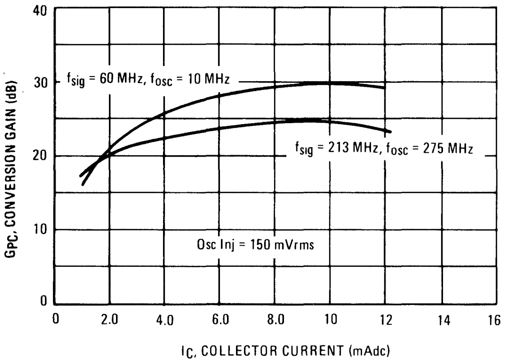
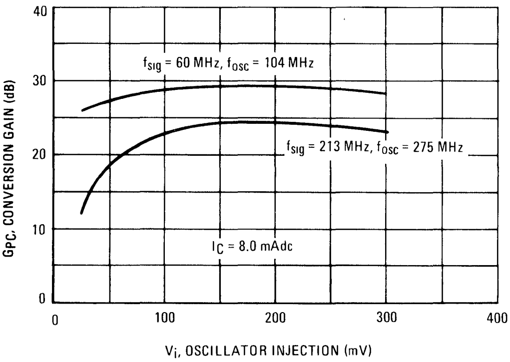


FIGURE 2 – CONVERSION GAIN versus INJECTION LEVEL



COMMON-EMITTER y PARAMETERS

(V_{CE} = 15 Vdc, T_A = 25°C)

FIGURE 3 – INPUT ADMITTANCE

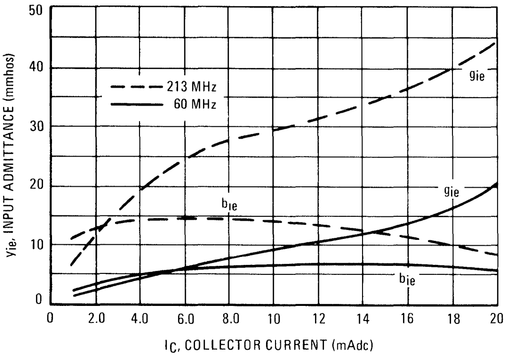


FIGURE 4 – REVERSE TRANSFER ADMITTANCE

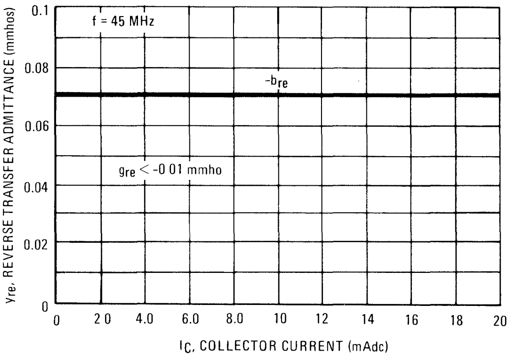


FIGURE 5 – FORWARD TRANSFER ADMITTANCE

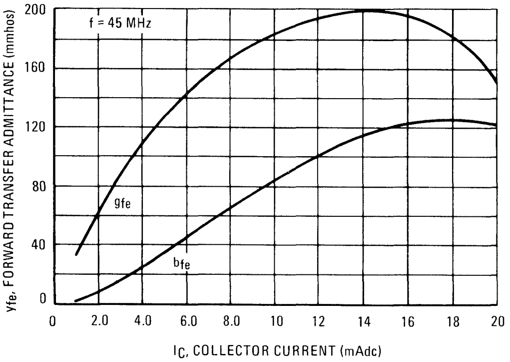


FIGURE 6 – OUTPUT ADMITTANCE

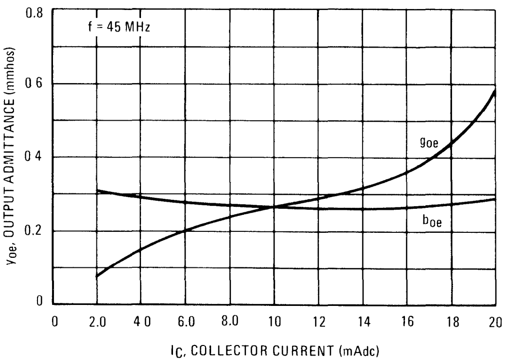
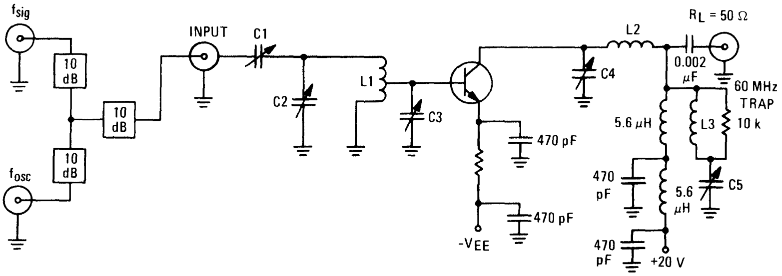


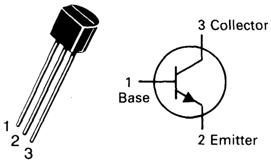
FIGURE 7 — VHF MIXER TEST CIRCUIT
(f_{if} = 44 MHz, B.W. = 6.0 MHz)

f_{sig}	60 MHz	213 MHz
f_{osc}	105 MHz	258 MHz
C1	1.5-20 pF	1.5-20 pF
C2	8.0-60 pF	6.0-12 pF
C3	8.0-60 pF	1.5-20 pF
C4	3.0-35 pF	–
C5	1.5-20 pF	–
L1	5 Turns #26 Air, Tap 1 Turn	3 Turns #16 Air, Tap ½ Turn
L2	10 Turns #26 Air	10 Turns #26 Arnold A1-10 Core
L3	Ohmite Z235	–



MPSH30

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



IF AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	200	°C/W

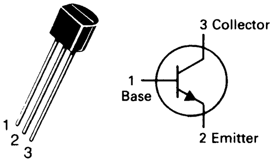
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 4.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	200	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	0.1	3.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	—	0.96	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	800	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz, emitter guarded)	C_{cb}	—	0.65	pF
Noise Figure (V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz)	NF	—	6.0	dB
FUNCTIONAL TESTS				
Power Gain (V_{AGC} = 2.75 Vdc, R_S = 50 ohms, f = 45 MHz)	G_{pe}	22.5	31	dB
Forward AGC Voltage (Gain Reduction = 30 dB, R_S = 50 ohms, f = 45 MHz)	V_{AGC}	4.4	5.4	Vdc

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

MPSH34

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



IF TRANSISTOR

NPN SILICON

Refer to MPSH24 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

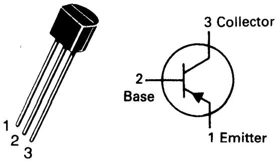
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 7.0 mAdc, V_{CE} = 15 Vdc) (I_C = 20 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	 40 15	 — —	 — —	—
Collector-Emitter Saturation Voltage (I_C = 7.0 mAdc, I_B = 2.0 mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 7.0 mAdc, V_{CE} = 15 Vdc)	$V_{BE(on)}$	—	—	0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 15 Vdc, f = 100 MHz)	f_T	500	720	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.25	0.32	pF

- Designed for UHF/VHF Amplifier Applications
- High Current Bandwidth Product
  f_T = 2000 MHz @ 10 mAdc

MPSH69

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



RF AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

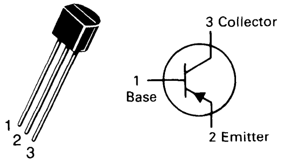
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	300	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	2000	—	—	MHz
Collector-Base Capacitance (V_{CE} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{rb}	—	—	0.3	pF

MPSH81

CASE 29-04, STYLE 2
TO-92 (TO-226AA)



RF AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to $+150$	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	357	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	60	—	—	—
Collector-Emitter Saturation Voltage ($I_C = 5.0$ mAdc, $I_B = 0.5$ mAdc)	$V_{CE(sat)}$	—	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)	$V_{BE(on)}$	—	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	600	—	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	—	0.85	pF
Collector-Emitter Capacitance ($I_B = 0$, $V_{CB} = 10$ Vdc, f = 1.0 MHz)	C_{ce}	—	—	0.65	pF

TYPICAL COMMON-BASE y-PARAMETERS

(V_{CB} = 10 Vdc, T_A = 25°C, Frequency Points in MHz)

FIGURE 1 — INPUT ADMITTANCE

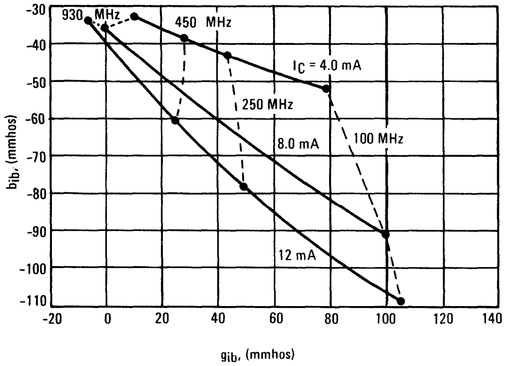


FIGURE 2 — REVERSE TRANSFER ADMITTANCE

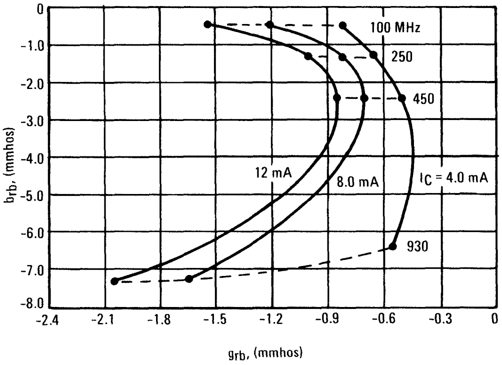


FIGURE 3 — FORWARD TRANSFER ADMITTANCE

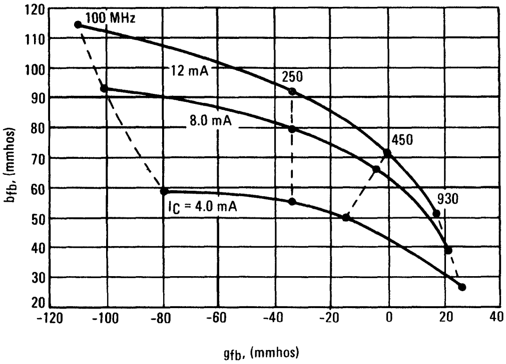


FIGURE 4 — OUTPUT ADMITTANCE

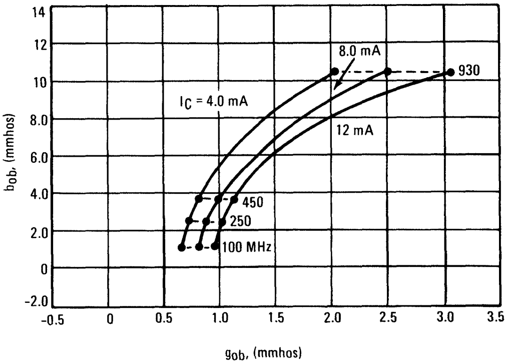
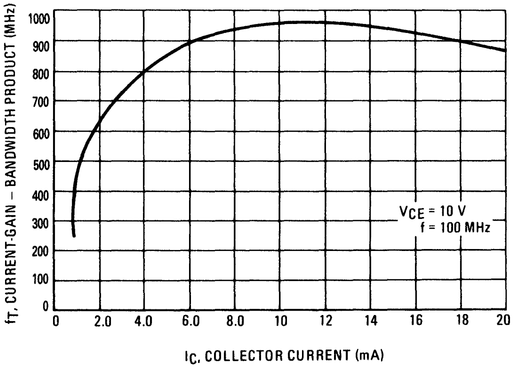
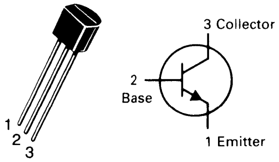


FIGURE 5 — CURRENT-GAIN — BANDWIDTH PRODUCT



MPSL01

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N5550 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	120	Vdc
Collector-Base Voltage	V_{CBO}	140	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

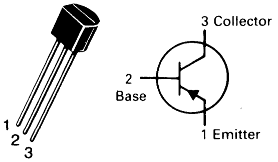
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	120	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	140	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 75$ Vdc, $I_E = 0$)	I_{CBO}	—	1.0	μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	50	300	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	 — —	 0.20 0.30	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)(1)	$V_{BE(sat)}$	 — —	 1.2 1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(1) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	60	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	8.0	pF
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30	—	—

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MPSL51

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N5400 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

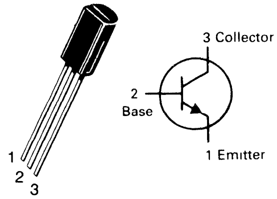
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	100	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	1.0	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain(1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	40	250	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 — —	 0.25 0.30	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 — —	 1.2 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	20	—	—

(1) Pulse Test: Pulse Test = 300 μs, Duty Cycle = 2.0%.

MPSW01, A

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT
HIGH CURRENT TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}		Vdc
MPSW01		30	
MPSW01A		40	
Collector-Base Voltage	V_{CBO}		Vdc
MPSW01		40	
MPSW01A		50	
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1000	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
($I_C = 10$ mAdc, $I_B = 0$)	MPSW01		30	—	
	MPSW01A		40	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100$ μAdc, $I_E = 0$)	MPSW01		40	—	
	MPSW01A		50	—	
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 30$ Vdc, $I_E = 0$)	MPSW01		—	0.1	
($V_{CB} = 40$ Vdc, $I_E = 0$)	MPSW01A		—	0.1	
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)			55	—	
($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)			60	—	
($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)			50	—	
Collector-Emitter Saturation Voltage ($I_C = 1000$ mAdc, $I_B = 100$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{obo}	—	20	pF

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

FIGURE 1 — DC CURRENT GAIN

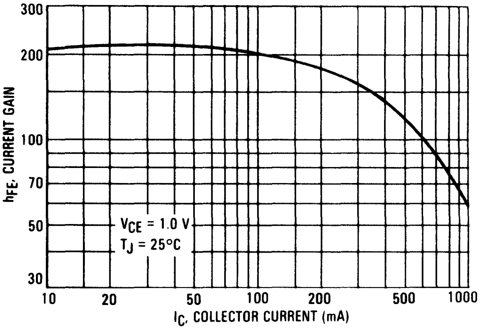


FIGURE 2 — COLLECTOR SATURATION REGION

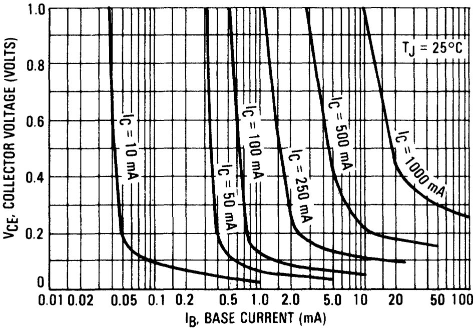


FIGURE 3 — ON VOLTAGES

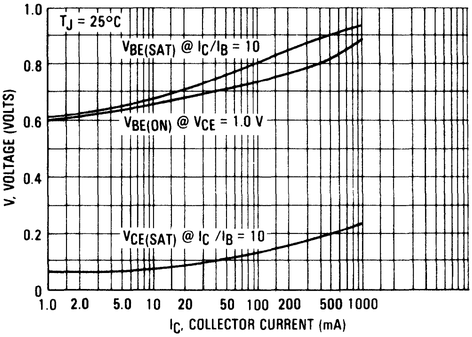


FIGURE 4 — TEMPERATURE COEFFICIENT

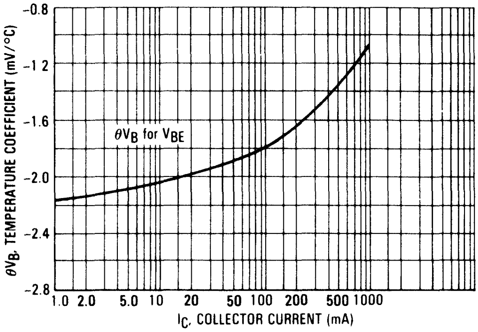


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT

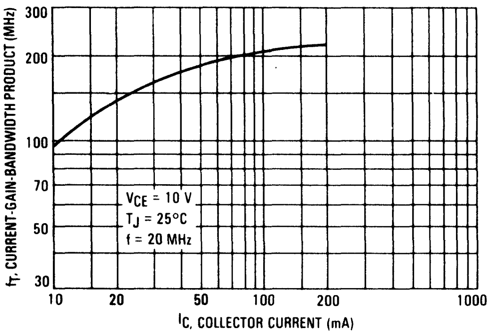


FIGURE 6 — CAPACITANCE

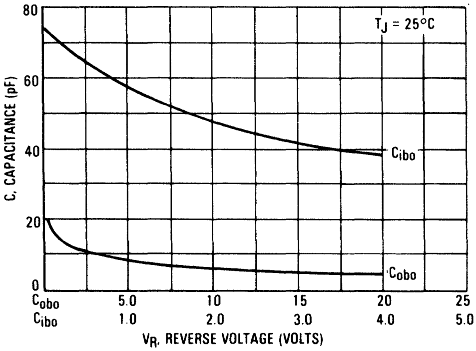
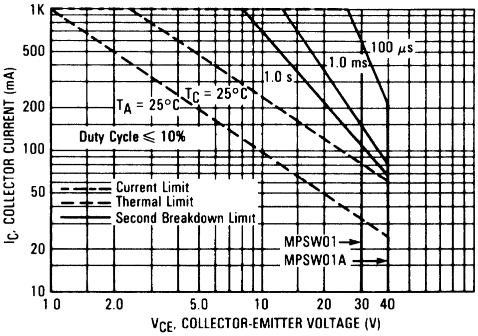
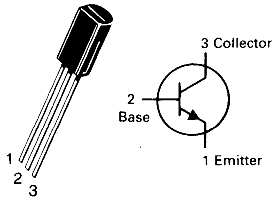


FIGURE 7 — ACTIVE REGION-SAFE OPERATING AREA



MPSW05
MPSW06

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSW05	MPSW06	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPSW05 MPSW06	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 40$ Vdc, $I_B = 0$) ($V_{CE} = 60$ Vdc, $I_B = 0$)	 MPSW05 MPSW06	I_{CEO}	 — —	 0.5 0.5	μAdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$)	 MPSW05 MPSW06	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 250$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 80 60	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 250$ mAdc, $I_B = 10$ mAdc)		$V_{CE(sat)}$	—	0.40	Vdc
Base-Emitter Saturation Voltage ($I_C = 250$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 200$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ V, f = 1.0 MHz)		C_{obo}	—	12	pF

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

FIGURE 1 — D.C. CURRENT GAIN

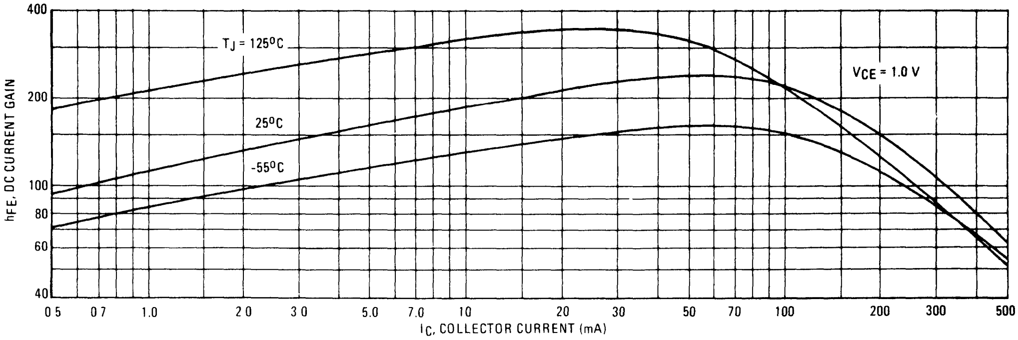


FIGURE 2 — COLLECTOR SATURATION REGION

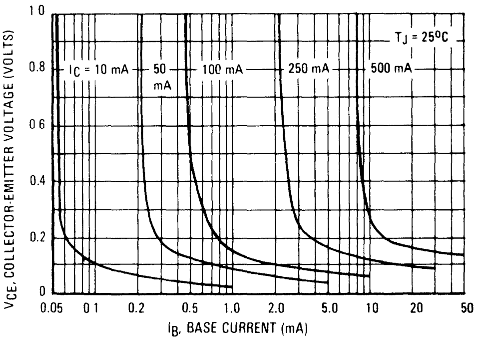


FIGURE 3 — ON VOLTAGES

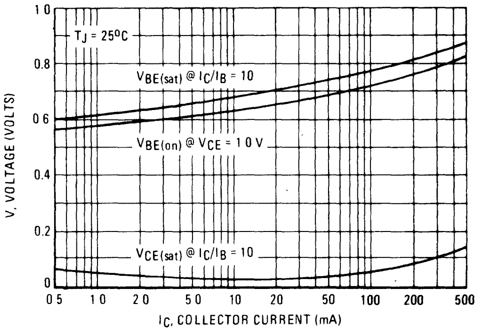


FIGURE 4 — BASE-EMITTER TEMPERATURE COEFFICIENT

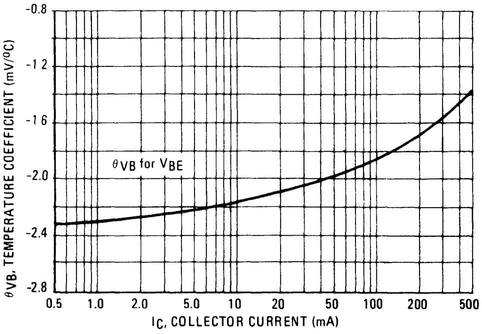


FIGURE 5 — CAPACITANCE

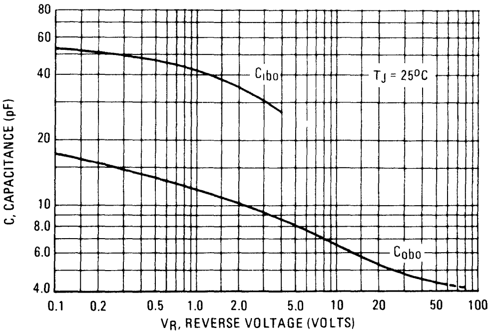


FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT

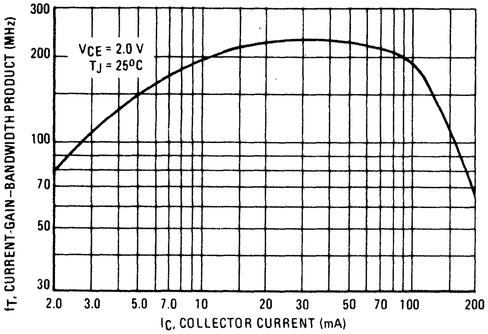
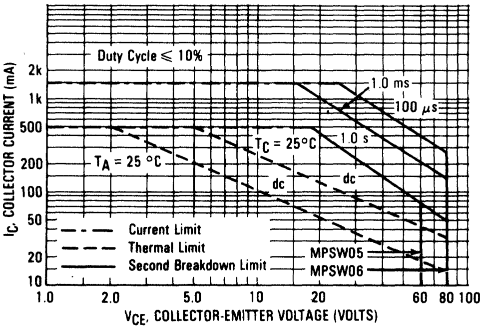
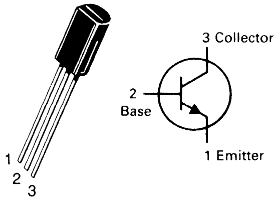


FIGURE 7 — ACTIVE REGION - SAFE OPERATING AREA



MPSW10

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTOR

NPN SILICON

Refer to MPSW42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

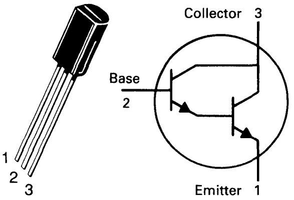
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ Vdc, $I_E = 0$)	I_{CBO}	—	0.2	μAdc
Emitter Cutoff Current ($V_{EB} = 6.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain	h_{FE}			—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)		25	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)		40	—	
($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)		40	—	
Collector-Emitter Saturation Voltage ($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)	$V_{CE(sat)}$	—	0.75	Vdc
Base-Emitter On Voltage ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	$V_{BE(on)}$	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)	f_T	45	—	MHz
Collector-Base Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	3.0	pF

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

MPSW13
MPSW14

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc$, $V_{BE} = 0$)		$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{EB} = 10$ Vdc, $I_C = 0$)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSW13		5000	—	
	MPSW14		10,000	—	
($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSW13		10,000	—	
	MPSW14		20,000	—	
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 0.1$ mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	125	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

FIGURE 1 — ACTIVE REGION SAFE OPERATING AREA

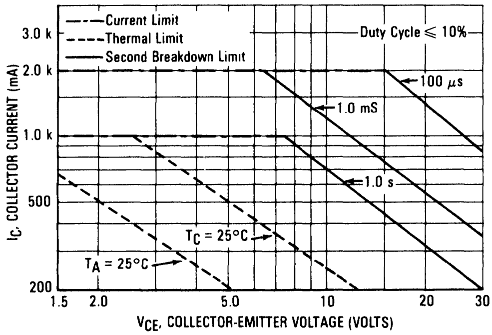


FIGURE 2 — DC CURRENT GAIN

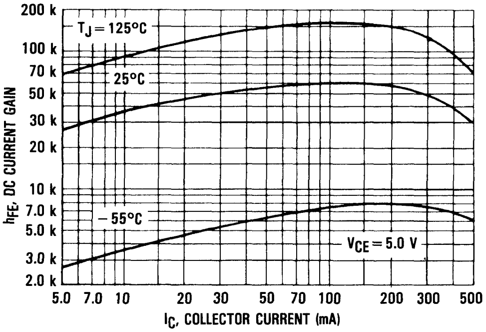


FIGURE 3 — COLLECTOR-SATURATION REGION

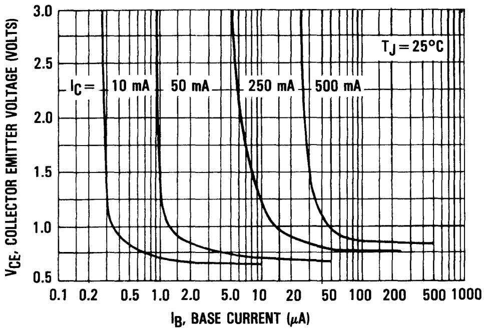


FIGURE 4 — ON VOLTAGES

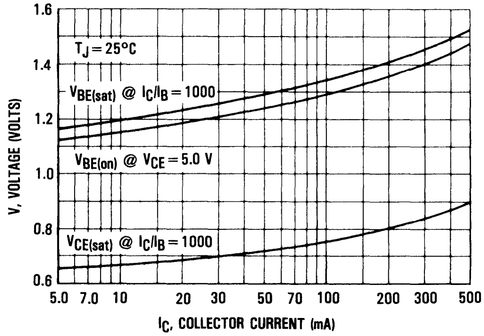


FIGURE 5 — TEMPERATURE COEFFICIENTS

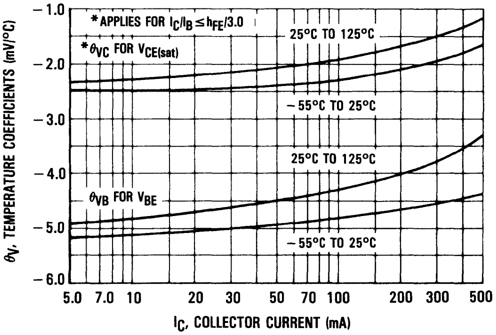


FIGURE 6 — HIGH FREQUENCY CURRENT GAIN

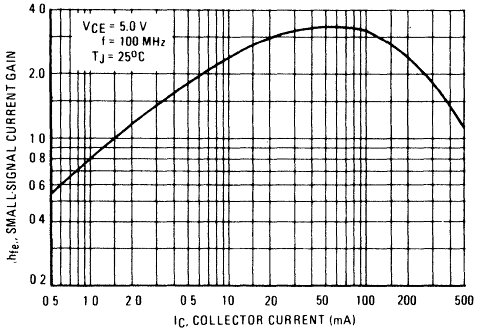
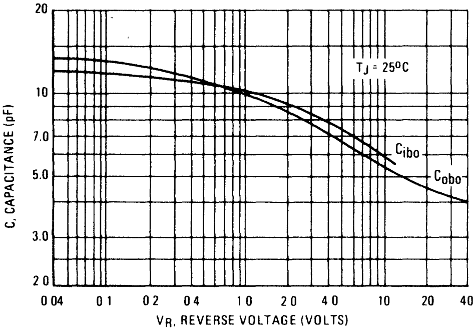
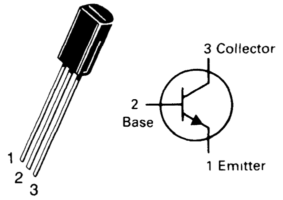


FIGURE 7 — CAPACITANCE



MPSW42
MPSW43

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSW42	MPSW43	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPSW42 MPSW43	$V_{(BR)CEO}$	 300 200	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPSW42 MPSW43	$V_{(BR)CBO}$	 300 200	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ Vdc, $I_E = 0$) ($V_{CB} = 160$ Vdc, $I_E = 0$)	 MPSW42 MPSW43	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 6.0$ Vdc, $I_C = 0$) ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	 MPSW42 MPSW43	I_{EBO}	 — —	 0.1 0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	 Both Types Both Types MPSW42 MPSW43	h_{FE}	 25 40 40 40	 — — — —	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)	 MPSW42 MPSW43	$V_{CE(sat)}$	 — —	 0.5 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Collector-Base Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)	 MPSW42 MPSW43	C_{cb}	 — —	 3.0 4.0	pF

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

FIGURE 1 — D.C. CURRENT GAIN

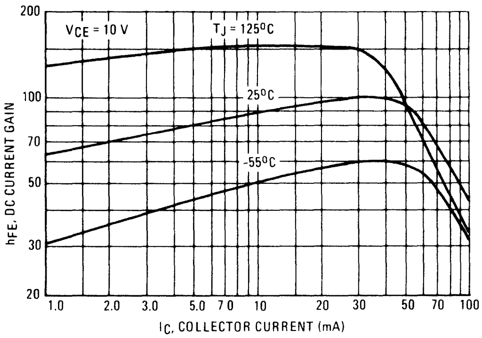


FIGURE 2 — COLLECTOR SATURATION REGION

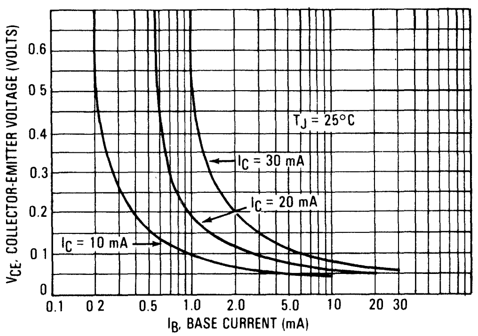


FIGURE 3 — ON VOLTAGES

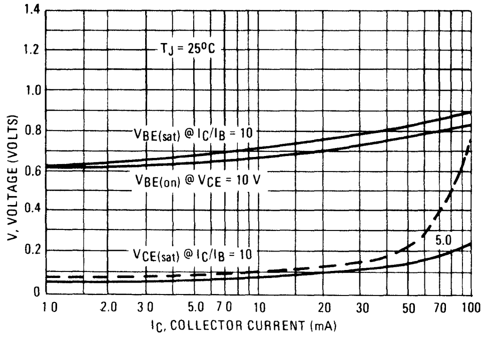


FIGURE 4 — TEMPERATURE COEFFICIENTS

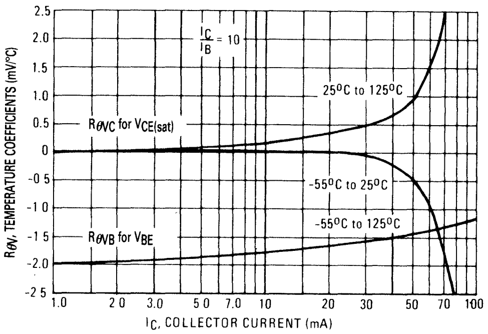


FIGURE 5 — CAPACITANCE

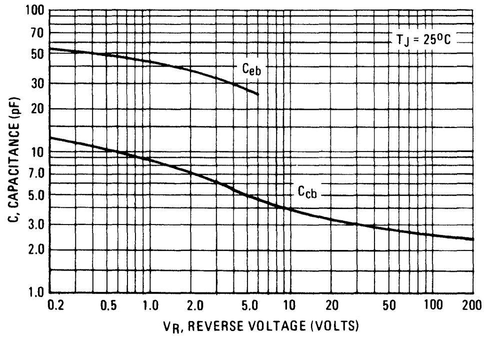


FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT

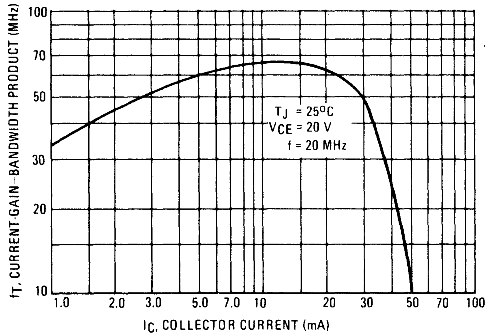
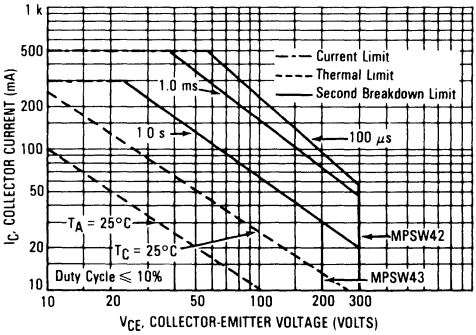
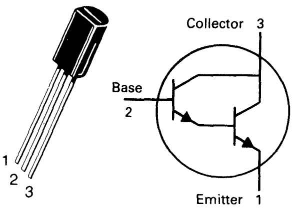


FIGURE 7 — ACTIVE REGION SAFE OPERATING AREA



MPSW45

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N6426 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc, V_{BE} = 0$)	$V_{(BR)CES}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc, I_E = 0$)	$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu Adc, I_C = 0$)	$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{EB} = 10$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain ($I_C = 200$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	 25,000 15,000 4,000	 150,000 — —	—
Collector-Emitter Saturation Voltage ($I_C = 1.0$ Adc, $I_B = 2.0$ mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 1.0$ Adc, $I_B = 2.0$ mAdc)	$V_{BE(sat)}$	—	2.0	Vdc
Base-Emitter On Voltage ($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 200$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)	f_T	100	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	6.0	pF

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

MAXIMUM RATINGS

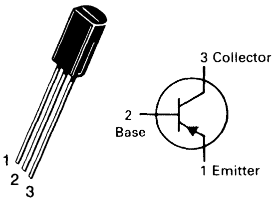
Rating	Symbol	Value	Unit
Collector-Emitter Voltage MPSW51 MPSW51A	V_{CEO}	 30 40	Vdc
Collector-Base Voltage MPSW51 MPSW51A	V_{CBO}	 40 50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1000	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

MPSW51, A

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT HIGH CURRENT TRANSISTORS

PNP SILICON

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPSW51 MPSW51A	$V_{(BR)CEO}$	 30 40	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPSW51 MPSW51A	$V_{(BR)CBO}$	 40 50	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$) ($V_{CB} = 40$ Vdc, $I_E = 0$)	 MPSW51 MPSW51A	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 55 60 50	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 1000$ mAdc, $I_B = 100$ mAdc)		$V_{CE(sat)}$	—	0.7	Vdc
Base-Emitter On Voltage ($I_C = 1000$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{obo}	—	30	pF

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

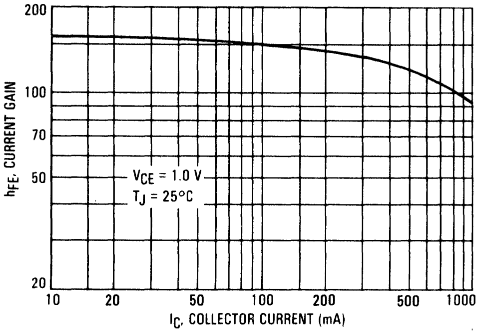


FIGURE 1 — DC CURRENT GAIN

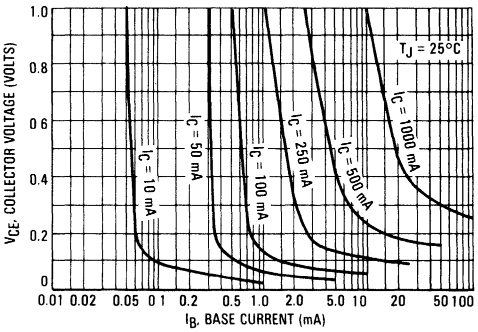


FIGURE 2 — COLLECTOR SATURATION REGION

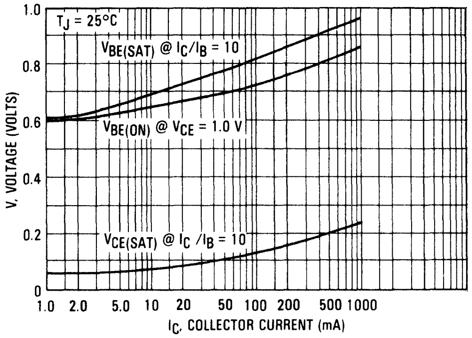


FIGURE 3 — ON VOLTAGES

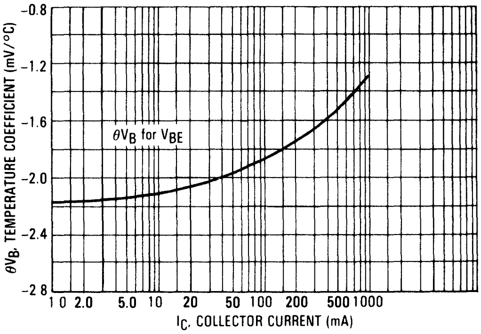


FIGURE 4 — TEMPERATURE COEFFICIENT

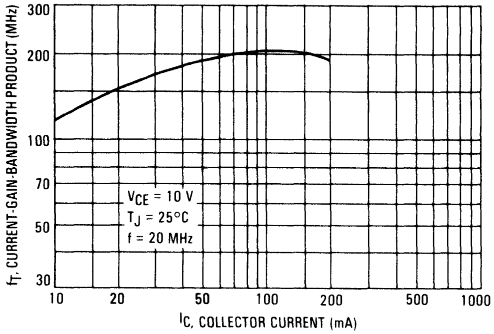


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT

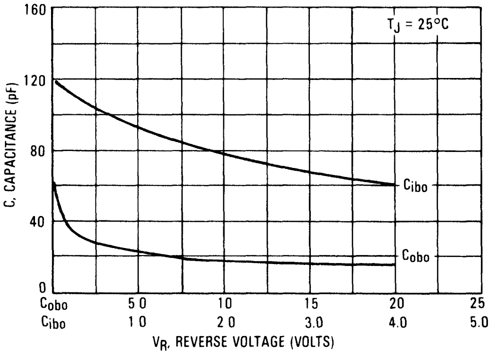
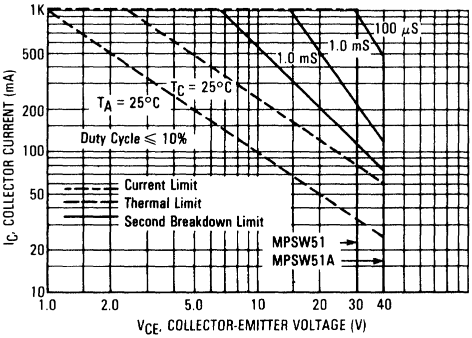


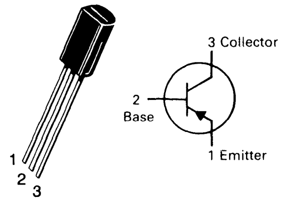
FIGURE 6 — CAPACITANCE

FIGURE 7 — ACTIVE REGION-SAFE OPERATING AREA



MPSW55
MPSW56

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSW55	MPSW56	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPSW55 MPSW56	$V_{(BR)CEO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 40$ Vdc, $I_B = 0$) ($V_{CE} = 60$ Vdc, $I_B = 0$)	 MPSW55 MPSW56	I_{CEO}	 — —	 0.5 0.5	μAdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$)	 MPSW55 MPSW56	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 250$ mAdc, $V_{CE} = 1.0$ Vdc)		h_{FE}	 100 50	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 250$ mAdc, $I_B = 10$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage ($I_C = 250$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 250$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, f = 1.0 MHz)		C_{obo}	—	15	pF

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

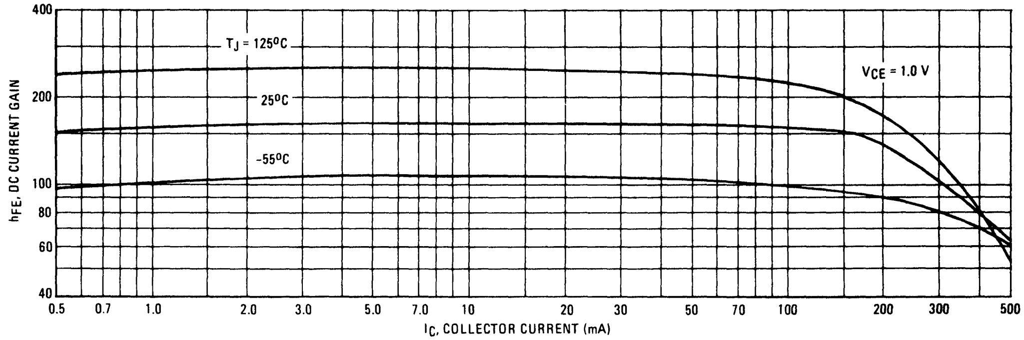


FIGURE 1 — D.C. CURRENT GAIN

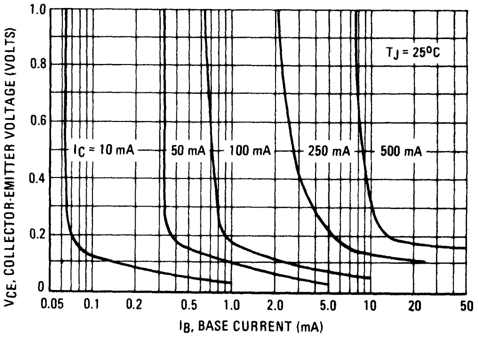


FIGURE 2 — COLLECTOR SATURATION REGION

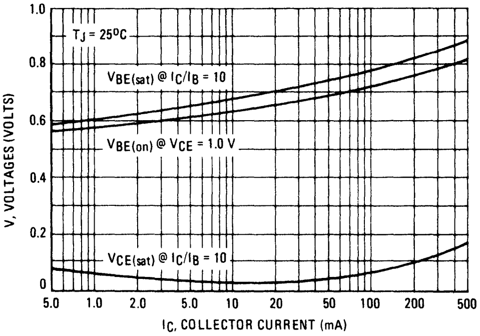


FIGURE 3 — ON VOLTAGES

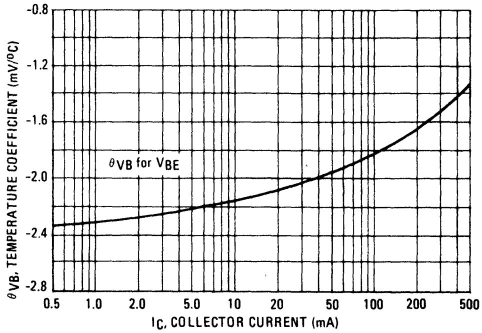


FIGURE 4 — BASE-EMITTER TEMPERATURE COEFFICIENT

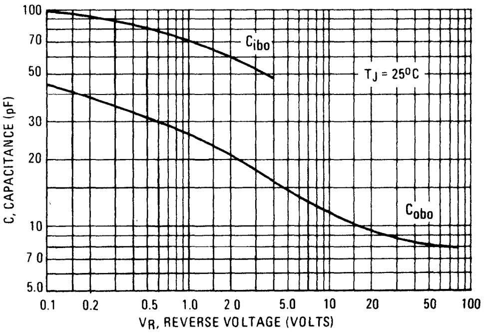


FIGURE 5 — CAPACITANCE

FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT

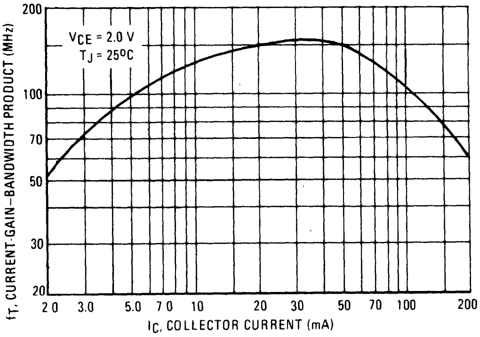
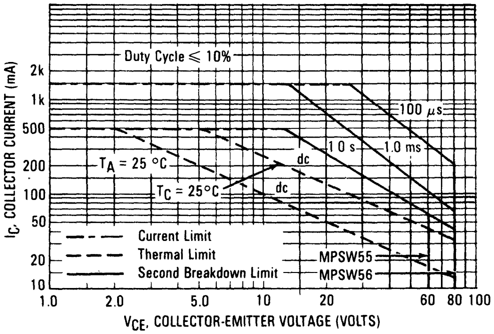
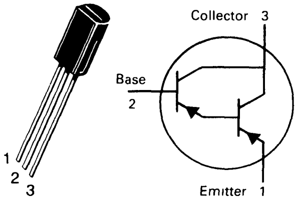


FIGURE 7 — ACTIVE REGION - SAFE OPERATING AREA



MPSW63
MPSW64

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT DARLINGTON TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSW63 MPSW64	Unit
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	10	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc$, $V_{BE} = 0$)		$V_{(BR)CES}$	30	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{EB} = 10$ Vdc, $I_C = 0$)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSW63		5,000	—	
	MPSW64		10,000	—	
($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	MPSW63		10,000	—	
	MPSW64		20,000	—	
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 0.1$ mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)		$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)		f_T	125	—	MHz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 – DC CURRENT GAIN

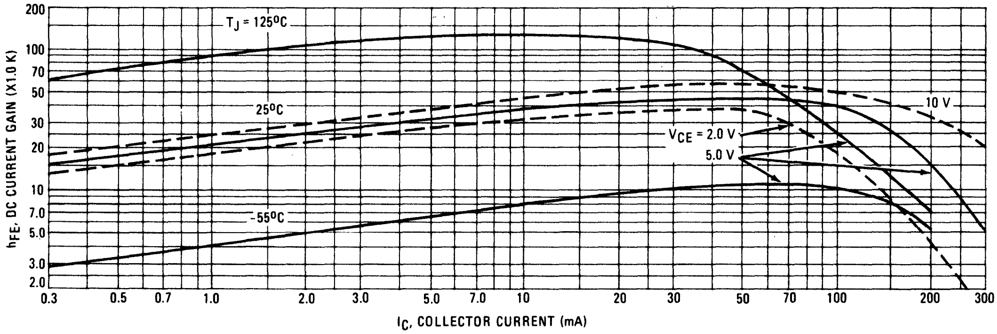


FIGURE 2 – "ON" VOLTAGE

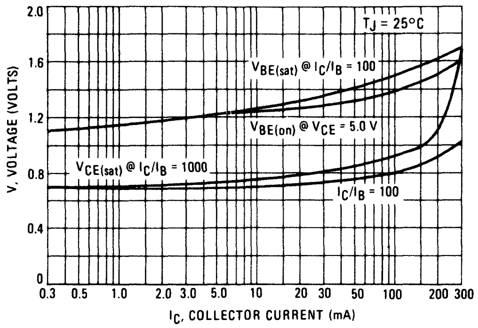


FIGURE 3 – COLLECTOR SATURATION REGION

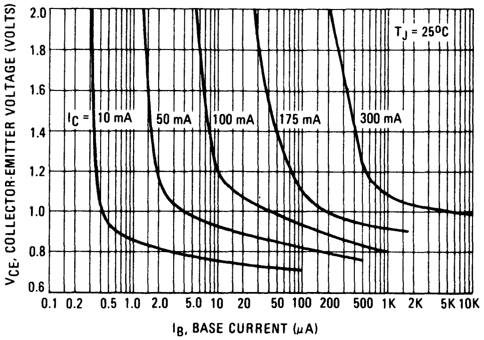


FIGURE 4 – TEMPERATURE COEFFICIENTS

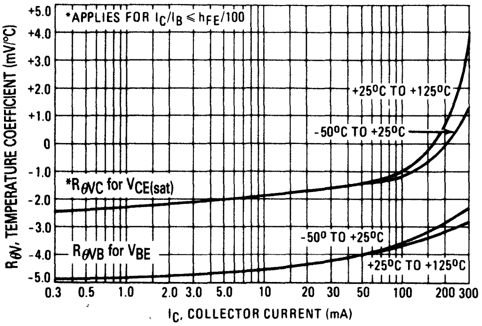


FIGURE 5 – CURRENT-GAIN–BANDWIDTH PRODUCT

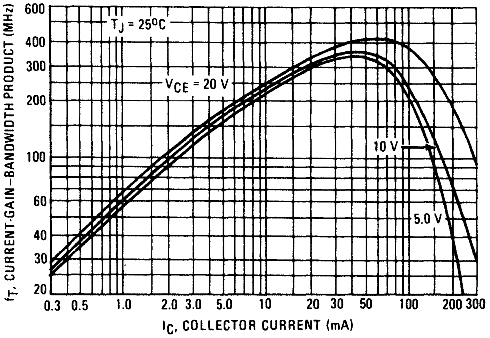


FIGURE 6 — CAPACITANCE

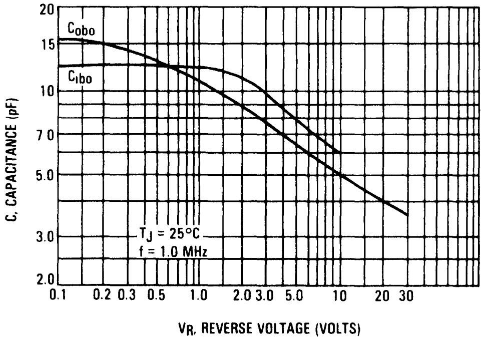
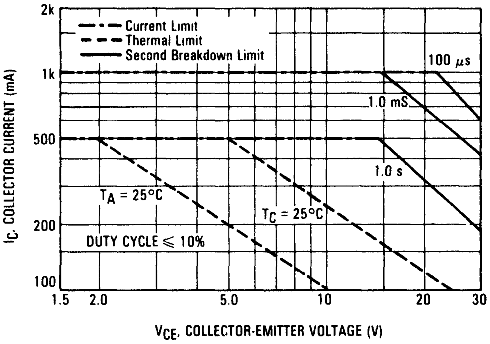
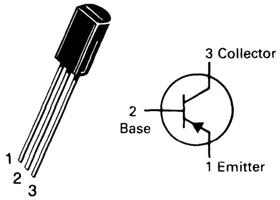


FIGURE 7 — ACTIVE REGION, SAFE OPERATING AREA



MPSW92
MPSW93

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT HIGH VOLTAGE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MPSW92	MPSW93	Unit
Collector-Emitter Voltage	V_{CEO}	300	200	Vdc
Collector-Base Voltage	V_{CBO}	300	200	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 20		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 MPSW92 MPSW93	$V_{(BR)CEO}$	 300 200	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 MPSW92 MPSW93	$V_{(BR)CBO}$	 300 200	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ Vdc, $I_E = 0$) ($V_{CB} = 160$ Vdc, $I_E = 0$)	 MPSW92 MPSW93	I_{CBO}	 — —	 0.25 0.25	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	 Both Types Both Types MPSW92 MPSW93	h_{FE}	 25 40 25 25	 — — — —	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)	 MPSW92 MPSW93	$V_{CE(sat)}$	 — —	 0.5 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Collector-Base Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)	 MPSW92 MPSW93	C_{cb}	 — —	 6.0 8.0	pF

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

FIGURE 1 — D.C. CURRENT GAIN

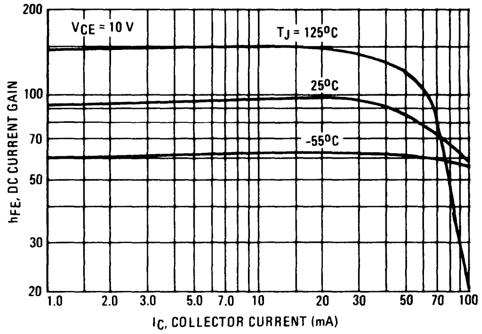


FIGURE 2 — COLLECTOR SATURATION REGION

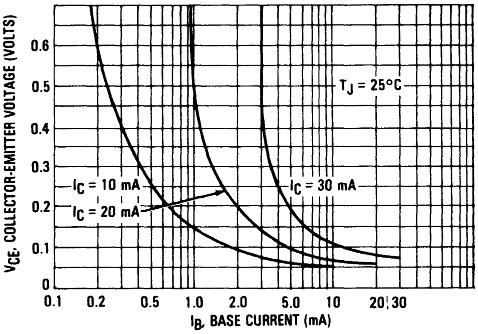


FIGURE 3 — ON VOLTAGES

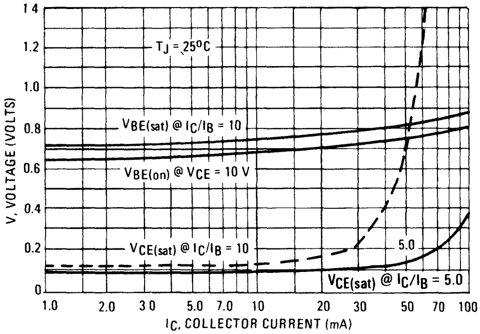


FIGURE 4 — TEMPERATURE COEFFICIENTS

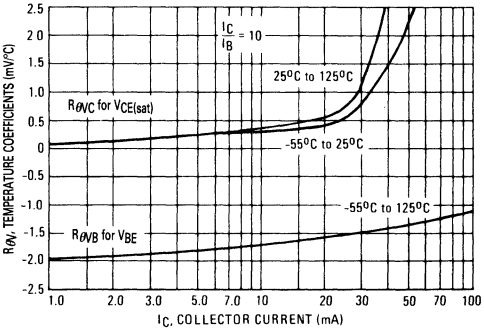


FIGURE 5 — CAPACITANCE

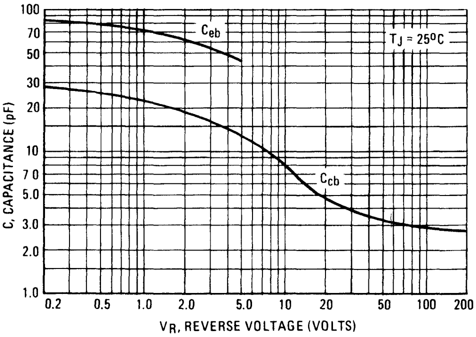


FIGURE 6 — CURRENT GAIN - BANDWIDTH PRODUCT

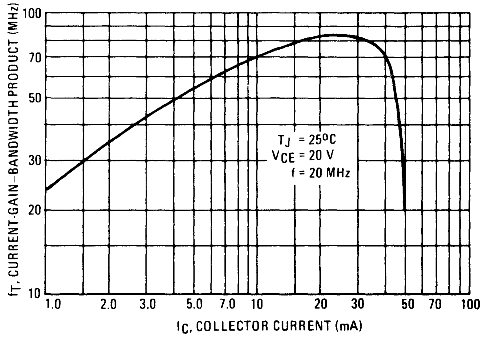
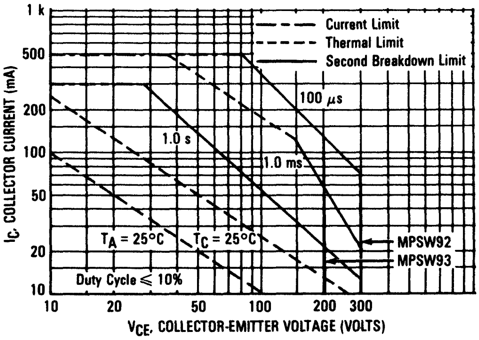
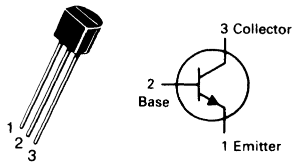


FIGURE 7 — ACTIVE REGION SAFE OPERATING AREA



PBF259, S

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	PBF259, S	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

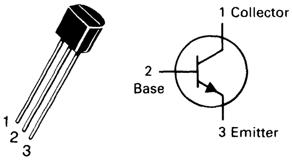
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JC}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 250 Vdc, I_E = 0)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 V)		I_{EBO}	—	20	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	50	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			—
(I_C = 20 mAdc, V_{CE} = 10 Vdc)	PBF259S		60	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 30 mAdc, I_B = 1.5 mAdc)			—	0.5	
(I_C = 30 mAdc, I_B = 60 mAdc)			—	1.0	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	40	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.0	pF

PBF259R, RS

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

Refer to MPSA92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	PBF493R,RS	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

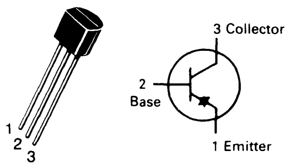
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JC}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 3.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 250 Vdc, I_E = 0)		I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 3.0 V)		I_{EBO}	—	20	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	50	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			—
(I_C = 20 mAdc, V_{CE} = 10 Vdc)	PBF259RS		60	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 30 mAdc, I_B = 1.5 mAdc)			—	0.5	
(I_C = 30 mAdc, I_B = 60 mAdc)			—	1.0	
Base-Emitter Saturation Voltage (I_C = 20 mA, I_B = 2.0 mA)		$V_{BE(sat)}$	—	0.9	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	40	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	3.0	pF

PBF493, S

CASE 29-04, STYLE 1
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA92 for graphs.

MAXIMUM RATINGS

Rating	Symbol	PBF493, S	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

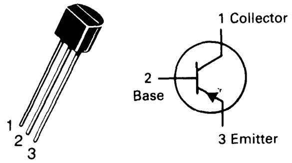
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JC}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)		I_{CBO}	—	0.25	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 V)		I_{EBO}	—	20	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	250	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	PBF493S		40	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	All Types		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		f_T	50	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	6.0	pF

PBF493R, RS

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



HIGH VOLTAGE TRANSISTORS

PNP SILICON

Refer to MPSA42 for graphs.

MAXIMUM RATINGS

Rating	Symbol	PBF259R,RS	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

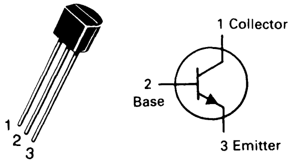
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JC}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 200 Vdc, I_E = 0)		I_{CBO}	—	0.25	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 V)		I_{EBO}	—	20	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	250	nAdc
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	PBF493RS		40	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	All Types		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)	All Types		25	—	
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		f_T	50	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	6.0	pF

P2N2222, A

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	P2N 2222	P2N 2222A	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current − Continuous	I_C	600		mAdc
Total Device Dissipation $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

Refer to MPS2222 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	P2N2222		30	—	
	P2N2222A		40	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	P2N2222		60	—	
	P2N2222A		75	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	P2N2222		5.0	—	
	P2N2222A		6.0	—	
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	P2N2222A	I_{CEX}	—	10	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	P2N2222		—	0.01	
(V_{CB} = 60 Vdc, I_E = 0)	P2N2222A		—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	P2N2222		—	10	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	P2N2222A		—	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	P2N2222A	I_{EBO}	—	10	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	P2N2222A	I_{BEX}	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)			35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)			50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)			75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	P2N2222A only		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc) (1)			100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (1)			50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc) (1)	P2N2222		30	—	
	P2N2222A		40	—	
Collector-Emitter Saturation Voltage (1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	P2N2222		—	0.4	
	P2N2222A		—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)	P2N2222		—	1.6	
	P2N2222A		—	1.0	

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

Characteristic	Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage (1)	$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc) P2N2222		—	1.3	
P2N2222A		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc) P2N2222		—	2.6	
P2N2222A		—	2.0	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain – Bandwidth Product (2)	f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) P2N2222		250	—	
P2N2222A		300	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance	C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz) P2N2222		—	30	
P2N2222A		—	25	
Input Impedance	h_{ie}			kΩ
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		0.25	1.25	
Voltage Feedback Ratio	h_{re}			$X10^{-4}$
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		—	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		—	4.0	
Small-Signal Current Gain	h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		75	375	
Output Admittance	h_{oe}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) P2N2222A		25	200	
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz) P2N2222A	$rb'C_c$	—	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz) P2N2222A	N_F		4.0	dB

SWITCHING CHARACTERISTICS MPS2222A only

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 1)	t_d	—	10	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_s	—	225	ns
Fall Time		t_f	—	60	ns

(1) Pulse Test: Pulse Width ≦ 300 μs, Duty Cycle ≦ 2.0%. (2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 — TURN-ON TIME

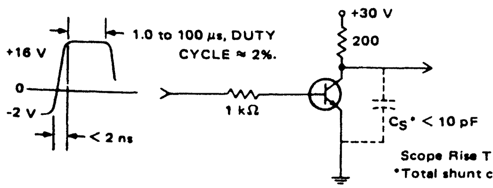
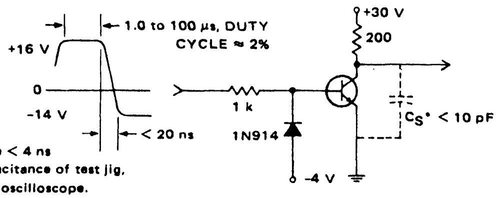


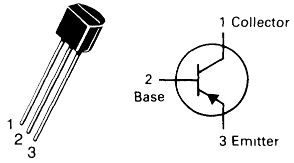
FIGURE 2 — TURN-OFF TIME



Scope Rise Time < 4 ns
*Total shunt capacitance of test jig, connectors, and oscilloscope.

P2N2907, A

CASE 29-04, STYLE 17
TO-92 (TO-226AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MPS2907 for graphs.

MAXIMUM RATINGS

Rating	Symbol	P2N 2907	P2N 2907A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current − Continuous	I_C	600		mAdc
Total Device Dissipation $T_A = 25°C$ Derate above 25°C	P_D	625 5.0		mW mW/°C
Total Device Dissipation $T_C = 25°C$ Derate above 25°C	P_D	1.5 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mAdc, I_B = 0)	P2N2907	$V_{(BR)CEO}$	40	—	Vdc
	P2N2907A		60	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc)		I_{CEX}	—	50	nAdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	P2N2907	I_{CBO}	—	0.02	μAdc
	P2N2907A		—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	P2N2907		—	20	
	P2N2907A		—	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc)		I_{EBO}	—	10	nAdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	10	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, $V_{EB(off)}$ = 0.5 Vdc)		I_{BEX}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	P2N2907	h_{FE}	35	—	—
	P2N2907A		75	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	P2N2907		50	—	
	P2N2907A		100	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	P2N2907		75	—	
	P2N2907A		100	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc) (1)	P2N2907, P2N2907A		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc) (1)	P2N2907		30	—	
	P2N2907A		50	—	
Collector-Emitter Saturation Voltage (1) (I_C = 150 mAdc, I_B = 15 mAdc)		$V_{CE(sat)}$	—	0.4	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.6	
Base-Emitter Saturation Voltage (1) (I_C = 150 mAdc, I_B = 15 mAdc)		$V_{BE(sat)}$	—	1.3	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)			—	2.6	

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain – Bandwidth Product (1), (2) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	30	pF
SWITCHING CHARACTERISTICS					
Turn-On Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figures 1 and 5)	t_{on}	—	50	ns
Delay Time		t_d	—	10	ns
Rise Rime		t_r	—	40	ns
Turn-Off Time	(V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 2)	t_{off}	—	110	ns
Storage Time		t_s	—	80	ns
Fall Time		t_f	—	30	ns

FIGURE 1 – DELAY AND RISE TIME TEST CIRCUIT

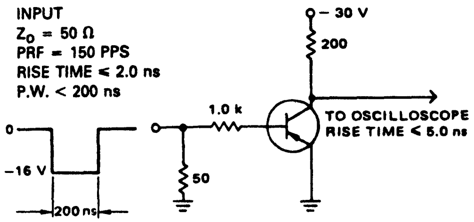
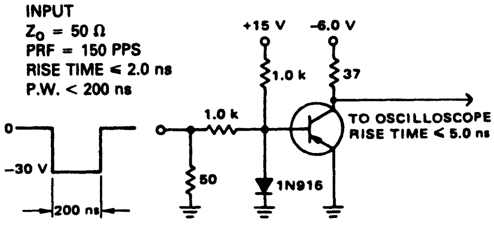
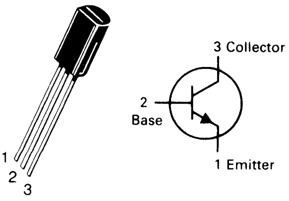


FIGURE 2 – STORAGE AND FALL TIME TEST CIRCUIT



P2N3019

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation $T_A = 25°C$ Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Total Device Dissipation $T_C = 25°C$ Derate above 25°C	P_D	2.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

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

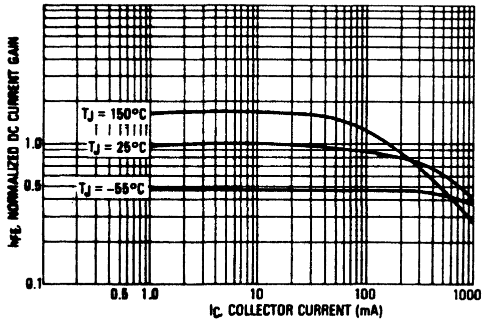
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) ($I_C = 30$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	120	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 90$ Vdc, $I_E = 0$) ($V_{CB} = 90$ Vdc, $I_E = 0$, $T_A = +150°C$)	I_{CBO}	 — —	 0.01 10	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.01	μAdc
ON CHARACTERISTICS				
DC Current Gain (1) ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) P2N3019 ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) P2N3019 ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc) P2N3019 ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc, $T_C = -55°C$) P2N3019 ($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc) P2N3019 ($I_C = 1.0$ Adc, $V_{CE} = 10$ Vdc)	h_{FE}	 50 90 100 40 50 15	 — — 300 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	 — —	 0.2 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz) P2N3019	f_T	80	—	MHz

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

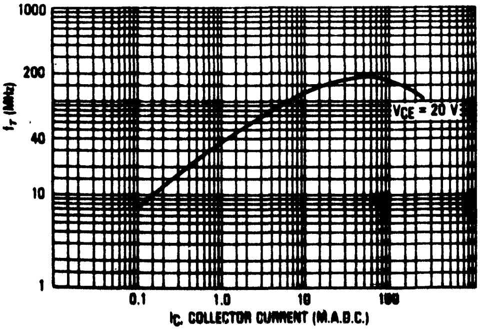
Characteristic	Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	12	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	60	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) P2N3019	h_{fe}	80	400	—
Collector Base Time Constant (I_E = 10 mAdc, V_{CB} = 10 Vdc, f = 4.0 MHz) P2N3019	$r_{b'}C_c$	—	400	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kohms, f = 1.0 kHz)	N_F	—	4.0	dB

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

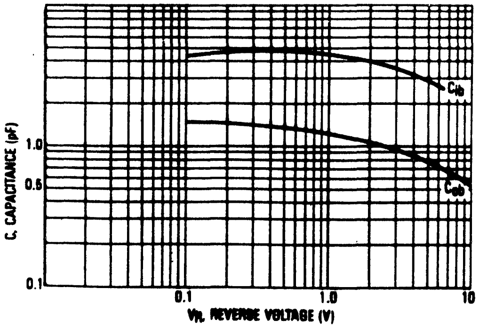
DC CURRENT GAIN
P2N3019



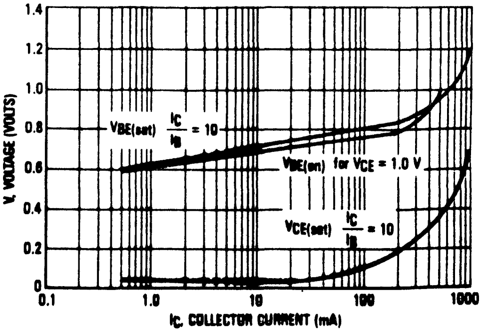
CURRENT GAIN — BANDWIDTH PRODUCT



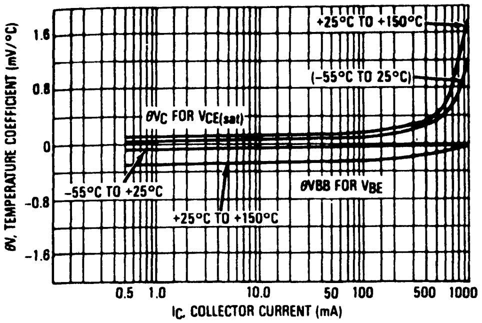
CAPACITANCE



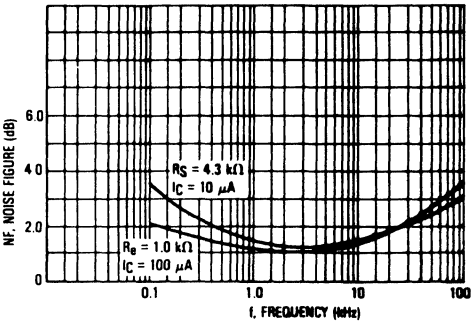
"ON" VOLTAGES



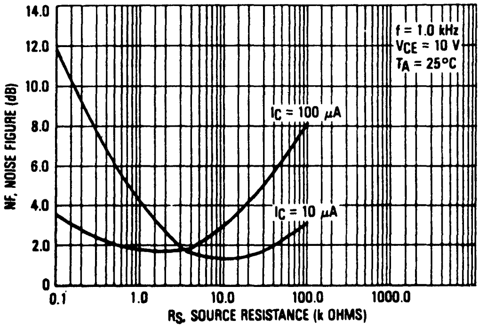
TEMPERATURE COEFFICIENTS



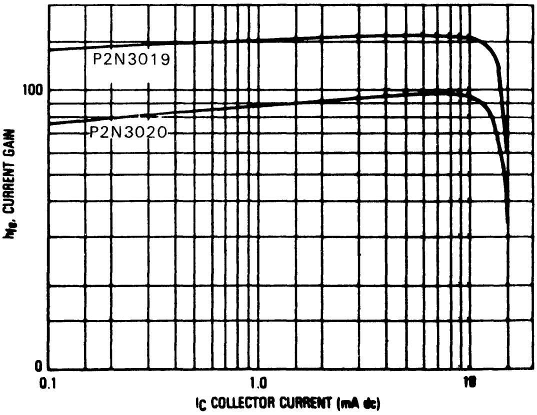
FREQUENCY EFFECTS



SOURCE RESISTANCE EFFECTS

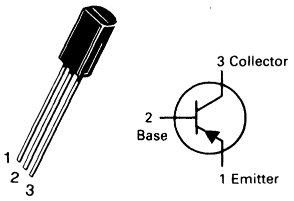


CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT — 1 kHz h_{fe}



P2N4033

CASE 29-03, STYLE 1
TO-92 (TO-226AE)



ONE WATT AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	W mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 20	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JC}$	125	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)		$V_{(BR)CEO}$	80	—	V
Collector-Base Breakdown Voltage (I_C = 10 μA)		$V_{(BR)CBO}$	80	—	V
Emitter-Base Breakdown Voltage (I_E = 10 μA)		$V_{(BR)EBO}$	5.0	—	V
Collector Cutoff Current		I_{CBO}			
(V_{CB} = 60 V)			—	5.0	nA
(V_{CB} = 60 V, T_A = 150°C)			—	50	μA
Emitter Cutoff Current (V_{EB} = 5.0 V)		I_{EBO}	—	10	nA
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 mA, V_{CE} = 5.0 V, −55°C)	P2N4033		40	—	
(I_C = 100 μA, V_{CE} = 5.0 V)	P2N4033		75	—	
(I_C = 100 mA, V_{CE} = 5.0 V)	P2N4033		100	300	
(I_C = 500 mA, V_{CE} = 5.0 V)	P2N4033		70	—	
(I_C = 1.0 A, V_{CE} = 5.0 V)	P2N4033		25	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)			—	0.15	
(I_C = 500 mA, I_B = 50 mA)			—	0.5	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)			—	0.9	
(I_C = 500 mA, I_B = 50 mA)			—	1.1	

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

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CE} = 10 V, f = 1.0 MHz)	C_{obo}	—	25	pF
Input Capacitance (V_{EB} = 0.5 V, f = 1.0 MHz)	C_{ibo}	—	150	pF
Current Gain — Bandwidth Product (I_C = 50 mA, V_{CC} = 10 V, f = 100 MHz)	f_T	150		MHz
SWITCHING CHARACTERISTICS				
Turn-On Time (see Figure 1) (I_C = 500 mA, I_{B1} = 50 mA)	t_{on}	—	100	ns
Turn-Off Time (see Figure 1) (I_C = 500 mA, I_{B1} = I_{B2} = 50 mA)	t_{off}	—	400	ns

(1) Pulse Width = 300 µs, Duty Cycle 1.0%.

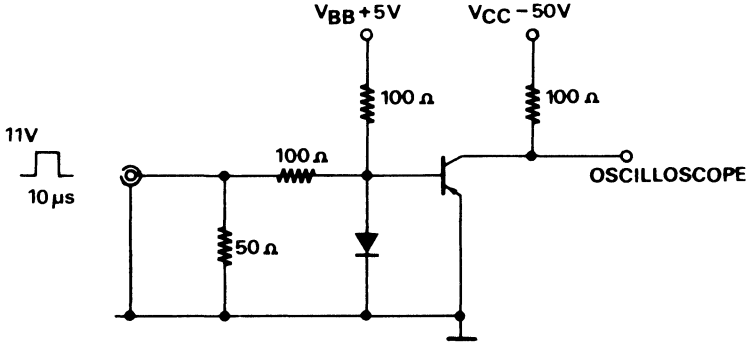
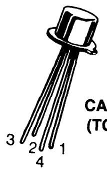
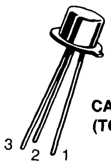


FIGURE 1: SWITCHING TIMES TEST CIRCUIT

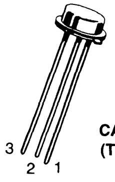
Metal-Can Transistors



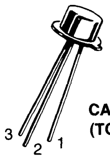
CASE 20-03
(TO-206AF)
TO-72



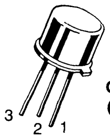
CASE 22-03
(TO-206AA)
TO-18



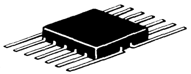
CASE 26-03
(TO-206AB)
TO-46



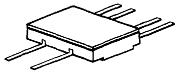
CASE 27-02
(TO-206AC)
TO-52



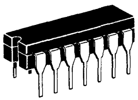
CASE 79-04
(TO-205AD)
TO-39



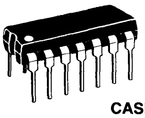
CASE 607-04



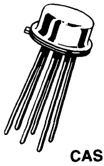
CASE 610A-04



CASE 632-08
(TO-116)



CASE 646-06
(TO-116)



CASE 654-07

Motorola's metal-can transistor product offering includes: general purpose, switching, high voltage, choppers, Darlingtons, low noise amplifiers and RF amplifiers.

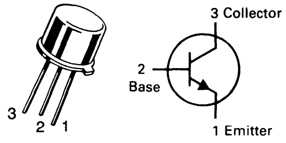
A variety of package options are available.

Many devices contained in this section are also available with high reliability MIL-S-19500 processing. JAN, JANTX, JANTXV, and JANS qualified devices are so noted on the following data sheets.

This section contains both single and multiple metal-can transistors.

2N657

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3498 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	8.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.7	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	4.0 22.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

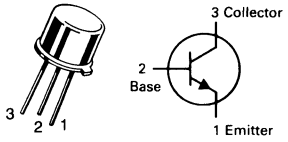
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 250\ \mu Adc$, $I_B = 0$)	$V_{(BR)CEO}$	100	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	100	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 250\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	8.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	10	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 200$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	30	90	—
Collector-Emitter Saturation Voltage(1) ($I_C = 200$ mAdc, $I_B = 40$ mAdc)	$V_{CE(sat)}$	—	4.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Input Impedance(1) ($I_B = 8.0$ mAdc, $V_{CE} = 10$ Vdc)	h_{fe}	—	0.5	k ohm

(1) Pulse Test: Pulse Length = 300 μs, Duty Cycle ≤ 2.0%.

2N697

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 4.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.0 13.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

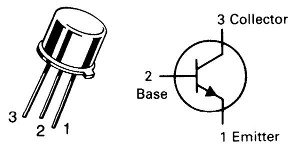
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 100 mAdc, R_{BE} = 10 ohms)	$V_{(BR)CER}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 1.0 100	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) (I_C = 150 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	120	—
Collector-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0)	C_{obo}	—	35	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	h_{fe}	2.5	—	MHz

(1) Pulse Test: Pulse Length ≤ 12 ms, Duty Cycle ≤ 2.0%.

2N699

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	80	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.6 4.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.0 13.3	Watts mW/°C
Operating and Storage Temperature Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	75	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	250	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) ($I_C = 100$ mAdc, $R_{BE} \leqq 10$ ohms)	$V_{(BR)CER}$	80	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	 — —	 2.0 200	μAdc
Emitter Cutoff Current ($V_{EB} = 2.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain (1) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	40	120	—
Collector-Emitter Saturation Voltage (1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	20	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ib}	 20 —	 30 10	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 khZ)	h_{rb}	 — —	 2.5 3.0	$X\ 10^{-4}$
Small Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	 35 45	 100 —	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ob}	 0.05 —	 0.5 1.0	μmhos

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

MAXIMUM RATINGS

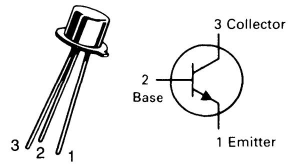
Rating	Symbol	Value	Unit
Collector-Emitter Voltage 2N706A,B	V_{CEO}	15	Vdc
Collector-Emitter Voltage(1)	V_{CER}	20	Volts
Collector-Base Voltage	V_{CBO}	25	Volts
Emitter-Base Voltage 2N706 2N706A 2N706B	V_{EBO}	3.0 5.0 5.0	Volts
Collector Current 2N706,A,B	I_C	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.3 2.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 6.67	Watts mW/°C
Total Device Dissipation @ $T_C = 100°C$ Derate above 100°C	P_D	0.5	Watt
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	150	°C/W
Thermal Resistance, Junction to Ambient 2N706A,B	$R_{\theta JA}$	500	°C/W

2N706, A, B

(2N706 JAN AVAILABLE)
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTORS

NPN SILICON

Refer to 2N2368 for graphs.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	15	—	Vdc
Collector-Emitter Breakdown Voltage(2) (R = 10 ohms, $I_C = 10$ mAdc)		$V_{(BR)CER}$	20	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$) ($V_{CB} = 15$ Vdc, $I_E = 0$, $T_A = 150°C$) ($V_{CB} = 25$ Vdc, $I_E = 0$)	 2N706A, 2N706B	I_{CBO}	 — — —	 0.5 30 10	μAdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $R_{BE} = 100k$)	 2N706A, 2N706B	I_{CER}	—	10	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$) ($V_{EB} = 5.0$ Vdc, $I_C = 0$)	 2N706 2N706A, 2N706B	I_{EBO}	 — —	 10 10	μAdc
ON CHARACTERISTICS					
DC Current Gain(2) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	 2N706 2N706A, 2N706B	h_{FE}	 20 20	 — 60	—
Collector-Emitter Saturation Voltage(2) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	 2N706, 2N706A 2N706B	$V_{CE(sat)}$	 — —	 0.6 0.4	Vdc
Base-Emitter Saturation Voltage(2) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	 2N706 2N706A, 2N706B	$V_{BE(sat)}$	 — 0.7	 0.9 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($V_{CE} = 15$ Vdc, $I_E = 10$ mAdc, f = 100 MHz)		f_T	200	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$) ($V_{CB} = 10$ Vdc, $I_E = 0$)	 2N706A, 2N706B 2N706	C_{obo}	 — —	 5.0 6.0	pF
Magnitude of Forward Current Transfer Ratio, Common-Emitter ($V_{CE} = 15$ Vdc, $I_E = 10$ mAdc, f = 100 Mhz) ($V_{CE} = 10$ Vdc, $I_E = 10$ mAdc, f = 100 MHz)	 2N706 2N706A,B	$\|h_{fe}\|$	 2.0 2.0	 — —	—

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

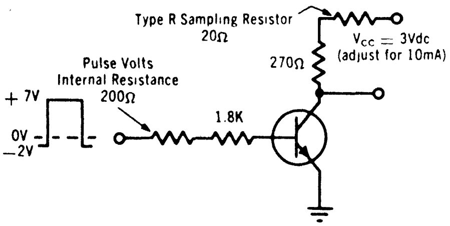
Characteristic		Symbol	Min	Max	Unit
Collector Base Time Constant (V_{CE} = 15 Vdc, I_E = 10 mAdc, f = 300 MHz)		r_b	—	50	ohms
Storage Time	2N706B	t_s	—	25	ns
Turn-On Time (I_{B1} = 3.0 mA, I_{B2} = 1.0 mA)		t_{on}	—	40	ns
Turn-Off Time (I_{B1} = 3.0 mA, I_{B2} = 1.0 mA)		t_{off}	—	75	ns
Charge Storage Time Constant(2)	2N706	τ_s	—	60	ns
	2N706A,B		—	25	

(1) Refers to collector breakdown voltage in the high current region when R_{be} = 10 Ω

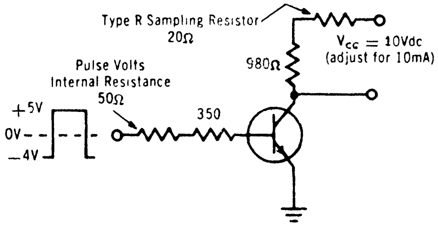
(2) Pulse Test: Pulse Width ≤ 12 μs, Duty Cycle ≤ 2.0%.

(3) Switching Times Measured with Tektronix Type R Plug-In (50 Ω Internal Impedance).

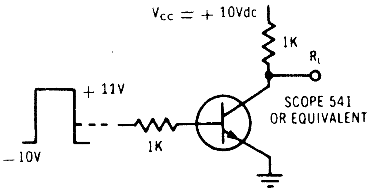
SWITCHING TIME TEST CIRCUIT



STORAGE TIME TEST CIRCUIT

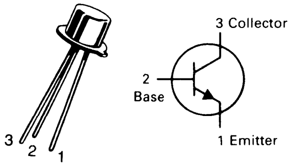


MEASUREMENT CIRCUIT



2N708

JAN, JTX AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage	V_{CER}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	limited by P_D only	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.1	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ $T_C = 100°C$ Derate above 25°C Derate above 100°C	P_D	1.2 680 6.9 6.9	Watts mW mW/°C mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

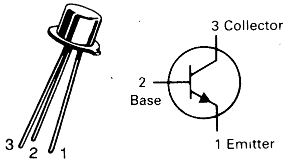
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	145	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 30$ mAdc, $R_{BE} \leq 10$ ohms)	$V_{CER(sus)}$	20	—	Vdc
Collector-Emitter Sustaining Voltage ($I_C = 30$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $V_{BE} = 0.25$ Vdc, $T_A = +125°C$)	I_{CEX}	—	10	μAdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) ($V_{CB} = 20$ Vdc, $I_C = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.025 15	μAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.08	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.5$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)(1) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$)(1)	h_{FE}	 15 30 15	 — 120 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 7.0$ mAdc, $I_B = 0.7$ mAdc, $T_A = -55°C$ to $+125°C$)	$V_{CE(sat)}$	 — —	 0.4 0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 7.0$ mAdc, $I_B = 0.7$ mAdc, $T_A = -55°C$)	$V_{BE(sat)}$	 0.72 —	 0.80 0.90	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, 100 kHz ≤ f ≤ 1.0 MHz)	C_{obo}	—	6.0	pF
Extrinsic Base Resistance ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 300 MHz)	r_b'	—	50	ohms
SWITCHING CHARACTERISTICS				
Storage Time ($I_C = I_{B1} = I_{B2} = 10$ mAdc)	t_s	—	25	ns
Turn-On Time	t_{on}	—	40	ns
Turn-Off Time	t_{off}	—	70	ns

2N718

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N2218 for graphs.

MAXIMUM RATINGS

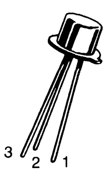
Rating	Symbol	Value	Unit
Collector-Emitter Voltage(1)	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	500	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 2.66	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 10	Watts mW/°C
Total Device Dissipation @$T_C = 100°C$	P_D	0.75	Watt
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

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

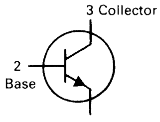
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, pulsed; $R_B \leq 10$ Ohms)	$V_{CER(sus)}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mA, I_C = 0)	$V_{(BR)EBO}$	5	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 1.0 100	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 150 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	120	—
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, f = 100 kHz, I_E = 0)	C_{obo}	—	35	pF
Input Capacitance (V_{BE} = 0.5 V, f = 100 kHz, I_C = 0)	C_{ibo}	—	80	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	h_{fe}	2.5	—	—

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

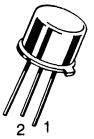
2N718A
2N956



2N718A JAN, JTX,
JTXV AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



2N1711



CASE 79-04, STYLE 1
TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N718A 2N956	2N1711	Unit
Collector-Emitter Voltage	V_{CER}	50		Vdc
Collector-Base Voltage	V_{CBO}	75		Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 2.86	800 4.57	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10.3	3.0 17.15	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, pulsed; $R_{BE} \leq$ 10 ohms)	$V_{CER(sus)}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 0.001 —	 0.01 10	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0) 2N718A, 2N956, 2N1711	I_{EBO}	 — —	 — —	 0.010 0.005	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.01 mAdc, V_{CE} = 10 Vdc) 2N956, 2N1711	h_{FE}	 20	 —	 —	—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc) 2N718A, 2N956, 2N1711		20 35	— —	— —	
(I_C = 10 mAdc, V_{CE} = 10 Vdc) 2N718A, 2N956, 2N1711		35 75	— —	— —	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C) 2N718A, 2N956, 2N1711		20 35	— —	— —	
(I_C = 150 mAdc, V_{CE} = 10 Vdc) 2N718A, 2N956, 2N1711		40 100	— —	120 300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc) 2N718A, 2N956, 2N1711		20 40	— —	— —	
Collector-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.24	1.5	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	1.0	1.3	Vdc

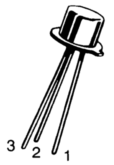
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

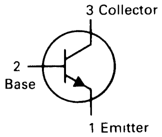
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	2N718A, 2N956, 2N1711	f_T	60 70	300 300	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	25	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	20	80	pF
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I_C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)		h_{ib}	24 4.0	— —	34 8.0	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N718A, 2N956, 2N1711	h_{rb}	— —	— —	3.0 5.0	X 10^{-4}
(I_C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)	2N718A, 2N956, 2N1711		— —	— —	3.0 5.0	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N718A, 2N956, 2N1711	h_{fe}	30 50	— —	100 200	—
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N718A, 2N956, 2N1711		35 70	— —	150 300	
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I_C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz)		h_{ob}	0.05 0.05	— —	0.5 0.5	μmhos
Noise Figure (I_C = 300 μAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N718A, 2N956, 2N1711	NF	— —	— —	12 8.0	dB

2N720A

CASE 22-03, STYLE 1
TO-18 (TO-206AA)





GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Emitter Voltage	V_{CER}	100	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.5 2.86	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	°C/W

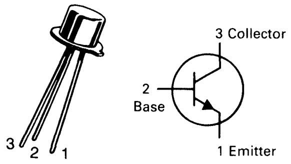
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 100$ mAdc, $R_{BE} \leq 10$ ohms)	$V_{CER(sus)}$	100	—	Vdc
Collector-Emitter Sustaining Voltage(1) ($I_C = 30$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	120	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 90$ Vdc, $I_E = 0$) ($V_{CB} = 90$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	.010 15	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	.010	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, $T_A = -55°C$) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)	h_{FE}	20 35 20 40	— — — 120	—
Collector-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	— —	1.2 5.0	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	— —	0.9 1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	15	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	85	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ib}	20 4.0	30 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{rb}	— —	1.25 1.50	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30 45	100 —	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ob}	— —	0.5 0.5	μmhos

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

2N835

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

MAXIMUM RATINGS

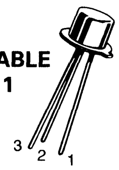
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous Peak	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.3 2.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 6.67	Watts mW/°C
Total Device Dissipation @ $T_C = 100°C$ Derate above 100°C	P_D	0.5 6.67	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

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

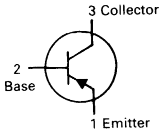
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) ($V_{CB} = 20$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.5 30	μAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 0$)	I_{CES}	—	10	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	— —	0.25 0.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 15$ Vdc, f = 100 MHz)	f_T	350	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	4.0	pF
Magnitude of Forward Current Transfer Ratio, Common-Emitter ($I_C = 10$ mAdc, $V_{CE} = 15$ Vdc, f = 100 MHz)	$\|h_{fe}\|$	3.5	—	—
SWITCHING CHARACTERISTICS				
Charge-Storage Time Constant (Figure 2) ($I_C = 10$ mAdc, $I_{B1} = I_{B2} = 10$ mAdc)	t_s	—	25	ns
Turn-On Time (Figure 1) ($I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc, $I_{B2} = 1.0$ mAdc)	t_{on}	—	35	ns
Turn-Off Time (Figure 1) ($I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc, $I_{B2} = 1.0$ mAdc)	t_{off}	—	75	ns

(1) Pulse Test: Pulse Width ≤ 12 ms, Duty Cycle ≤ 2.0%.

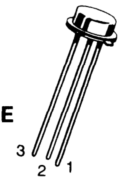
2N869A



JAN, JTX, JTXV AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



2N4453



JAN, JANTX AVAILABLE
CASE 26-03, STYLE 1
TO-46 (TO-206AB)

SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N869A	2N4453	Unit
Collector-Emitter Voltage	V_{CEO}	18	18	Vdc
Collector-Emitter Voltage	V_{CES}	25		Vdc
Collector-Base Voltage	V_{CBO}	25	25	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.06	400 2.29	mW mW/°C
Total Device Dissipation @ T_C = 25°C TC = 100°C Derate above 25°C	P_D	1.2 0.686 6.86	2.0 1.03 11.3	Watts Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N869A	2N4453	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	97.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	585	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0) 2N4453	$V_{(BR)CEO}$	18	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0) 2N869A, 2N4453	$V_{(BR)CES}$	25	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	18	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0) 2N869A, 2N4453	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C) 2N869A	I_{CBO}	—	25	μAdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	10	nAdc
Emitter Cutoff Current (V_{EB} = 4.5 Vdc, I_C = 0) 2N4453	I_{EBO}	—	10	nAdc
Base Current 2N869A (V_{CE} = 15 Vdc, V_{BE} = 0)	I_B	—	10	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 0.3 Vdc) 2N869A (I_C = 10 mAdc, V_{CE} = 5.0 Vdc) 2N869A (I_C = 30 mAdc, V_{CE} = 0.5 Vdc) 2N869A, 2N4453 (I_C = 30 mAdc, V_{CE} = 0.5 Vdc, T_A = −55°C) 2N869A, 2N4453 (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) 2N869A, 2N4453	h_{FE}	 30 40 40 17 25	 — 120 120 — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) 2N869A (I_C = 30 mAdc, I_B = 1.5 mAdc) 2N4453 (I_C = 30 mAdc, I_B = 3.0 mAdc) 2N869A (I_C = 100 mAdc, I_B = 10 mAdc) 2N869A, 2N4453	$V_{CE(sat)}$	 — — — —	 0.15 0.25 0.2 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) 2N869A (I_C = 30 mAdc, I_B = 1.5 mAdc) 2N4453 (I_C = 30 mAdc, I_B = 3.0 mAdc) 2N869A (I_C = 100 mAdc, I_B = 10 mAdc) 2N869A, 2N4453	$V_{BE(sat)}$	 0.78 0.8 0.85 —	 0.98 1.1 1.2 1.7	Vdc

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1)(2) (I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 100 MHz)		f_T	400	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	2N869A	C_{obo}	—	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 150 kHz)	2N869A	C_{ibo}	—	6.0	pF
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	2N4453	C_{cb}	—	6.0	pF
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N4453	C_{eb}	—	6.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time	I_C = 30 mAdc, I_{B1} = 1.5 mAdc; V_{CC} = 2.0 Vdc, 2N869A	t_{on}	—	50	ns
Delay Time	V_{CC} = 3.0 Vdc 2N4453	t_d	—	35	ns
Rise Time	2N4453	t_r	—	20	ns
Turn-Off Time	I_C = 30 mAdc, I_{B1} = I_{B2} = 1.5 mAdc; V_{CC} = 2.0 Vdc 2N869A	t_{off}	—	80	ns
Storage Time	V_{CC} = 3.0 Vdc 2N4453	t_s	—	65	ns
Fall Time	2N4453	t_f	—	20	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 1.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

TYPICAL SWITCHING CHARACTERISTICS

FIGURE 1 — CAPACITANCE

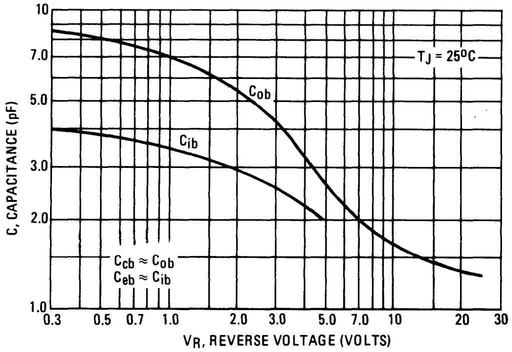


FIGURE 2 — DC CURRENT GAIN

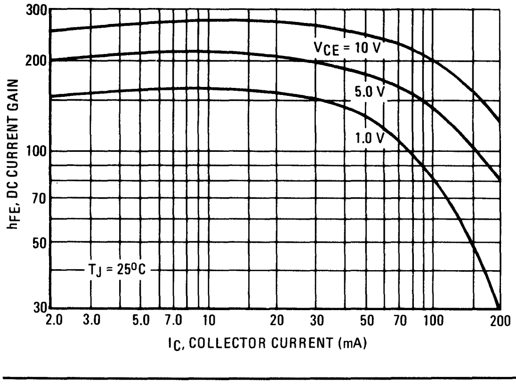


FIGURE 3 — "ON" VOLTAGES

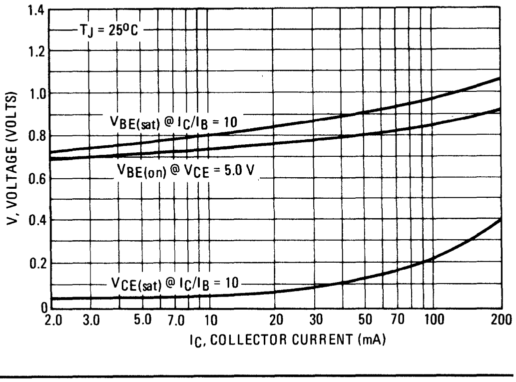


FIGURE 4 — CURRENT-GAIN — BANDWIDTH PRODUCT

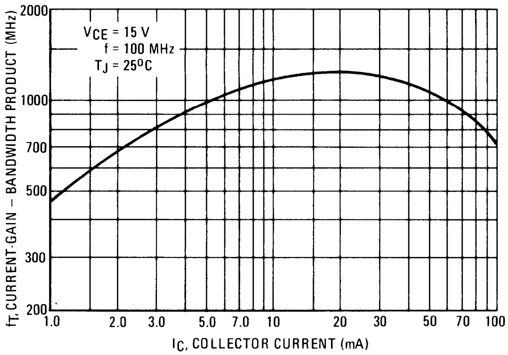


FIGURE 5 — TURN-ON TIME

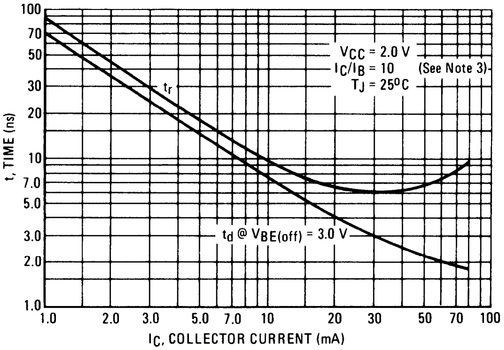


FIGURE 6 — TURN-OFF TIME

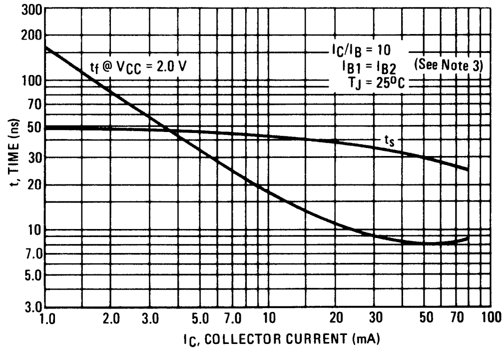


FIGURE 7 — SWITCHING TIME TEST CIRCUIT

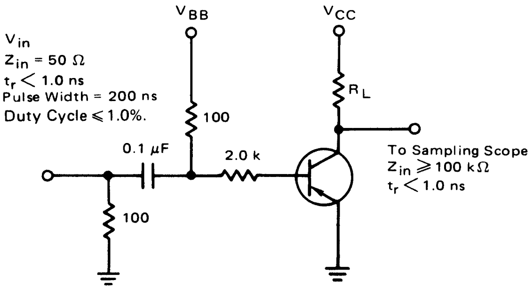


FIGURE 8 — SWITCHING TEST CIRCUIT VALUES

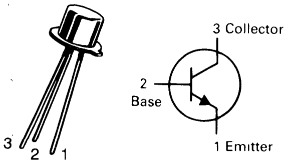
		V_{in} Volts	V_{BB} Volts	V_{CC} Volts	R_L Ohms	I_C mA	I_{B1}[4] mA	I_{B2}[4] mA
t_{on}, t_r, t_d	2N869A	-7.0	3.0	2.0	62	30	1.5	–
	2N4453	-7.0	3.0	3.0	91	30	1.5	–
t_{off}, t_s, t_f	2N869A	+6.0	-4.0	2.0	62	30	1.5	1.5
	2N4453	+6.0	-4.0	3.0	91	30	1.5	1.5

(3) I_C/I_B = 10. Switching is shown to reflect current industry practices. Compare the values shown in Figures 1 and 2 @ I_C = 30 mA to the typical values in the Electrical Characteristics table @ I_C/I_B = 20.

(4) I_{B1} = I_{B2} = 3.0 mA @ I_C/I_B = 10

2N910

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CER}	80	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current — Continuous	I_C	1.0	Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.86	Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.8 1.0 10.3	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97.4	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	350	°C/W

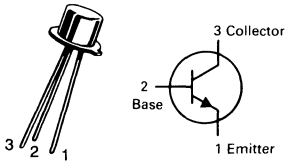
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, $R_{BE} \leq$ 10 ohms)(1)	$V_{CER(sus)}$	80	—	Vdc
Collector-Emitter Sustaining Voltage (I_C = 30 mAdc, I_B = 0)(1)	$V_{CEO(sus)}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current (V_{CB} = 75 Vdc, I_E = 0) (V_{CB} = 75 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	0.025 15	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	0.025	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	h_{FE}	35 75 30	— — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	— —	0.4 1.2	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	0.6 —	0.8 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	15	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	85	pF
Input Impedance (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{ie}	—	1800	Ohms
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I_C = 5.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ib}	20 4.0	30 8.0	Ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{rb}	—	3.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	76	200	—
Output Admittance (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{oe}	—	100	μmhos
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) (I_C = 5.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ob}	— —	0.5 1.0	μmho
Noise Figure (I_C = 0.3 mAdc, V_{CB} = 10 Vdc, R_G = 510 ohms, f = 1.0 kHz, B W = 200 Hz)	NF	—	12	dB

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

2N914

JAN, JTX AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage ($R_{BE} \leq 10$ ohms)	V_{CER}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous(1)	I_C	150	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.06	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.8	Watts mW/°C
Total Device Dissipation @ $T_C = 100°C$ Derate above 100°C	P_D	0.68	Watt
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

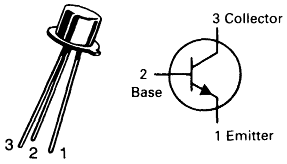
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) ($I_C = 30$ mAdc, $R_{BE} \leq 10$ ohms)	$V_{CER(sus)}$	20	—	Vdc
Collector-Emitter Sustaining Voltage(2) ($I_C = 30$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $V_{BE} = 0.25$ Vdc, $T_A = 125°C$)	I_{CEX}	—	10	μAdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) ($V_{CB} = 20$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.025 15	μAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain(2) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$) ($I_C = 500$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	 30 12 10	 120 — —	—
Collector-Emitter Saturation Voltage(2) ($I_C = 200$ mAdc, $I_B = 20$ mAdc) ($I_C = 10$ mAdc, $I_B = 1.0$ thru 20 mAdc, $T_A = -55$ to $+125°C$)	$V_{CE(sat)}$	 — —	 0.70 0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	0.70	0.80	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	9.0	pF
SWITCHING CHARACTERISTICS				
Storage Time(3) ($I_C = I_{B1} = I_{B2} = 20$ mAdc)	t_s	—	20	ns
Turn-On Time(3) ($I_C = 200$ mAdc, $I_{B1} = 40$ mAdc, $I_{B2} = 20$ mAdc)	t_{on}	—	40	ns
Turn-Off Time(3) ($I_C = 200$ mAdc, $I_{B1} = 40$ mAdc, $I_{B2} = 20$ mAdc)	t_{off}	—	40	ns

(1) Limited by Power Dissipation.
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 1.0%.
(3) Measured on Sampling Scope: Pulse Width ≥ 200 ns.

2N915

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3946 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.05	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.81	Watts mW/°C
Total Power Dissipation @ + 100°C Case	P_D	0.68	W
Operating and Storage Temperature Temperature Range	T_J, T_{stg}	−65 to +200	°C

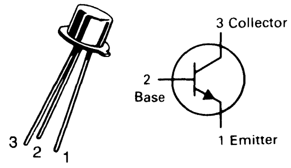
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage(1) ($I_C = 10$ mA $I_B = 0$)	$V_{CEO(sus)}$	50	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$A $I_E = 0$)	$V_{(BR)CBO}$	70	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$A, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ V, $I_E = 0$)	I_{CBO}	—	0.010	μA
Collector Cutoff Current ($V_{CB} = 60$ V, $I_E = 0$) ($V_{CB} = 60$ V, $I_E = 0$, $T_A = +150°C$)	I_{CBO}	 — —	 0.010 30	μA
ON CHARACTERISTICS				
DC Current Gain ($I_C = 10$ mA $V_{CE} = 5.0$ V)	h_{FE}	50	200	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mA $I_B = 1.0$ mA	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mA $I_B = 1.0$ mA)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($I_E = 0$ $V_{CB} = 10$ V, f = 100 kHz)	C_{obo}	—	3.5	pF
Emitter Transition Capacitance ($I_C = 0$ $V_{EB} = 0.5$ V, f = 100 kHz)	C_{TE}	—	10	pF
Input Impedance ($I_C = 1.0$ mA $V_{CE} = 5.0$ V) ($I_C = 5.0$ mA $V_{CE} = 5.0$ V)	h_{ie}	 — —	 6000 2000	ohms
High Frequency Current Gain f = 100 MHz ($I_C = 10$ mA $V_{CE} = 15$ V)	h_{fe}	2.5	—	—
Small-Signal Current Gain f = 1 kHz ($I_C = 1.0$ mA $V_{CE} = 5.0$ V) ($I_C = 5.0$ mA $V_{CE} = 5.0$ V)	h_{fe}	 40 50	 200 250	—
Output Admittance ($I_C = 1.0$ mA $V_{CE} = 5.0$ V) ($I_C = 5.0$ mA $V_{CE} = 5.0$ V)	h_{oe}	 — —	 75 125	 μmhos μmho
Collector Base Time Constant ($I_C = 10$ mA, $V_{CB} = 10$ V, f = 40 mHz)	$r_{b}'C_c$		300	ps

(1) Pulse Test: PW ≦ 300 μs, Duty Cycle ≦ 1.0%.

2N916

JAN AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3946 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

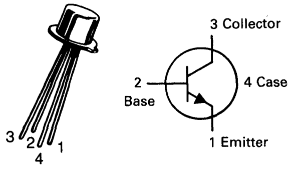
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage(1) (I_C = 30 mA, I_B = 0)	$V_{CEO(sus)}$	25	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)	$V_{(BR)CBO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0)	I_{CBO}	—	10	nAdc
Collector Cutoff Current @ 150°C (V_{CB} = 30 V, I_E = 0)	I_{CBO}	—	10	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) (I_C = 10 mA, V_{CE} = 1.0 V) (I_C = 10 mA, V_{CE} = 1.0 V, −55°C)	h_{FE}	 50 15	 200 —	—
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1.0 mA)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 V, I_E = 0)	C_{obo}	—	6.0	pF
Input Capacitance (V_{EB} = 0.5 V, I_C = 0)	C_{ibo}	—	10	pF
Input Impedance, f = 1.0 kHz (I_C = 1.0 mA, V_{CE} = 5.0 V) (I_C = 5.0 mA, V_{CE} = 5.0 V)	h_{ie}	 — —	 6000 2000	 ohms ohms
Small-Signal Current Gain, f = 1.0 kHz (I_C = 1.0 mA, V_{CE} = 5.0 V) (I_C = 5.0 mA, V_{CE} = 5.0 V)	h_{fe}	 40 50	 200 250	—
Magnitude of Forward Circuit Transfer Ratio, Common-Emitter (I_C = 10 mA, V_{CE} = 15 V)	$\|h_{fe}\|$	3.0	—	—
Output Admittance, f = 1.0 kHz (I_C = 1.0 mA, V_{CE} = 5.0 V) (I_C = 5.0 mA, V_{CE} = 5.0 V)	h_{oe}	 — —	 75 125	 μmho μmho
Collector Base Time Constant (I_C = 10 mA, V_{CB} = 10 V, f = 40 MHz)	$r_b'C_c$	—	300	ps

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

2N918

JAN, JTX, JTXV AVAILABLE
CASE 20-03, STYLE 10
TO-72 (TO-206AF)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

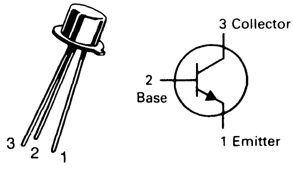
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage ($I_C = 3.0$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$) ($V_{CB} = 15$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	.010 1.0	μAdc μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 3.0$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	20	—	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(1) ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	600	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz) ($V_{CB} = 0$, $I_E = 0$, f = 140 kHz)	C_{obo}	— —	1.7 3.0	pF
Input Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	2.0	pF
Noise Figure ($I_C = 1.0$ mAdc, $V_{CE} = 6.0$ Vdc, $R_G = 400$ Ohms, f = 60 MHz)	NF	—	6.0	dB
FUNCTIONAL TEST				
Amplifier Power Gain ($V_{CB} = 12$ Vdc, $I_C = 6.0$ mAdc, f = 200 MHz)	G_{pe}	15	—	dB
Power Output ($V_{CB} = 15$ Vdc, $I_C = 8.0$ mAdc, f = 500 MHz)	P_o	30	—	mW
Collector Efficiency ($V_{CB} = 15$ Vdc, $I_C = 8.0$ mAdc, f = 500 MHz)	η	25	—	%

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

2N930, A

JAN, JTX AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2481 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N930	2N930A	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	Vdc
Collector-Base Voltage	V_{CBO}	45	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current	I_C	30		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 3.33		W mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 12		Watt mW/°C
Operating and Storage Temperature Temperature Range	T_J, T_{stg}	−65 to +175		°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0) 2N930		5.0	—	
2N930A		6.0	—	
Collector Cutoff Current (V_{CE} = 5.0 Vdc, I_B = 0)	I_{CEO}	—	2.0	nAdc
Collector Cutoff Current	I_{CBO}			nAdc
(V_{CB} = 45 Vdc, I_E = 0) 2N930		—	10	
2N930A		—	2.0	
Collector Cutoff Current	I_{CES}			
(V_{CE} = 45 Vdc, V_{BE} = 0) 2N930		—	10	nAdc
2N930A		—	2.0	
(V_{CE} = 45 Vdc, V_{BE} = 0, T_A = 170°C) 2N930		—	10	μAdc
2N930A		—	2.0	
Emitter Cutoff Current	I_{EBO}			nAdc
(V_{BE} = 5.0 Vdc, I_C = 0) 2N930		—	10	
2N930A		—	2.0	
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 1.0 μAdc, V_{CE} = 5.0 Vdc) 2N930A		60	—	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)		100	300	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C) 2N930		20	—	
2N930A		30	—	
(I_C = 500 μAdc, V_{CE} = 5.0 Vdc) 2N930		150	—	
2N930A		—	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc) (1) 2N930		—	600	
2N930A		—	600	

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

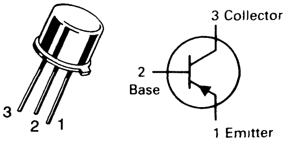
Characteristic		Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage (1) (I_C = 10 mAdc, I_B = 0.5 mAdc)	2N930	$V_{CE(sat)}$	—	1.0	Vdc
	2N930A		—	0.5	
Base-Emitter Saturation Voltage (1) (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{BE(sat)}$	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 30 MHz)	2N930	f_T	30	—	MHz
	2N930A		45	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	2N930	C_{obo}	—	8.0	pF
	2N930A		—	6.0	
Input Impedance (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)		h_{ib}	25	32	ohms
Voltage Feedback Ratio (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)		h_{rb}	—	600	X 10^{-6}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}	150	600	—
Output Admittance (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)		h_{ob}	—	1.0	μmhos
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 k ohms, f = 10 Hz to 15.7 kHz)		NF	—	3.0	dB

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

2N956 For Specifications, See 2N718A Data.

2N1132, A

JAN AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

PNP SILICON

Refer to 2N2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N1132	2N1132A	Unit
Collector-Emitter Voltage	V_{CEO}	35	40	Vdc
Collector-Emitter Voltage ($R_{BE} \leq 10$ Ohms)	V_{CER}	← 50 →		Vdc
Collector-Base Voltage	V_{CBO}	50	60	Vdc
Emitter-Base Voltage	V_{EBO}	← 5.0 →		Vdc
Collector Current — Continuous	I_C	← 600 →		mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	← 600 → ← 3.43 →		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	← 2.0 → ← 11.43 →		Watts mW/°C
Total Device Dissipation @ $T_C = 100°C$ 2N1132A	P_D	← 1.0 →		Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	87.49	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	291.55	°C/W

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

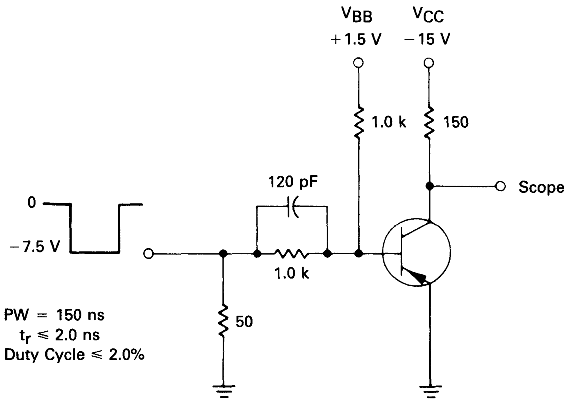
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage	2N1132A	$V_{(BR)CEO}$	40	—	Vdc
($I_C = 10$ mA)	2N1132		35		
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100\ \mu$Adc, $I_E = 0$)	2N1132		50	—	
	2N1132A		60	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$		—	Vdc
($I_E = 100\ \mu$Adc, $I_C = 0$)	2N1132		5.0	—	
($I_E = 1.0$ mA, $I_C = 0$)	2N1132A		5.0		
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 30$ Vdc, $I_E = 0$)	2N1132		—	1.0	
($V_{CB} = 50$ Vdc, $I_E = 0$)	2N1132		—	100	
($V_{CB} = 30$ Vdc, $I_E = 0$, $T_A = 150°C$)	2N1132		—	100	
($V_{CB} = 45$ Vdc, $I_E = 0$)	2N1132A		—	0.5	
($V_{CB} = 45$ Vdc, $I_E = 0$, $T_A = 150°C$)	2N1132A		—	50	
Collector Cutoff Current	2N1132	I_{CER}	—	10	mA
($V_{CE} = 50$ V, $R_{BE} = \leq 10$ Ohms)	2N1132A		—	10	mA
Emitter Cutoff Current		I_{EBO}			μAdc
($V_{BE} = 5.0$ Vdc, $I_C = 0$)	2N1132A		—	100	
($V_{BE} = 2.0$ Vdc, $I_C = 0$)	2N1132		—	100	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc)			25	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)			30	90	
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{BE(sat)}$	—	1.3	Vdc

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

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	60	—	MHz
Output Capacitance	C_{obo}			pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz) 2N1132,		—	45	
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz) 2N1132A		—	30	
Input Capacitance	C_{ibo}			pF
(V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 kHz) 2N1132,		—	80	
(V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz) 2N1132A		—	80	
Input Impedance	h_{ib}			Ohms
(I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz		25	35	
(I_C = 5.0 mAdc, V_{CB} = 10 Vdc, f = 1.0 kHz		—	10	
Voltage Feedback Ratio	h_{rb}			X 10^{-4}
(I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		—	8.0	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		—	8.0	
Small-Signal Current Gain	h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) 2N1132,		25	100	
2N1132A		25	75	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N1132,		30	—	
2N1132A		30		
Output Admittance	h_{ob}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		—	1.0	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		—	5.0	
SWITCHING CHARACTERISTICS				
Turn-On Time 2N1132A	t_{on}	—	45	ns
Turn-Off Time 2N1132A	t_{off}	—	35	ns

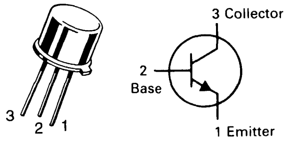
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1. SWITCHING TIMES TEST CIRCUIT



2N1613

JAN, JTX, JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage ($R_{BE} \leq 10$ Ohms)	V_{CER}	50	Vdc
Collector-Base Voltage	V_{CBO}	75	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.0 17.15	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	58.3	°C/W

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

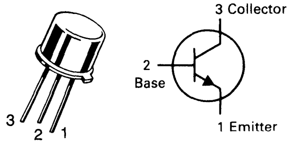
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 100$ mAdc, $R_{BE} \leq 10$ Ohms)	$V_{CER(sus)}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	75	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	— —	10 10	nAdc μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	10	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, $T_A = -55°C$) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	20 35 20 40 20	35 50 — 80 30	— — — 120 —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.3	1.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.78	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	60	—	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	10	25	pF
Input Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	50	80	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ib}	24 4.0	— —	34 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{rb}	— —	— —	3.0 3.0	$\times 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30 35	— —	100 150	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ob}	0.05 0.05	— —	0.5 0.5	μmhos
Noise Figure ($I_C = 0.3$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 510$ Ohms, f = 1.0 kHz, Bandwidth = 1.0 Hz)	NF	—	—	12	dB
SWITCHING CHARACTERISTICS					
Switching Time	$t_d + t_r + t_f$	—	—	30	ns

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

2N1711 For Specifications, See 2N718A Data.

2N1893

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR
NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Emitter Voltage	V_{CER}	100	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.0 17.2	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	58.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	219	°C/W

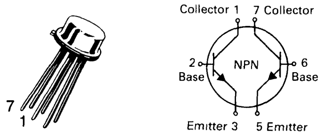
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 100$ mAdc, $R_{BE} = 10$ ohms)	$V_{CER(sus)}$	100	—	Vdc
Collector-Emitter Sustaining Voltage(1) ($I_C = 30$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	120	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 90$ Vdc, $I_E = 0$) ($V_{CB} = 90$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.01 15	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.01	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, $T_A = -55°C$) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	20 35 20 40	— — — 120	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	— —	1.2 5.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	— —	0.9 1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, 100 kHz ≤ f ≤ 1.0 MHz)	C_{obo}	—	15	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, 100 kHz ≤ f ≤ 1.0 MHz)	C_{ibo}	—	85	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ib}	20 4.0	30 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{rb}	— —	1.25 1.5	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30 45	100 —	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CB} = 10$ Vdc, f = 1.0 kHz)	h_{ob}	— —	0.5 0.5	μmho

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

2N2060
2N2223, A
2N2480A

2N2060 JAN, JTX, JTXV AVAILABLE
CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N2060 2N2223,A	2N2480	2N2480A	Unit
Collector-Emitter Voltage	V_{CEO}	60	40	40	Vdc
Collector-Emitter Voltage	V_{CER}	80	—	—	Vdc
Collector-Base Voltage	V_{CBO}	100	75	80	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	5.0	5.0	Vdc
Collector Current — Continuous	I_C	500			mAdc

Rating	Symbol	One Die	All Die Equal Power	Unit
Total Device Dissipation @ T_A = 25°C	P_D			Watts
2N2060,A		0.5	0.6	
2N2223,A		0.5	0.6	
2N2480,A		0.3	0.6	
Derate above 25°C				mW/°C
2N2060,A		2.86	3.43	
2N2223,A		2.86	3.43	
2N2480,A		1.72	3.43	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
2N2060,A		1.5	3.0	
2N2223,A		1.6	3.0	
2N2480,A		1.0	2.0	
Derate above 25°C				mW/°C
2N2060,A		8.6	17.2	
2N2223,A		9.1	11.4	
2N2480,A		5.7	11.4	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 100 mAdc, $R_{BE} \leq$ 10 ohms)	2N2060, 2N2223, 2N2223A	$V_{CER(sus)}$	80	—	Vdc
Collector-Emitter Sustaining Voltage(1)		$V_{CEO(sus)}$			Vdc
(I_C = 20 mAdc, I_B = 0)	2N2480A		40	—	
(I_C = 30 mAdc, I_B = 0)	2N2060, 2N2223, 2N2223A		60	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	2N2060, 2N2223, 2N2223A		100	—	
	2N2480A*		80	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 100 μAdc, I_C = 0)	2N2060, 2N2223, 2N2223A		7.0	—	
	2N2480A		5.0	—	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = 150°C)	2N2480A		—	15	
(V_{CB} = 60 Vdc, I_E = 0)	2N2480A		—	0.02	
(V_{CB} = 80 Vdc, I_E = 0)	2N2060		—	0.002	
	2N2223, 2N2223A		—	0.01	
(V_{CB} = 80 Vdc, I_E = 0, T_A = 150°C)	2N2060		—	10	
	2N2223, 2N2223A		—	15	
Emitter Cutoff Current		I_{EBO}			nAdc
(V_{BE} = 5.0 Vdc, I_C = 0)	2N2060		—	2.0	
	2N2223, 2N2223A		—	10	
	2N2480A		—	20	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

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

Characteristic		Symbol	Min	Max	Unit
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N2060		25	75	
	2N2223, 2N2223A		15	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060		30	90	
	2N2223, 2N2223A		25	150	
	2N2480A		35	—	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060		40	120	
	2N2480A		50	200	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N2060		50	150	
	2N2223, 2N2223A		50	200	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 50 mAdc, I_B = 5.0 mAdc)	2N2060A		—	0.6	
	2N2060, 2N2223, 2N2223A, 2N2480A		—	1.2	
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	2N2060, 2N2223, 2N2223A, 2N2480A	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 50 mAdc, V_{CE} = 10 Vdc,	2N2223, 2N2223A, 2N2480A		50	—	
f = 20 MHz)	2N2060		60	—	
Output Capacitance		C_{obo}			pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N2060, 2N2060A, 2N2223, 2N2223A		—	15	
	2N2480A		—	18	
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	2N2060, 2N2223A, 2N2480A	C_{ibo}	—	85	pF
Input Impedance		h_{ie}			ohms
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc,	2N2060		1000	4000	
f = 1.0 kHz)	2N2480A		1000	5000	
Input Impedance		h_{ib}			ohms
(I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc,	2N2060, 2N2223, 2N2223A		20	30	
f = 1.0 kHz)	2N2480A		20	35	
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N2223, 2N2223A	h_{rb}	—	3.0	X 10^{-4}
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc,	2N2060		50	150	
f = 1.0 kHz)	2N2223, 2N2223A		40	200	
	2N2480A		50	300	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2060, 2N2480A	h_{oe}	—	16	μmhos
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	2N2223, 2N2223A	h_{ob}	—	0.5	μmhos

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

Characteristic		Symbol	Min	Max	Unit
Noise Figure (I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 510 Ω, f = 1.0 kHz, BW = 1.0 Hz)	2N2480A	NF	—	8.0	dB
(I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 510 Ω, f = 1.0 kHz, BW = 200 Hz)	2N2060		—	8.0	
(I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz, BW = 15.7 kHz)(2)			—	8.0	

MATCHING CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
DC Current Gain Ratio(3)		h_{FE1}/h_{FE2}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2223A		0.9	1.0	
	2N2223, 2N2480A		0.8	1.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060		0.9	1.0	
	2N2480		0.8	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$			mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2223A, 2N2480A		—	5.0	
	2N2223		—	15	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2060, 2N2060A, 2N2480A		—	5.0	
	2N2480		—	10	
Base-Emitter Voltage Differential Change Due to Temperature (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +125°C)	2N2060	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T}$	—	10	μV/°C
	2N2223, 2N2223A		—	25	
	2N2480A		—	15	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) Amplifier: 3.0 dB points at 25 Hz and 10 kHz with a roll-off of 6.9 dB per octave.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

FIGURE 1 — DC CURRENT GAIN versus COLLECTOR CURRENT

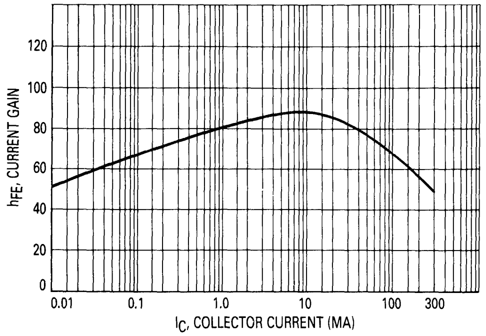
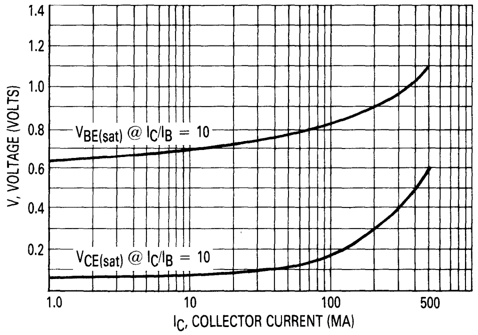
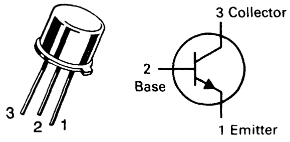


FIGURE 2 — "ON" VOLTAGES



2N2102

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Emitter Voltage, $R_{BE} \leq 10$ Ohms	V_{CER}	80	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	175	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100$ mAdc, $R_{BE} \leq 10$ ohms)	$V_{CER(sus)}$	80	—	—	Vdc
Collector-Emitter Sustaining Voltage(2) ($I_C = 100$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	65	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 100$ μAdc, $V_{EB} = 1.5$ Vdc)	$V_{(BR)CEX}$	120	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$) ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	— —	2.0 2.0	nAdc μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	2.0	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, $T_A = -55°C$) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(2) ($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)(2) ($I_C = 1.0$ Adc, $V_{CE} = 10$ Vdc)(2)	h_{FE}	20 35 20 40 25 10	— — — — — —	— — — 120 — —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.15	0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.88	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	60	—	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	6.0	15	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	50	80	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ib}	24 4.0	— —	34 8.0	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{rb}	— —	— —	3.0 3.0	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	30 35	— —	100 150	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz) ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ob}	0.01 0.01	— —	0.5 1.0	μmho
Noise Figure ($I_C = 300$ μAdc, $V_{CE} = 10$ Vdc, $R_S = 1.0$ k Ohm, f = 1.0 kHz, Bandwidth = 1.0 Hz)	NF	—	4.0	6.0	dB
SWITCHING CHARACTERISTICS					
Switching Time	$t_d + t_r + t_f$	—	—	30	ns

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board. (2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle $\leq 2.0\%$.

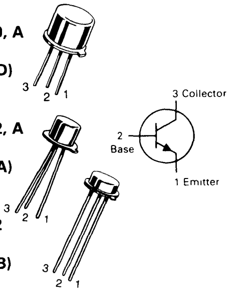
2N2218, A/2N2219, A
2N2221, A/2N2222, A
2N5581/82

JAN, JTX, JTXV AVAILABLE

2N2218, A/2N2219, A
CASE 79-04
TO-39 (TO-205AD)
STYLE 1

2N2221, A/2N2222, A
CASE 22-03
TO-18 (TO-206AA)
STYLE 1

2N5581/2N5582
CASE 26-03
TO-46 (TO-206AB)
STYLE 1



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N2218 2N2219 2N2221 2N2222	2N2218A 2N2219A 2N2221A 2N2222A	2N5581 2N5582	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	6.0	Vdc
Collector Current — Continuous	I_C	800	800	800	mAdc
		2N2218,A 2N2219,A	2N2221,A 2N2222,A	2N5581 2N5582	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.8 4.57	 0.5 2.28	 0.6 3.33	 Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 3.0 17.1	 1.2 6.85	 2.0 11.43	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	Non-A Suffix		30	—	
	A-Suffix, 2N5581, 2N5582		40	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	Non-A Suffix		60	—	
	A-Suffix, 2N5581, 2N5582		75	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)	Non-A Suffix		5.0	—	
	A-Suffix, 2N5581, 2N5582		6.0	—	
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	A-Suffix, 2N5581, 2N5582	I_{CEX}	—	10	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	Non-A Suffix		—	0.01	
(V_{CB} = 60 Vdc, I_E = 0)	A-Suffix, 2N5581, 2N5582		—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	Non-A Suffix		—	10	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	A-Suffix, 2N5581, 2N5582		—	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	A-Suffix, 2N5581, 2N5582	I_{EBO}	—	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	A-Suffix	I_{BL}	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	2N2218,A, 2N2221,A, 2N5581(1)		20	—	
	2N2219,A, 2N2222,A, 2N5582(1)		35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N2218,A, 2N2221,A, 2N5581		25	—	
	2N2219,A, 2N2222,A, 2N5582		50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N2218,A, 2N2221,A, 2N5581(1)		35	—	
	2N2219,A, 2N2222,A, 2N5582(1)		75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	2N2218A, 2N2221A, 2N5581		15	—	
	2N2219A, 2N2222A, 2N5582		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)	2N2218,A, 2N2221,A, 2N5581		40	120	
	2N2219,A, 2N2222,A, 2N5582		100	300	

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

Characteristic		Symbol	Min	Max	Unit
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)(1)	2N2218,A, 2N2221,A, 2N5581		20	—	
	2N2219,A, 2N2222,A, 2N5582		50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	2N2218, 2N2221		20	—	
	2N2219, 2N2222		30	—	
	2N2218A, 2N2221A, 2N5581		25	—	
	2N2219A, 2N2222A, 2N5582		40	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	Non-A Suffix		—	0.4	
	A-Suffix, 2N5581, 2N5582		—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)	Non-A Suffix		—	1.6	
	A-Suffix, 2N5581, 2N5582		—	1.0	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	Non-A Suffix		0.6	1.3	
	A-Suffix, 2N5581, 2N5582		0.6	1.2	
(I_C = 500 mAdc, I_B = 50 mAdc)	Non-A Suffix		—	2.6	
	A-Suffix, 2N5581, 2N5582		—	2.0	

SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product(2)		f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	All Types, Except		250	—	
	2N2219A, 2N2222A, 2N5582		300	—	
Output Capacitance(3) (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	8.0	pF
Input Capacitance(3)		C_{ibo}			pF
(V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	Non-A Suffix		—	30	
	A-Suffix, 2N5581, 2N5582		—	25	
Input Impedance		h_{ie}			kohms
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		1.0	3.5	
	2N2219A, 2N2222A		2.0	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		0.2	1.0	
	2N2219A, 2N2222A		0.25	1.25	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		—	5.0	
	2N2219A, 2N2222A		—	8.0	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		—	2.5	
	2N2219A, 2N2222A		—	4.0	
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		30	150	
	2N2219A, 2N2222A		50	300	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		50	300	
	2N2219A, 2N2222A		75	375	
Output Admittance		h_{oe}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		3.0	15	
	2N2219A, 2N2222A		5.0	35	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N2218A, 2N2221A		10	100	
	2N2219A, 2N2222A		25	200	
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	A-Suffix	$r_{b'}C_c$	—	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kohm, f = 1.0 kHz)	2N2222A	NF	—	4.0	dB
Real Part of Common-Emitter High Frequency Input Impedance (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 300 MHz)	2N2218A, 2N2219A 2N2221A, 2N2222A	$Re(h_{ie})$	—	60	Ohms

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.
(3) 2N5581 and 2N5582 are Listed C_{cb} and C_{eb} for these conditions and values.

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 14)	t_d	—	10	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure15)	t_s	—	225	ns
Fall Time		t_f	—	60	ns
Active Region Time Constant (I_C = 150 mAdc, V_{CE} = 30 Vdc) (See Figure 12 for 2N2218A, 2N2219A, 2N2221A, 2N2222A)		T_A	—	2.5	ns

FIGURE 1 – NORMALIZED DC CURRENT GAIN

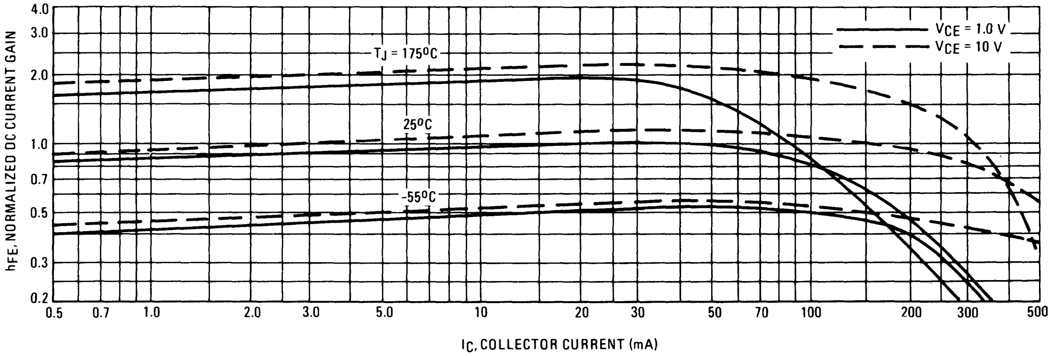
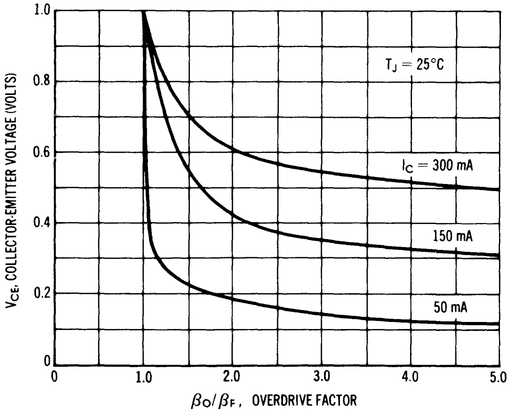


FIGURE 2 – COLLECTOR CHARACTERISTICS IN SATURATION REGION



This graph shows the effect of base current on collector current. β_o (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit.

EXAMPLE: For type 2N2219, estimate a base current (I_{BF}) to insure saturation at a temperature of 25°C and a collector current of 150 mA.

Observe that at I_C = 150 mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h_{FE} @ 1 volt is approximately 0.62 of h_{FE} @ 10 volts. Using the guaranteed minimum gain of 100 @ 150 mA and 10 V, β_o = 62 and substituting values in the overdrive equation, we find:

$$\frac{\beta_o}{\beta_F} = \frac{h_{FE} @ 1.0\,V}{I_C/I_{BF}} \qquad 2.5 = \frac{62}{150/I_{BF}} \qquad I_{BF} \approx 6.0\ mA$$

FIGURE 3 – "ON" VOLTAGES

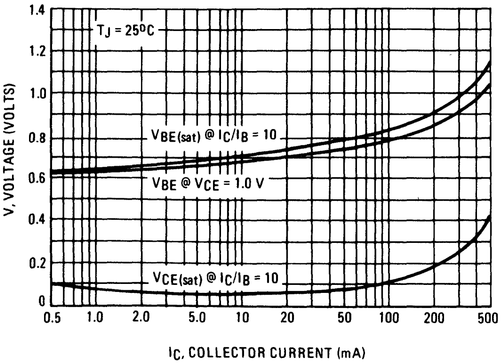
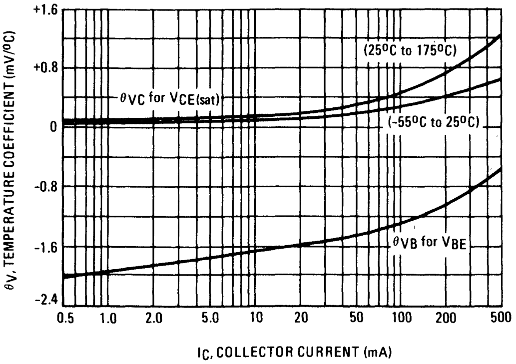


FIGURE 4 – TEMPERATURE COEFFICIENTS



h PARAMETERS

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

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

FIGURE 5 — INPUT IMPEDANCE

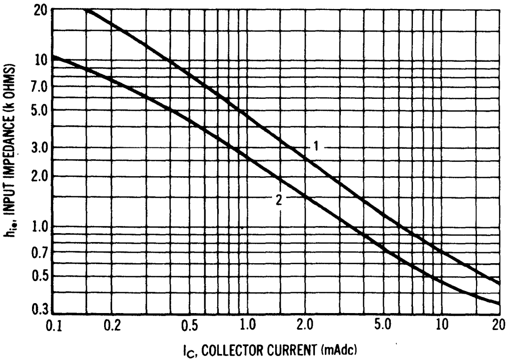


FIGURE 6 — VOLTAGE FEEDBACK RATIO

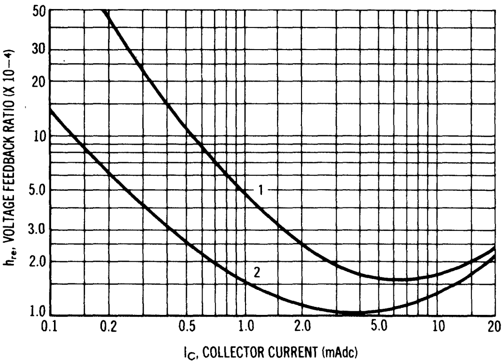


FIGURE 7 — CURRENT GAIN

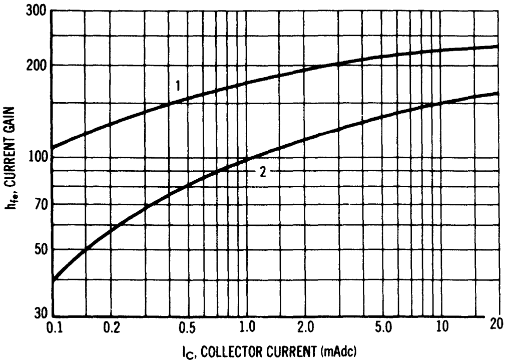
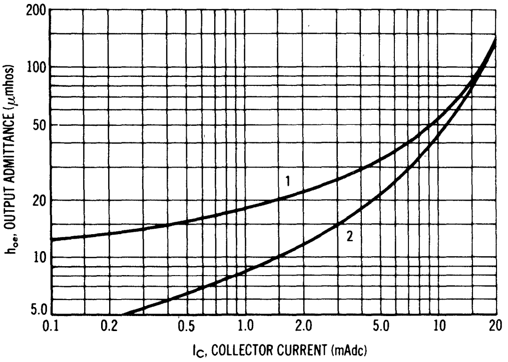


FIGURE 8 — OUTPUT ADMITTANCE



SWITCHING TIME CHARACTERISTICS

FIGURE 9 — TURN-ON TIME

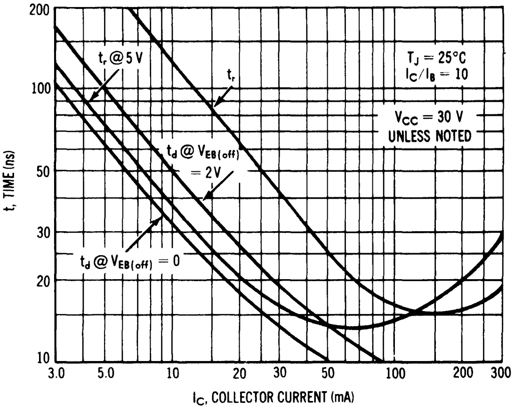


FIGURE 10 — CHARGE DATA

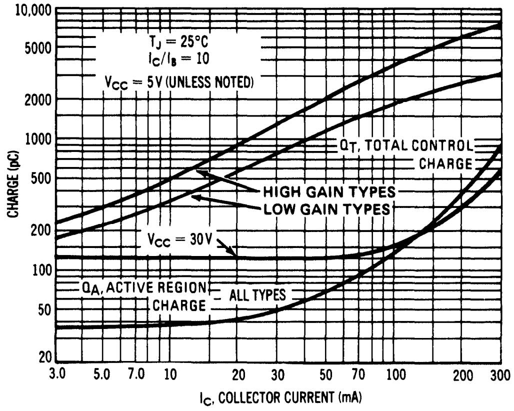


FIGURE 11 — TURN-OFF BEHAVIOR

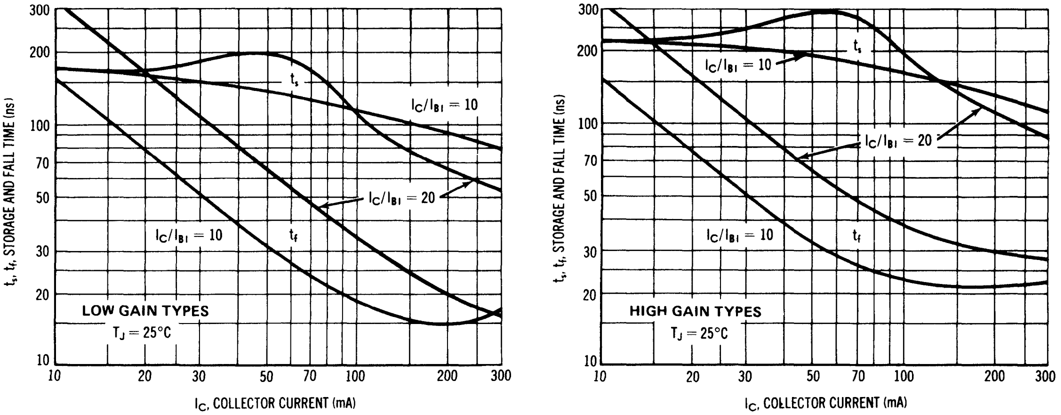


FIGURE 12 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

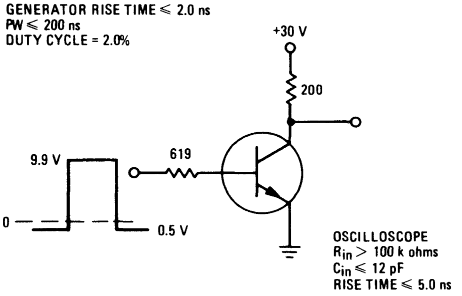
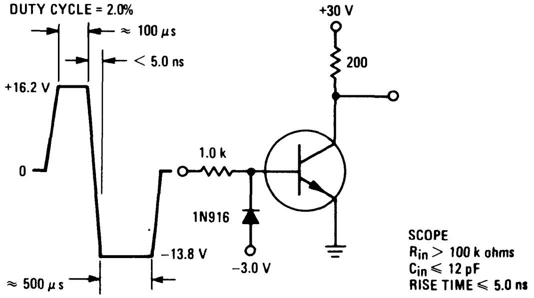


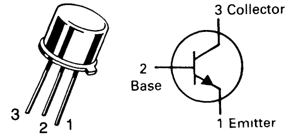
FIGURE 13 — STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT



2N2223, A For Specifications, See 2N2060 Data

2N2270

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Emitter Voltage, $R_{BE} \leq 10$ Ohms	V_{CER}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	175	°C/W

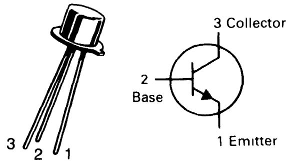
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 100$ mAdc, $R_{BE} \leq 10$ Ohms)	$V_{(BR)CER}$	60	—	—	Vdc
Collector-Emitter Sustaining Voltage(2) ($I_C = 100$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	45	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.05$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_C = 25°C$) ($V_{CB} = 60$ Vdc, $I_E = 0$, $T_C = 150°C$)	I_{CBO}	— —	— —	0.05 100	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	 30 50	 90 135	 — 200	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.15	0.9	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.88	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	100	250	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	10	15	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	60	80	pF
Small-Signal Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	50	—	275	—
Noise Figure ($I_C = 0.3$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 1.0$ k Ohm, f = 1.0 kHz, B.W. = 1.0 Hz)	NF	—	7.0	10	dB
SWITCHING CHARACTERISTICS					
Total Switching Time	$t_{on} + t_{off}$	—	—	30	ns

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2N2368
2N2369, A
2N3227

2N2369A JAN, JTX
JTXV AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage 2N2368,9,A 2N3227	V_{CEO}	 15 20	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage 2N2368,9,A 2N3227	V_{EBO}	 4.5 6.0	Vdc
Collector Current (10 μs pulse)	$I_{C(Peak)}$	500	mA
Collector Current — Continuous 2N2369A, 2N3227	I_C	200	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.36 2.06	 Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C 2N3227	P_D	 1.2 6.85	 Watts mW/°C
Total Device Dissipation @ T_C = 100°C Derate above 100°C	P_D	 .68 6.85	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, V_{BE} = 0)	 2N3227	$V_{(BR)CEO}$	20	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μA, V_{BE} = 0)		$V_{(BR)CES}$	40	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA, I_B = 0)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	 2N2368, 2N2369, 2N2369A 2N3227	$V_{(BR)EBO}$	 4.5 6.0	 — —	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 3.0 Vdc)	 2N3227	I_{CEX}	—	0.2	μAdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 150°C)	 2N2368, 2N2369 2N3227 2N2368, 2N2369, 2N2369A 2N3227	I_{CBO}	 — — — —	 0.4 0.2 30 50	μAdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 0)	 2N2369A	I_{CES}	—	0.4	μAdc
Base Current (V_{CE} = 20 Vdc, V_{BE} = 0)	 2N2369A	I_B	—	0.4	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C) (I_C = 10 mAdc, V_{CE} = 0.35 Vdc, T_A = −55°C) (I_C = 30 mAdc, V_{CE} = 0.4 Vdc)	 2N2368 2N2369 2N2369A 2N3227 2N2368 2N2369 2N3227 2N2369A 2N2369A	h_{FE}	 20 40 — 100 10 20 40 20 30	 60 120 120 300 — — — — —	—

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

Characteristic		Symbol	Min	Max	Unit
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N2369A		20	—	
	2N3227		30	—	
(I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	2N2368		10	—	
	2N2369		20	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N2368, 2N2369, 2N3227		—	0.25	
	2N2369A		—	0.20	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = +125°C)	2N2369A		—	0.30	
(I_C = 30 mAdc, I_B = 3.0 mAdc)	2N2369A		—	0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N2369A		—	0.50	
	2N3227		—	.45	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	All Types		0.70	0.85	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = +125°C)	2N2369A		0.59	—	
(I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = −55°C)	2N2369A		—	1.02	
(I_C = 30 mAdc, I_B = 3.0 mAdc)	2N2369A		—	1.15	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N2369A		—	1.60	
	2N3227		0.8	1.4	

SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N2368		400	—	
	2N2369, 2N2369A, 2N3227		500	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	All Types	C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 140 kHz)	2N3227	C_{ibo}	—	4.0	pF

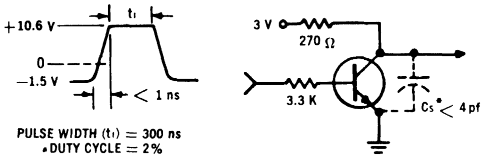
SWITCHING CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Delay Time (V_{CC} = 10 V, V_{EB} = 2.0 Vdc, 100 mA, I_{B1} = 10 mA)	2N3227	t_d	—	5.0	ns
Rise Time		t_r	—	18	ns
Storage Time		t_s			ns
(I_C = I_{B1} = 10 mAdc, I_{B2} = −10 mAdc)	2N2368		—	10	
(I_C = 100 mAdc, I_{B1} = I_{B2} = 10 mAdc, V_{CC} = 10 V)	2N2369A		—	13	
	2N3227		—	13	
Fall Time (V_{CC} = 10 V, I_C = 100 mA, I_{B1} = I_{B2} = 10 mA)	2N3227	t_f	—	15	ns
Turn-On Time (I_C = 10 mAdc, I_{B1} = 3.0 mA, I_{B2} = −1.5 mA, V_{CC} = 3.0 Vdc)	All Types	t_{on}	—	12	ns
Turn-Off Time		t_{off}			ns
(I_C = 10 mAdc, I_{B1} = 3.0 mA, I_{B2} = −1.5 mA, V_{CC} = 3.0 Vdc)	2N2368		—	—	
	2N2369,		—	—	
	2N2369A,		—	15	
	2N3227		—	18	
Total Control Charge (I_C = 10 mA, I_B = 1.0 mA, V_{CC} = 3.0 V)	2N3227	Q_T	—	50	pC

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

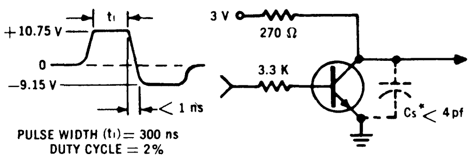
SWITCHING TIME EQUIVALENT TEST CIRCUITS FOR 2N2369, 2N3227

FIGURE 1 — t_{on} CIRCUIT — 10 mA



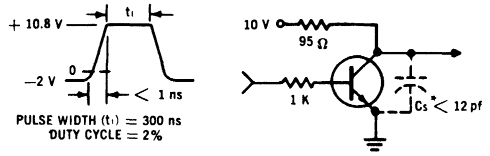
PULSE WIDTH (t_1) = 300 ns
DUTY CYCLE = 2%

FIGURE 3 — t_{off} CIRCUIT — 10 mA



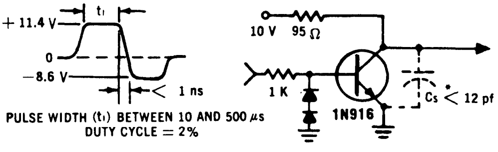
PULSE WIDTH (t_1) = 300 ns
DUTY CYCLE = 2%

FIGURE 2 — t_{on} CIRCUIT — 100 mA



PULSE WIDTH (t_1) = 300 ns
DUTY CYCLE = 2%

FIGURE 4 — t_{off} CIRCUIT — 100 mA



PULSE WIDTH (t_1) BETWEEN 10 AND 500 μs
DUTY CYCLE = 2%

* Total shunt capacitance of test jig and connectors.

FIGURE 5 — TURN-ON AND TURN-OFF TIME TEST CIRCUIT

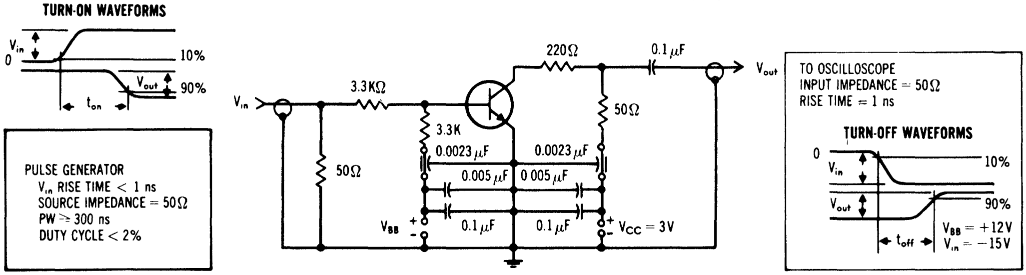


FIGURE 6 — JUNCTION CAPACITANCE VARIATIONS

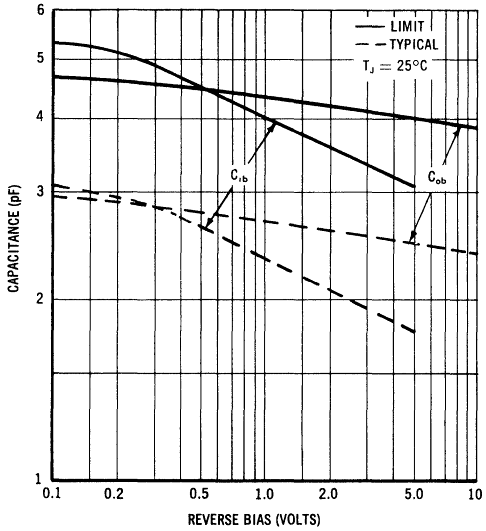


FIGURE 7 — TYPICAL SWITCHING TIMES

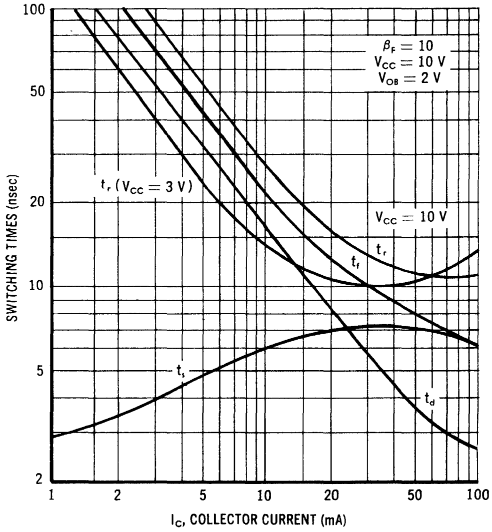


FIGURE 8 — MAXIMUM CHARGE DATA

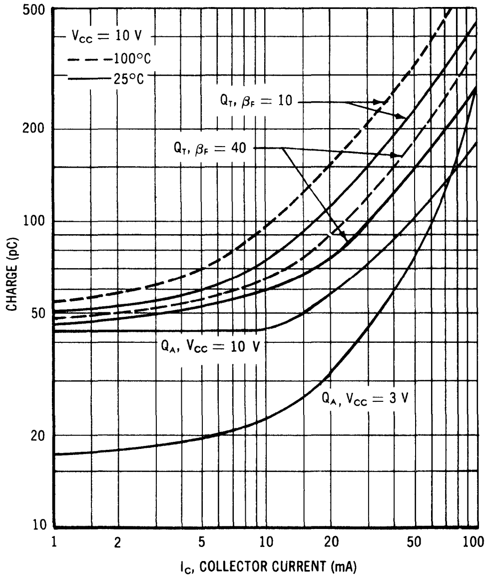


FIGURE 9 — Q_T TEST CIRCUIT

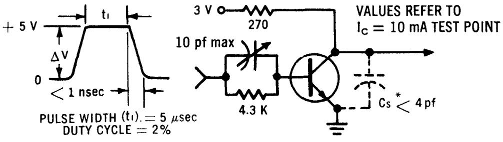


FIGURE 10 — TURN-OFF WAVE FORM

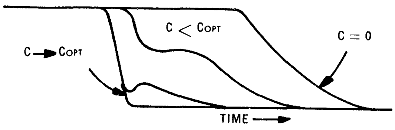


FIGURE 11 — STORAGE TIME EQUIVALENT TEST CIRCUIT

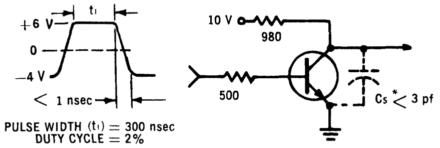


FIGURE 12 — MAXIMUM COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

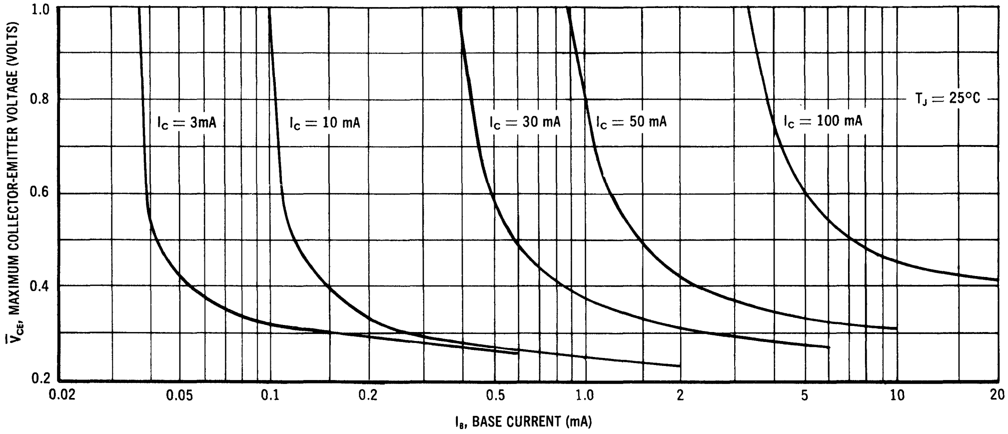


FIGURE 13 — MINIMUM CURRENT GAIN CHARACTERISTICS

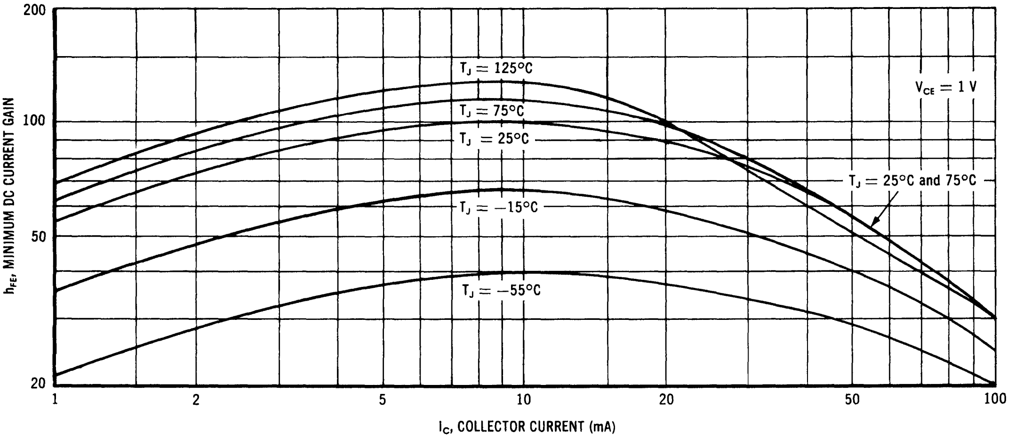


FIGURE 14 — SATURATION VOLTAGE LIMITS

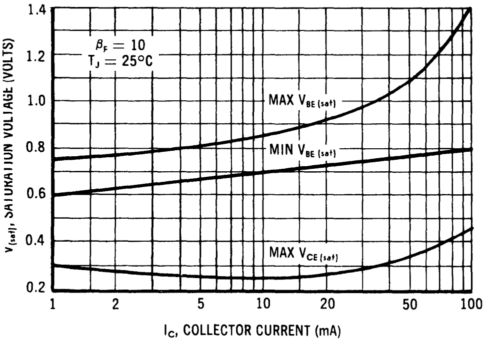
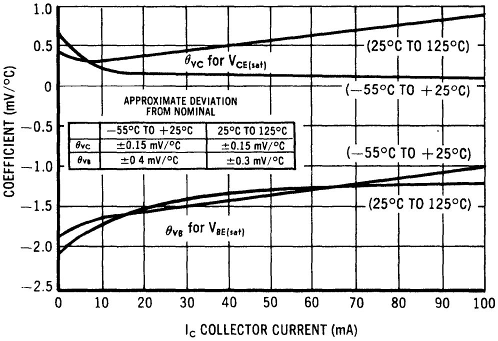
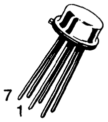


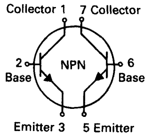
FIGURE 15 — TYPICAL TEMPERATURE COEFFICIENTS



2N2453, A

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2920 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N2453	2N2453A	Unit
Collector-Emitter Voltage	V_{CEO}	30	50	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	300 1.71	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	600 3.43	1200 6.86	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	 2N2453 2N2453A	$V_{CEO(sus)}$	 30 50	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	 2N2453 2N2453A	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 μAdc, I_C = 0)		$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)		I_{CBO}	 — —	 0.005 10	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	0.002	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)		h_{FE}	 80 40 150 75	 — — 600 —	—
Collector-Emitter Saturation Voltage (I_C = 5.0 mAdc, I_B = 0.5 mAdc)		$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 5.0 mAdc, I_B = 0.5 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 30 MHz)		f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)		C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)		C_{ibo}	—	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{ie}	5.0	—	kohms
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)		h_{ib}	20	30	Ohms

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

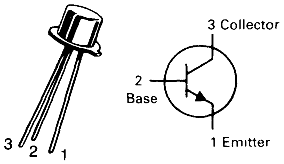
Characteristic	Symbol	Min	Max	Unit
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{re}	—	6.0	X 10^{-4}
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{rb}	—	5.0	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	150	600	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{oe}	5.0	30	μmhos
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ob}	—	0.2	μmho
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz)	NF	—	7.0	dB
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2)	h_{FE1}/h_{FE2}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc) 2N2453A		0.90	1.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		0.90	1.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +125°C)		0.85	1.0	
Base-Emitter Voltage Differential	$\|V_{BE1}-V_{BE2}\|$			mVdc
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)		—	3.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		—	5.0	
Base-Emitter Voltage Differential Gradient	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$			μV/°C
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +125°C) 2N2453		—	10	
2N2453A		—	5.0	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) Lowest h_{FE} reading is taken as h_{FE1} for this ratio.

2N2480A For Specifications, See 2N2060 Data.

2N2481

JAN, JTX AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 30$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ μAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $V_{BE} = 3.0$ Vdc) ($V_{CE} = 20$ Vdc, $V_{BE} = 3.0$ Vdc, $T_A = 150°C$)	I_{CEX}	 — —	 0.05 15	μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
Base Cutoff Current ($V_{CE} = 20$ Vdc, $V_{BE} = 3.0$ Vdc)	I_{BL}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$)(1) ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1)	h_{FE}	 25 40 20 20	 — 120 — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)(1)	$V_{CE(sat)}$	 — —	 0.25 0.40	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)(1)	$V_{BE(sat)}$	 0.7 —	 0.82 1.25	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 5.0$ V, $I_C = 0$, f = 1.0 MHz)	C_{obo}	—	5.0	pF
Input Capacitance ($V_{EB} = 0.5$ V, f = 1.0 MHz)	C_{ibo}	—	7.0	pF
Small-Signal Current Gain ($V_{CE} = 10$ V, $I_C = 10$ mA, f = 100 MHz)	h_{fe}	3.0	—	—
Real Part of Input Impedance ($I_C = 10$ mA, $V_{CE} = 10$ V, f = 250 MHz)	$Re(h_{ie})$	—	60	Ohms

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

Characteristic	Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS				
Storage Time (I_C = 10 mA, I_{B1} = 10 mA, I_{B2} = 10 mA)	t_s	—	20	ns
Turn-On Time (I_C = 100 mA, I_{B1} = 10 mA, $V_{BE(off)}$ = 2.0 V) (I_C = 10 mA, I_{B1} = 1.0 mA, $V_{BE(off)}$ = 2.0 V)	t_{on}	 — —	 40 75	ns
Turn-Off Time (I_C = 100 mA, I_{B1} = 10 mA, I_{B2} = 5.0 mA) (I_C = 10 mA, I_{B1} = 1.0 mA, I_{B2} = 0.5 mA)	t_{off}	 — —	 55 45	ns

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

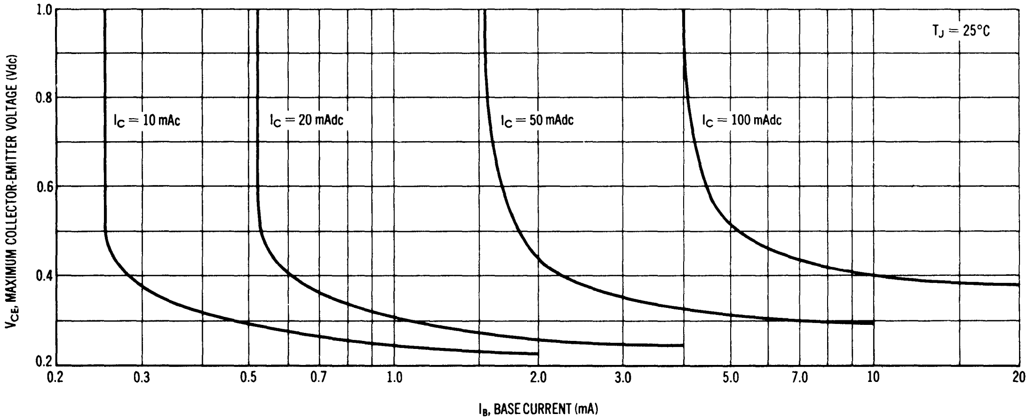


FIGURE 2 — MINIMUM CURRENT GAIN CHARACTERISTICS

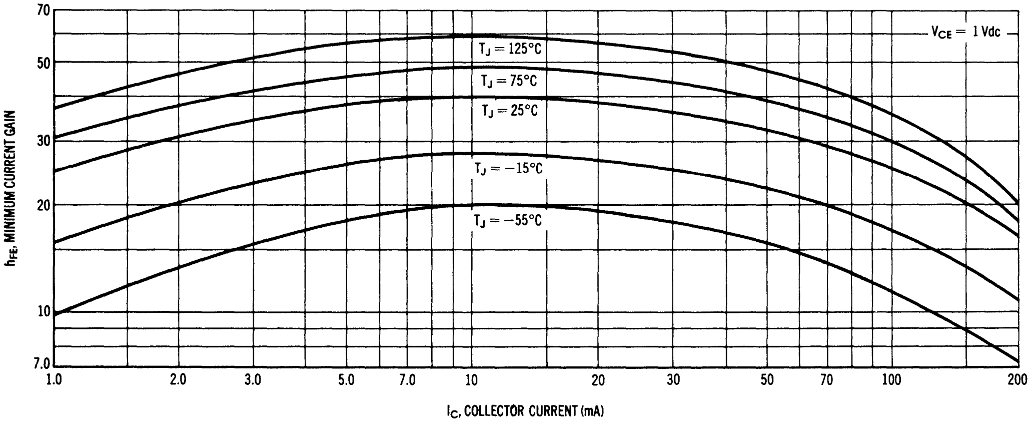


FIGURE 3 — LIMITS OF SATURATION VOLTAGES

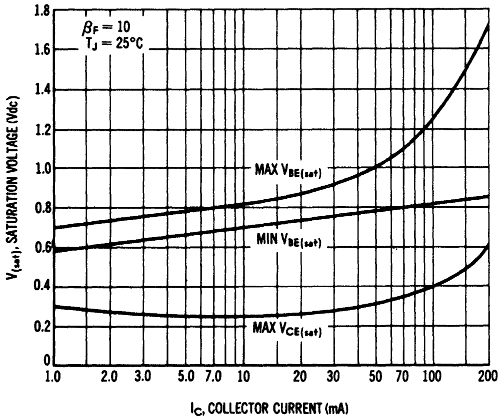
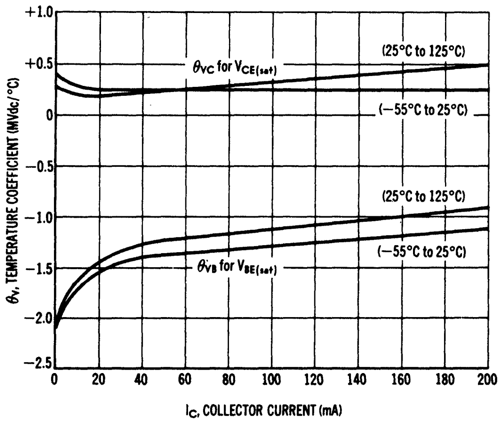


FIGURE 4 — TYPICAL TEMPERATURE COEFFICIENTS



TYPICAL SWITCHING CHARACTERISTICS

FIGURE 5 — TURN-ON TIME VARIATIONS WITH VOLTAGE

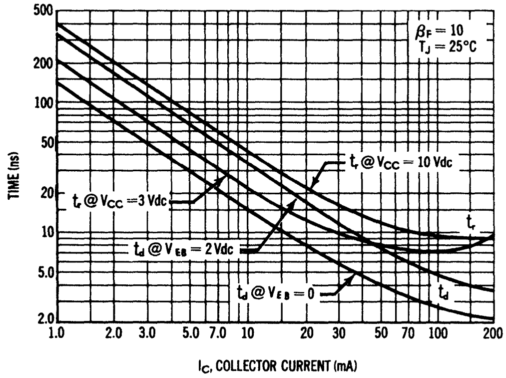


FIGURE 6 — RISE TIME BEHAVIOR

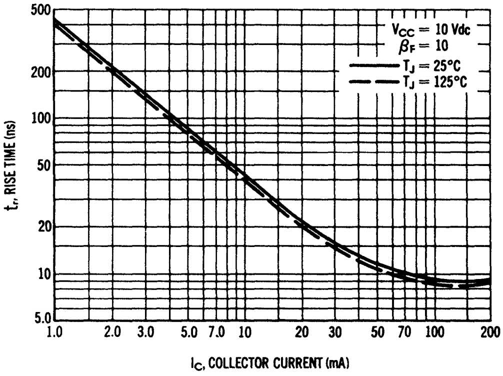


FIGURE 7 — STORAGE TIME BEHAVIOR

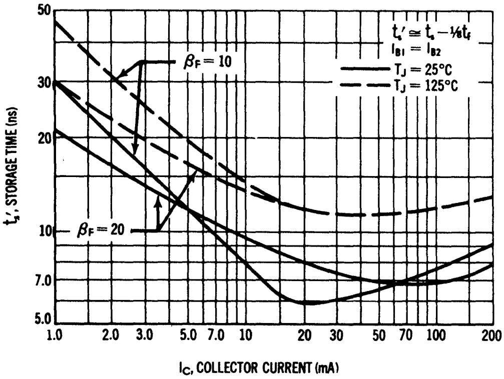


FIGURE 8 — FALL TIME BEHAVIOR

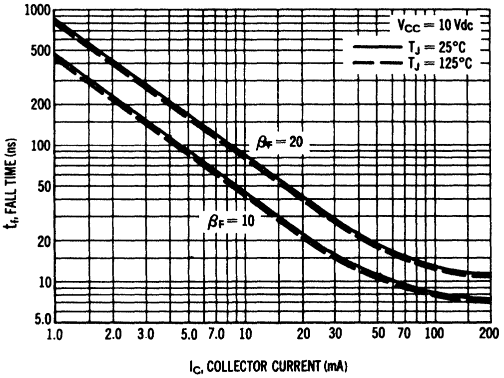


FIGURE 9 — JUNCTION CAPACITANCE VARIATIONS

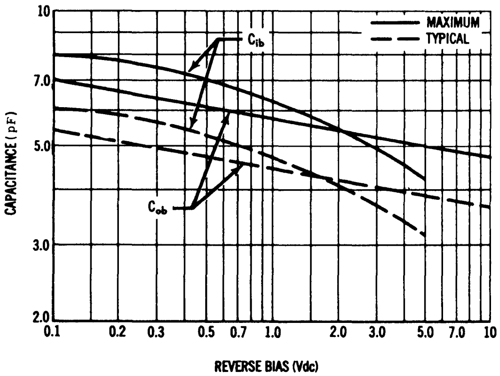
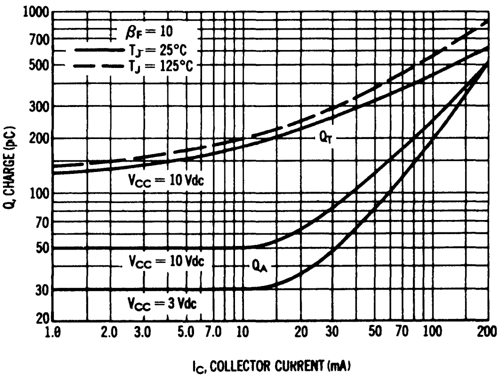
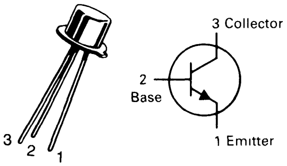


FIGURE 10 — MAXIMUM CHARGE DATA



2N2484

JAN, JTX, JTXV AVAILABLE
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2481 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.06	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	485	°C/W
Lead Temperature 1/16″ from Case for 10 Seconds	T_L	300	°C

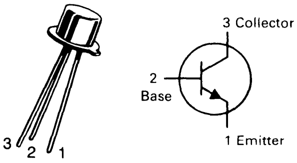
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0) (V_{CB} = 45 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	— —	10 10	nAdc μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = 55°C) (I_C = 100 μAdc, V_{CE} = 5.0 Vdc) (I_C = 500 μAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)(1)	h_{FE}	30 100 20 175 200 250 —	190 250 40 275 300 350 400	— 500 — — — — 800	—
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)	$V_{CE(sat)}$	—	0.25	0.35	Vdc
Base-Emitter On Voltage (I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	0.5	0.65	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 0.05 mAdc, V_{CE} = 5.0 Vdc, f = 5.0 MHz) (I_C = 0.5 mAdc, V_{CE} = 5.0 Vdc, f = 30 MHz)	f_T	15 60	50 100	— —	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	3.0	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	4.0	6.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{ie}	3.5	—	24	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{re}	—	—	800	X 10^{-6}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz	h_{fe}	150	—	900	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{oe}	—	—	40	μmhos
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 100 Hz, BW = 20 Hz) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 kHz, BW = 2.0 kHz) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 kHz, BW = 15.7 kHz)	NF	— — — —	8.0 — — —	10 3.0 2.0 3.0	dB

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2N2501

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.1	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0, Pulsed)	$V_{(BR)CEO}$	20	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, V_{BE} = 3.0 Vdc)	I_{CEX}	—	25	nAdc
Base Cutoff Current	I_{BL}			nAdc
(V_{CE} = 20 Vdc, V_{BE} = 3.0 Vdc)		—	0.025	
(V_{CE} = 20 Vdc, V_{BE} = 3.0 Vdc, T_A = 150°C)		—	50	
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 1.0 Vdc)		20	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)		30	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		50	150	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)		20	—	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)		40	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		30	—	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)		10	—	
Collector-Emitter Saturation Voltage(1)	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	0.3	
(I_C = 100 mAdc, I_B = 10 mAdc)		—	0.4	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)		—	1.0	
(I_C = 100 mAdc, I_B = 10 mAdc)		—	1.2	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (V_{CE} = 20 Vdc, I_C = 10 mAdc, f = 100 MHz)	f_T	350	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	7.0	pF
Small-Signal Current Gain (V_{CE} = 20 Vdc, I_C = 10 mAdc, f = 100 MHz)	h_{fe}	3.5	—	—

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

Characteristic	Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS				
Charge Storage Time Constant ($I_C = I_{B1} = I_{B2}$ = 10 mAdc)	τ_S	—	15	ns
Total Control Charge (I_C = 10 mAdc, I_B = 1.0 mAdc)	Q_T	—	60	pC
Active Region Time Constant (I_C = 10 mAdc)	τ_A	—	2.5	ns

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

FIGURE 1 — COLLECTOR-EMITTER SATURATION VOLTAGES versus BASE CURRENT

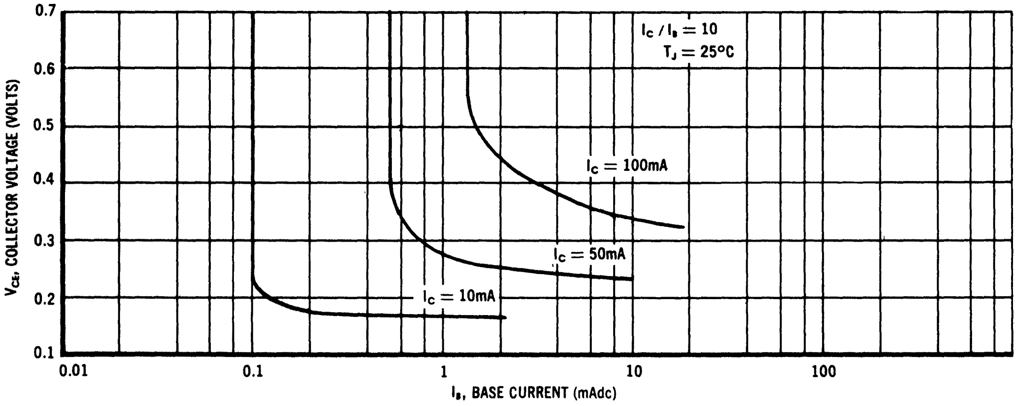


FIGURE 2 — BASE-EMITTER VOLTAGE versus COLLECTOR CURRENT

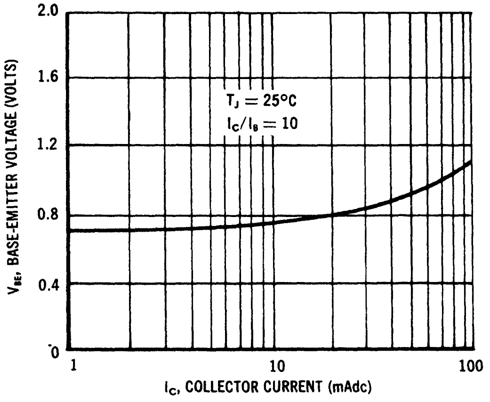


FIGURE 3 — TEMPERATURE COEFFICIENTS

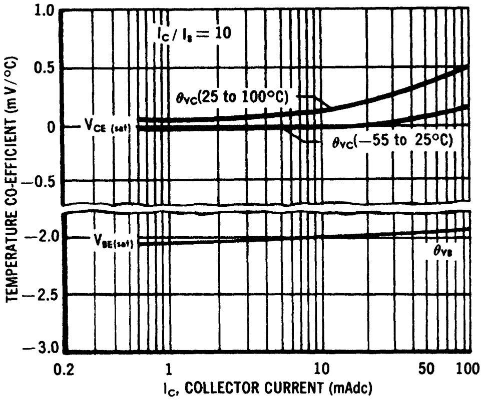


FIGURE 4 — ACTIVE REGION TIME CONSTANT

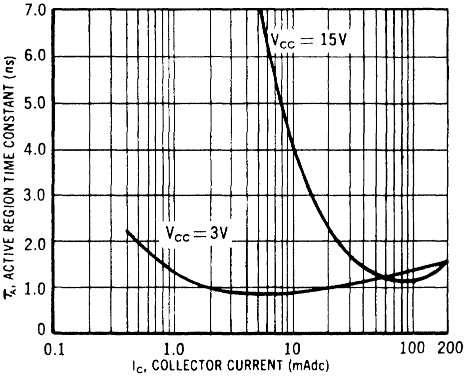


FIGURE 5 — COMMON EMITTER DC LEAKAGE CHARACTERISTICS

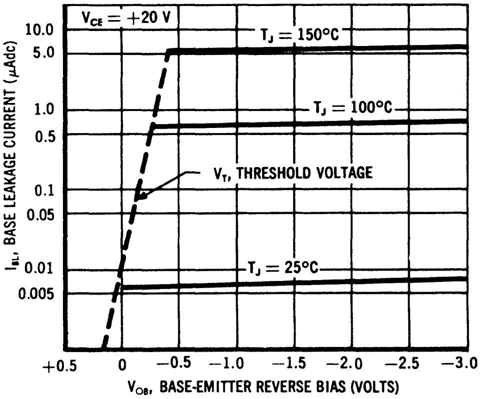


FIGURE 6 — RISE TIME FACTOR

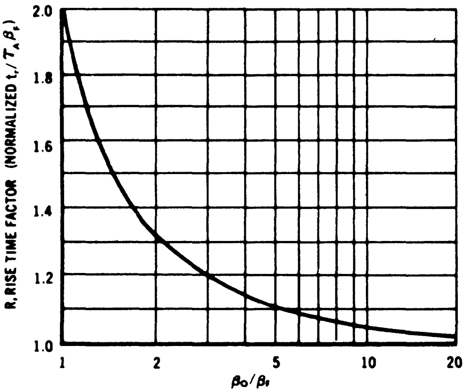
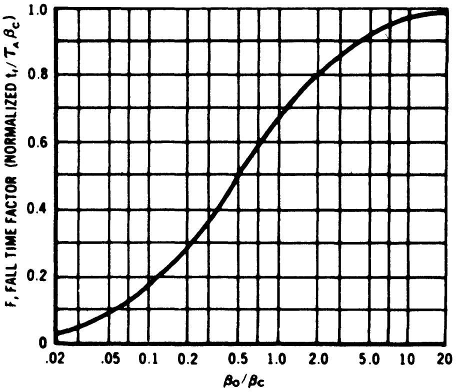
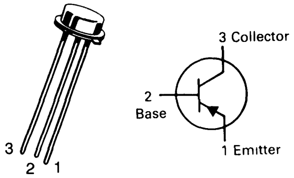


FIGURE 7 — FALL TIME FACTOR



2N2605

JAN, JTX AVAILABLE
CASE 26-03, STYLE 1
TO-46 (TO-206AB)



AMPLIFIER TRANSISTOR

PNP SILICON

Refer to 2N3798 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.28	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

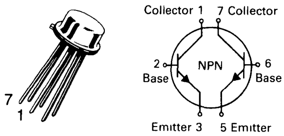
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) I_C = 10 mA (Pulse)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μA)	$V_{(BR)EBO}$	6	—	Vdc
Collector Cutoff Current (V_{CB} = 45 V)	I_{CBO}	—	10	nA
Base-Emitter Short Circuit Current (V_{CE} = 45 V) (V_{CE} = 45 V, T_A = 170°C)	I_{CES}	— —	10 10	nA μA
Emitter Cutoff Current (V_{BE} = 5.0 V)	I_{EBO}	—	2	nA
ON CHARACTERISTICS				
DC Current Gain(1) (V_{CE} = 5.0 V, I_C = 10 μA) (V_{CE} = 5.0 V, I_C = 500 μA) (V_{CE} = 5.0 V, I_C = 10 mA) (V_{CE} = 5.0 V, I_C = 10 μA, T_A = −55°C)	h_{FE}	100 150 — 20	300 — 600 —	— — — —
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 500 μA)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 500 μA)	$V_{BE(sat)}$	0.7	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6	pF
Input Impedance (V_{CE} = 5.0 V, I_C = 1.0 mA, f = 100 MHz)	h_{ie}	—	200	Ω
Input Impedance (V_{CB} = 5.0 V, I_E = 1.0 mA, f = 1.0 kHz)	h_{ib}	25	35	Ω
Voltage Feedback Ratio (V_{CB} = 5.0 V, I_E = 1.0 mA, f = 1.0 kHz)	h_{rb}	—	10	10^{-4}
Small-Signal Current Gain (V_{CB} = 5.0 V, I_E = 1.0 mA, f = 1.0 kHz) (V_{CB} = 5.0 V, I_C = 500 μA, f = 30 MHz)	h_{fe}	150 1.0	600 —	— —
Output Admittance (V_{CB} = 5.0 V, I_E = 1.0 mA, f = 1.0 kHz)	h_{ob}	—	1	μmho
Noise Figure(2) (V_{CB} = 5.0 V, I_C = 10 μA, R_g = 10 k Ω, BW = 15.7 kHz)	NF	—	3	dB

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) Measured in amplifier with response down 3 dB at 10 Hz.

2N2639
thru
2N2644

CASE 654-07, STYLE 1



DUAL
AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2913 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	45		Vdc
Collector-Base Voltage	V_{CBO}	45		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	30		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.72	600 3.43	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	600 3.43	1200 6.87	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{CEO(sus)}$	45	—	Vdc
Collector Cutoff Current (V_{CE} = 5.0 Vdc, I_B = 0)		I_{CEO}	—	0.010	μAdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0) (V_{CB} = 45 Vdc, I_E = 0, T_A = +150°C)		I_{CBO}	 — —	 0.010 10	μAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	0.010	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644		50 100	300 300	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644		10 20	— —	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644		55 110	— —	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644		65 130	— —	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{BE(sat)}$	0.6	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	40	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz, I_E = −1.0 mA)		h_{ib}	25	32	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz, I_E = −1.0 mA)		h_{rb}	—	600	X 10^{-6}

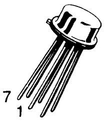
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

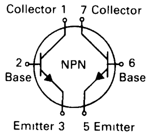
Characteristic	Symbol	Min	Max	Unit
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz) 2N2639, 2N2640, 2N2641 2N2642, 2N2643, 2N2644	h_{fe}	 65 130	 600 600	—
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz, I_E = −1.0 mA)	h_{ob}	—	1.0	μmhos
Noise Figure (I_C = 10 μAdc, V_{CB} = 5.0 Vdc, R_S = 10 kΩ, Bandwidth = 10 Hz to 15 kHz)	NF	—	4.0	dB
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) 2N2639, 2N2642 2N2640, 2N2643	h_{FE1}/h_{FE2}	 0.9 0.8	 1.0 1.0	—
Base-Emitter Voltage Differential (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) 2N2639, 2N2642 2N2640, 2N2643	$\|V_{BE1}-V_{BE2}\|$	 — —	 5.0 10	mVdc
Base-Emitter Voltage Differential Gradient (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +125°C) 2N2639, 2N2642 2N2640, 2N2643	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	 — —	 10 20	μV/°C

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) The lowest h_{FE} reading is taken as h_{FE1} for this test.

2N2652, A

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2060,A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CBO}	100		Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	Both Die	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.3 1.72	0.6 3.43	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 5.7	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

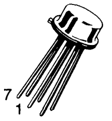
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	100	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$) ($V_{CB} = 50$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.010 15	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$) 2N2652	I_{EBO}	—	0.010	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 100\ \mu$Adc, $V_{CE} = 5.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, $T_A = -55°C$)	h_{FE}	35 50 15	— 200 —	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	—	1.2	Vdc
Base-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	60	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	15	pF
Input Capacitance ($V_{BE} = 0$, 0.5 Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	85	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{ie}	1.0	10.5	kohms
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{ib}	20	35	ohms
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{fe}	50	300	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{oe}	—	50	μmhos
Noise Figure ($I_C = 0.3$ mAdc, $V_{CE} = 10$ Vdc, $R_S = 610$ ohms, B. W. = 1.0 Hz, f = 1.0 kHz)	NF	—	8.0	dB
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2) ($I_C = 100\ \mu$Adc, $V_{CE} = 5.0$ Vdc) 2N2652 ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc) 2N2652	h_{FE1}/h_{FE2}	0.85 0.85	1.0 1.0	—
Base-Emitter Voltage Differential ($I_C = 100\ \mu$Adc, $V_{CE} = 5.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc)	$\lvert V_{BE1}-V_{BE2}\rvert$	— —	3.0 3.0	mVdc
Base-Emitter Voltage Differential Gradient ($I_C = 100\ \mu$Adc, $V_{CE} = 5.0$ Vdc, $T_A = -55$ to +125°C)	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	—	10	μV/°C

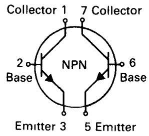
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(2) The lowest of the two h_{FE} readings is taken as h_{FE1} for the purpose of measurement.

2N2721

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2060 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CBO}	80		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	40		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.3 1.71	0.6 3.4	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.6 3.4	1.2 6.8	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

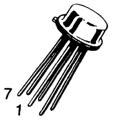
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

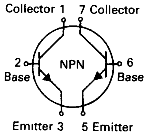
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector Cutoff Current (V_{CE} = 5.0 Vdc, I_B = 0)	I_{CEO}	—	10	nAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	0.01 10	µAdc
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 100 µAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30 35 42	120 — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	0.65	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	80	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Impedance (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ib}	25	32	ohms
Voltage Feedback Ratio (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{rb}	—	500	$X\ 10^{-6}$
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	30	200	—
Output Admittance (I_E = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ob}	—	1.0	µmhos
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2) (I_C = 100 µAdc, V_{CE} = 5.0 Vdc)	h_{FE1}/h_{FE2}	0.8	1.0	—
Base-Emitter Voltage Differential (I_C = 100 µAdc, V_{CE} = 5.0 Vdc)	$\lvert V_{BE1}-V_{BE2}\rvert$	—	10	mVdc
Base-Emitter Voltage Differential Change Due to Temperature (I_C = 100 µAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +25°C) (I_C = 100 µAdc, V_{CE} = 5.0 Vdc, T_A = +25 to +125°C)	$\Delta(V_{BE1}-V_{BE2})$	— —	1.6 2.0	mV

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
(2) The lower of the two h_{FE} readings is taken as h_{FE1} for the purpose of measurement.

2N2722

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2920 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	45		Vdc
Collector-Base Voltage	V_{CBO}	45		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	40		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.3 1.7	0.6 3.4	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.6 3.4	1.2 6.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	45	—	Vdc
Collector Cutoff Current ($V_{CE} = 5.0$ Vdc, $I_B = 0$)	I_{CEO}	—	2.0	nAdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$) ($V_{CB} = 30$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.001 1.0	μAdc
Emitter Cutoff Current ($V_{EB} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	1.0	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0\ \mu$Adc, $V_{CE} = 5.0$ Vdc) ($I_C = 10\ \mu$Adc, $V_{CE} = 5.0$ Vdc) ($I_C = 0.1$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	50 100 125	250 — —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 0.5$ mAdc)	$V_{BE(sat)}$	0.65	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	100	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Impedance ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{ib}	25	32	ohms
Voltage Feedback Ratio ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{rb}	—	600	X 10^{-6}
Small-Signal Current Gain ($I_E = 0.1$ mAdc, $V_{CE} = 5.0$ Vdc, f = 1.0 kHz)	h_{fe}	100	700	—
Output Admittance ($I_E = 1.0$ mAdc, $V_{CB} = 5.0$ Vdc, f = 1.0 kHz)	h_{ob}	—	1.0	μmhos
Noise Figure ($I_C = 10\ \mu$Adc, $V_{CE} = 5.0$ Vdc, $R_S = 10$ kΩ, f = 10 Hz to 15.7 kHz)	NF	—	4.0	dB
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2) ($I_C = 1.0\ \mu$Adc, $V_{CE} = 5.0$ Vdc)	h_{FE1}/h_{FE2}	0.9	1.0	—
Base-Emitter Voltage Differential ($I_C = 10\ \mu$Adc, $V_{CE} = 5.0$ Vdc)	$\lvert V_{BE1}-V_{BE2}\rvert$	—	5.0	mVdc
Base-Emitter Voltage Differential Change Due to Temperature ($I_C = 10\ \mu$Adc, $V_{CE} = 5.0$ Vdc, $T_A = -55$ to $+25°C$) ($I_C = 10\ \mu$Adc, $V_{CE} = 5.0$ Vdc, $T_A = +25$ to $+125°C$)	$\Delta(V_{BE1}-V_{BE2})$	 — —	 0.8 1.0	mVdc

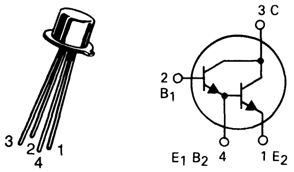
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(2) The lower of the two h_{FE} readings is taken as h_{FE1} for the purpose of measurement.

2N2723

CASE 20-03, STYLE 8

TO-72 (TO-206AF)



DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N998 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (Base 1 and Base 2 open)	V_{CE2O}	60	Vdc
Collector-Base Voltage	V_{CB1}	80	Vdc
Emitter-Base Voltage	V_{E2B1}	12	Vdc
Collector Current — Continuous	I_C	40	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.9	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10.5	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

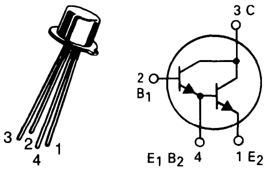
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_{B1} = 0)	$V_{(BR)CE2O}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_{E2} = 0)	$V_{(BR)CB1O}$	80	—	Vdc
Emitter-Base Breakdown Voltage (I_{E2} = 10 μAdc, I_C = 0)	$V_{(BR)E2B1O}$	12	—	Vdc
Collector Cutoff Current (V_{CB1} = 60 Vdc, I_E = 0) (V_{CB1} = 60 Vdc, I_E = 0, T_A = 150°C)	I_{CB1O}	 — —	 0.01 10	μAdc
Emitter Cutoff Current (V_{B1E2} = 10 Vdc, I_C = 0)	I_{E2B1O}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 mAdc, V_{CE2} = 5.0 Vdc, I_{B2} = 0)	h_{FE}	2000	10,000	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	$V_{CE2(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	$V_{BE2(sat)}$	—	1.7	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB1} = 10 Vdc, I_{E2} = 0, f = 140 kHz)	C_{ob1o}	—	10	pF
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE2} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	1500	15,000	—
Current Gain — Bandwidth Product (Each Unit) (I_C = 10 mAdc, V_{CE1} or V_{CE2} = 10 Vdc, f = 20 MHz)	$\|h_{fe}\|$	5.0	—	—
Noise Figure (Input Stage Only) (I_C = 50 μAdc, V_{CE} = 5.0 Vdc, R_S = 3.0 kohms, f = 1.0 kHz, BW = 100 Hz)	NF	—	10	dB

(1) Pulse Test: Pulse Width ≤ 12 ms, Duty Cycle ≤ 2.0%.

2N2785

CASE 20-03, STYLE 8
TO-72 (TO-206AF)



DARLINGTON TRANSISTOR

NPN SILICON

Refer to 2N998 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (Base 1 and Base 2 open)	V_{CE2O}	40	Vdc
Collector-Base Voltage	V_{CB1O}	60	Vdc
Emitter-Base Voltage (Pin 4 to Pin 2)	V_{E2B1O}	15 7.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.5 2.9	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10.5	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

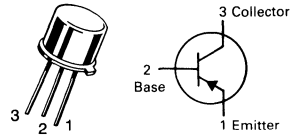
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 20$ mAdc, $I_{B1} = 0$)	$V_{(BR)CEO2O}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_{E2} = 0$)	$V_{(BR)CBO1O}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_{E2} = 100$ μAdc, $I_C = 0$)	$V_{(BR)E2BO1O}$	15	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $I_B = 0$)	I_{CEO}	—	500	nAdc
Collector Cutoff Current ($V_{CB1} = 30$ Vdc, $I_E = 0$) ($V_{CB1} = 30$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	 — —	 0.05 10	μAdc
Emitter Cutoff Current ($V_{E2B1} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	20	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 1.0$ mAdc, $V_{CE2} = 4.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE2} = 5.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE2} = 5.0$ Vdc)	h_{FE}	 600 1200 2000	 — — 20,000	—
Collector-Emitter Saturation Voltage ($I_C = 15$ mAdc, $I_{B1} = 3.0$ mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB1} = 10$ Vdc, $I_{E2} = 0$, f = 1.0 MHz)	C_{ob1o}	—	30	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CB1} = 5.0$ Vdc, f = 1.0 kHz)	h_{ib}	30	80	Ohms
Voltage Feedback Ratio ($I_C = 1.0$ mAdc, $V_{CE2} = 5.0$ Vdc, f = 1.0 kHz)	h_{rb}	—	10	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE2} = 5.0$ Vdc, f = 1.0 kHz)	h_{fe}	600	—	—
Current Gain — High Frequency ($I_C = 1.0$ mAdc, $V_{CE2} = 5.0$ Vdc, f = 10 MHz)	$\|h_{fe}\|$	1.0	—	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CB1} = 5.0$ Vdc, f = 1.0 kHz)	h_{ob}	—	0.5	μmhos

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

2N2800

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	800	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.0 17.14	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 100$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	35	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 25$ Vdc, $V_{BE} = 0.5$ Vdc Off)	I_{CEX}	—	100	nAdc
Base Cutoff Current ($V_{CE} = 25$ Vdc, $V_{BE} = 0.5$ Vdc Off)	I_{BL}	—	100	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)		20	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)		30	90	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1)		15	—	
($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)(1)		25	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)		—	0.4	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)		—	1.2	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)		—	1.3	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)		—	1.8	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	120	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, f = 100 kHz)	C_{obo}	—	25	pF

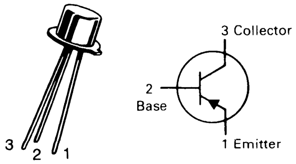
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	$I_C = 150$ mA, $I_B = 15$ mA, $V_{BE(off)} = +0.5$ V	t_d	9	25	ns
Rise Time		t_r	25	45	
Storage Time	$I_C = 150$ mA, $I_{B1} = -15$ mA, $I_{B2} = +15$ mA	t_s	100	225	ns
Fall Time		t_f	30	45	

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

2N2894

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N869A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage(1)	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.06	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1200 6.85	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

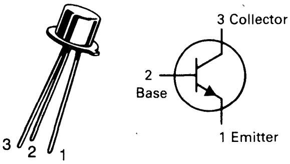
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	12	—	Vdc
Collector-Emitter Sustaining Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0, T_A = 125°C)	I_{CBO}	—	10	μAdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0)	I_{CES}	—	80	nAdc
Base Current (V_{CE} = 6.0 Vdc, V_{BE} = 0)	I_B	—	80	nAdc
ON CHARACTERISTICS				
DC Current Gain(2)	h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 0.3 Vdc)		30	—	
(I_C = 30 mAdc, V_{CE} = 0.5 Vdc)		40	150	
(I_C = 30 mAdc, V_{CE} = 0.5 Vdc, T_A = −55°C)		17	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)(2)		25	—	
Collector-Emitter Saturation Voltage(2)	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		—	0.15	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		—	0.2	
(I_C = 100 mAdc, I_B = 10 mAdc)		—	0.5	
Base-Emitter Saturation Voltage(2)	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)		0.78	0.98	
(I_C = 30 mAdc, I_B = 3.0 mAdc)		0.85	1.2	
(I_C = 100 mAdc, I_B = 10 mAdc)		—	1.7	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	6.0	pF
Input Capacitance (V_{BE} = −0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	6.0	pF
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 2.0 Vdc, V_{BE} = 3.0 Vdc, I_C = 30 mAdc, I_{B1} = 1.5 mAdc)	t_{on}	—	60	ns
Turn-Off Time (V_{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = I_{B2} = 1.5 mAdc)	t_{off}	—	90	ns

(1) Applicable from 0.01 to 10 mAdc.
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

2N2895
thru
2N2897

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N2895	2N2896	2N2897	Unit
Collector-Emitter Voltage	V_{CEO}	65	90	45	Vdc
Collector-Emitter Voltage	V_{CER}	80	140	60	Vdc
Collector-Base Voltage	V_{CBO}	120	140	60	Vdc
Emitter-Base Voltage	V_{EBO}	7.0			Vdc
Collector Current — Continuous	I_C	1.0			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.86			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10.3			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CES}$			Vdc
(I_C = 100 mAdc, R_{BE} = 10 ohms)	2N2895		80	—	
	2N2896		140	—	
	2N2897		60	—	
Collector-Emitter Sustaining Voltage(1)		$V_{CEO(sus)}$			Vdc
(I_C = 100 mAdc, I_B = 0)	2N2895		65	—	
	2N2896		90	—	
	2N2897		45	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 0.1 mAdc, I_E = 0)	2N2895		120	—	
	2N2896		140	—	
	2N2897		60	—	
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 60 Vdc, I_C = 0)	2N2895		—	0.002	
	2N2896		—	0.01	
	2N2897		—	0.05	
(V_{CB} = 60 Vdc, I_E = 0, T_A = +150°C)	2N2895		—	2.0	
	2N2897		—	50	
(V_{CB} = 90 Vdc, I_E = 0)	2N2896		—	0.01	
(V_{CB} = 90 Vdc, I_E = 0, T_A = +150°C)	2N2896		—	10	
Emitter Cutoff Current		I_{EBO}			μAdc
(V_{BE} = 5.0 Vdc, I_C = 0)	2N2895		—	0.005	
	2N2896		—	0.01	
	2N2897		—	0.05	
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 10 Vdc)	2N2895		10	—	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	2N2895		20	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N2896, 2N2897		35	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N2895		35	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = −55°C)	2N2895, 2N2896		20	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)	2N2895		40	120	
	2N2896		60	200	
	2N2897		50	200	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	2N2895		25	—	

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

Characteristic		Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	2N2895, 2N2896		—	0.6	
	2N2897		—	1.0	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	2N2895, 2N2896		—	1.2	
	2N2897		—	1.3	

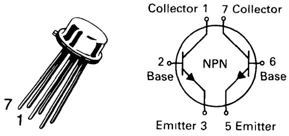
SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	2N2895, 2N2896		120	—	
	2N2897		100	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	15	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	80	pF
Small-Signal Current Gain		h_{fe}			—
(I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N2895		50	200	
	2N2896, 2N2897		50	275	
Noise Figure		NF			dB
(I_C = 0.3 mAdc, V_{CE} = 10 Vdc, R_S = 500 ohms,	2N2895				
f = 1.0 kHz, BW = 15 kHz)			—	8.0	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.8%.

2N2903

CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N2920 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	300 1.71	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.6 3.43	1.2 6.86	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{CEO(sus)}$	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 μAdc, I_C = 0)	$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	0.01 15	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	0.01	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	h_{FE}	60 25 125 60	— — 625 —	—
Collector-Emitter Saturation Voltage (I_C = 5.0 mAdc, I_B = 0.5 mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 5.0 mAdc, I_B = 0.5 mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 30 MHz)	f_T	60	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{ie}	1.0	—	kohm
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ib}	20	30	ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{re}	—	6.0	$X\ 10^{-4}$
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{rb}	—	5.0	$X\ 10^{-4}$
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	150	600	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{oe}	5.0	30	μmhos
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ob}	—	0.2	μmho
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 1.0 kHz)	NF	—	7.0	dB
MATCHING CHARACTERISTICS				
DC Current Gain Ratio(2) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE1}/h_{FE2}	0.8	1.0	—
Base-Emitter Voltage Differential (I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	$\lvert V_{BE1}-V_{BE2}\rvert$	—	10	mVdc
Base-Emitter Voltage Differential Gradient (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +125°C)	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	—	20	μV/°C

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) Lowest h_{FE} reading is taken as h_{FE1} for this ratio.

PNP SILICON ANNULAR HERMETIC TRANSISTORS

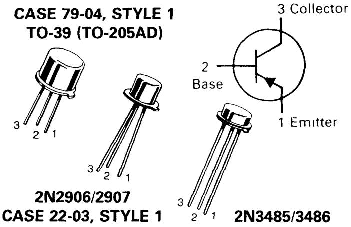
... designed for high-speed switching circuits, DC to VHF amplifier applications and complementary circuitry.

- High DC Current Gain Specified — 0.1 to 500 mAdc
- High Current-Gain — Bandwidth Product — f_T = 200 MHz (Min) @ I_C = 50 mAdc
- Low Collector-Emitter Saturation Voltage — $V_{CE(sat)}$ = 0.4 Vdc (Max) @ I_C = 150 mAdc
- 2N2904, A thru 2N2907, A Complement to NPN 2N2218, A, 2N2219, A, 2N2221, A, 2N2222, A
- JAN, JANTX Available for 2N2904, A thru 2N2907, A

2N2904, A
thru
2N2907, A
2N3485, A, 2N3486, A

JAN, JTX, JTXV AVAILABLE*

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



2N2906/2907
CASE 22-03, STYLE 1
TO-18 (TO-206AA)

2N3485/3486
CASE 26-03, STYLE 1
TO-46 (TO-206AB)

GENERAL PURPOSE TRANSISTORS

PNP SILICON

***ALSO AVAILABLE**
JANS 2N2905AL AND
JANS 2N2907A

MAXIMUM RATINGS

Rating	Symbol	Non-A Suffix	A-Suffix		Unit
Collector-Emitter Voltage	V_{CEO}	40	60		Vdc
Collector-Base Voltage	V_{CBO}	60			Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous	I_C	600			mAdc
		2N2904,A 2N2905,A	2N2906,A 2N2907,A	2N3485,A 2N3486,A	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	600 3.43	400 2.28	400 2.28	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.0 17.2	1.8 10.3	2.0 11.43	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	Non-A Suffix	$V_{(BR)CEO}$	40	—	—	Vdc
	A-Suffix		60	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0.5 Vdc)		I_{CEX}	—	—	50	nAdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	Non-A Suffix	I_{CBO}	—	—	0.02	μAdc
	A-Suffix		—	—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	Non-A Suffix		—	—	20	
	A-Suffix		—	—	10	
Base Current (V_{CE} = 30 Vdc, V_{BE} = 0.5 Vdc)		I_B	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	2N2904, 2N2906, 2N3485	h_{FE}	20	—	—	—
	2N2905, 2N2907, 2N3486		35	—	—	
	2N2904A, 2N2906A, 2N3485A		40	—	—	
	2N2905A, 2N2907A, 2N3486A		75	—	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N2904, 2N2906, 2N3485		25	—	—	
	2N2905, 2N2907, 2N3486		50	—	—	
	2N2904A, 2N2906A, 2N3485A		40	—	—	
	2N2905A, 2N2907A, 2N3486A		100	—	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N2904, 2N2906, 2N3485		35	—	—	
	2N2905, 2N2907, 2N3486		75	—	—	
	2N2904A, 2N2906A, 2N3485A		40	—	—	
	2N2905A, 2N2907A, 2N3486A		100	—	—	

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

(continued)

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

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS (continued)						
DC Current Gain		h_{FE}	40	—	120	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)(1)	2N2904A, 2N2906A, 2N3485A		100	—	300	
	2N2905A, 2N2907A, 2N3486A					
(I_C = 500 mAdc, V_{CE} = 10 Vdc)(1)	2N2904, 2N2906, 2N3485		20	—	—	
	2N2905, 2N2907, 2N3486		30	—	—	
	2N2904A, 2N2906A, 2N3485A		40	—	—	
	2N2905A, 2N2907A, 2N3486A		50	—	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	—	1.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)(1)			—	—	1.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	—	2.6	
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{ob}	—	—	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ib}	—	—	30	pF
SWITCHING CHARACTERISTICS						
Turn-On Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 15a)	t_{on}	—	26	45	ns
Delay Time		t_d	—	6.0	10	
Rise Time		t_r	—	20	40	
Turn-Off Time	(V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 15b)	t_{off}	—	70	100	ns
Storage Time		t_s	—	50	80	
Fall Time		t_f	—	20	30	

(1) Pulse Test: Pulse Width ≦ 300 μs, Duty Cycle ≦ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — NORMALIZED DC CURRENT GAIN

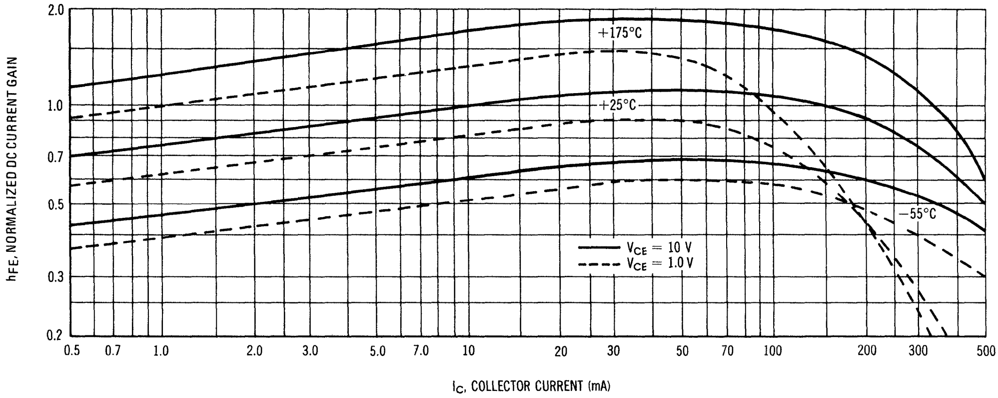
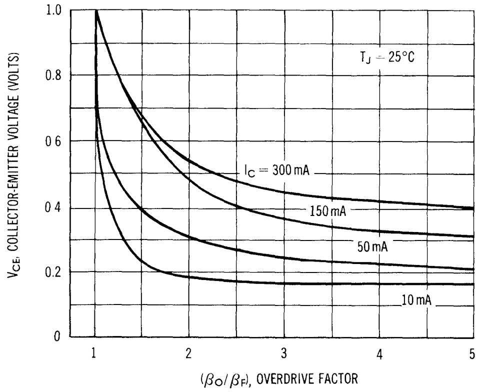


FIGURE 2 – NORMALIZED COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current. β_O (current gain at edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit.

EXAMPLE: For type 2N2905, estimate a base current (I_{BF}) to insure saturation at a temperature of 25°C and a collector current of 150 mA.

Observe that at $I_C = 150$ mA an overdrive factor of at least 3 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h_{FE} @ 1 volt is approximately 0.60 of h_{FE} @ 10 volts. Using the guaranteed minimum of 100 @ 150 mA and 10 V, $\beta_O = 60$ and substituting values in the overdrive equation, we find:

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE} \ @ \ 1 \text{ V}}{I_C/I_{BF}} \qquad 3 = \frac{60}{150/I_{BF}} \qquad I_{BF} \approx 7.5 \text{ mA}$$

FIGURE 3 – "ON" VOLTAGES

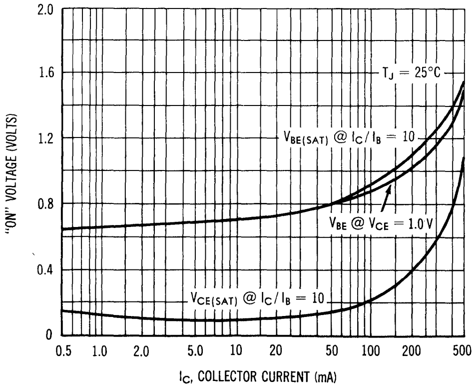
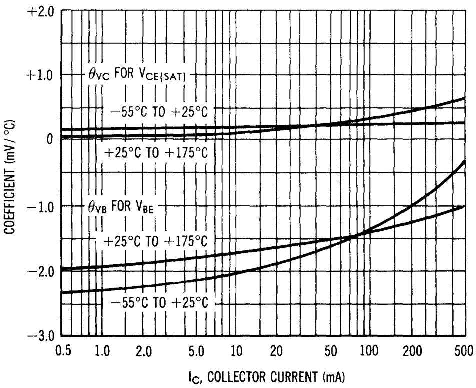


FIGURE 4 – TEMPERATURE COEFFICIENTS



SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

$V_{CE} = 10$ V, $T_A = 25°C$

FIGURE 5 – FREQUENCY EFFECTS

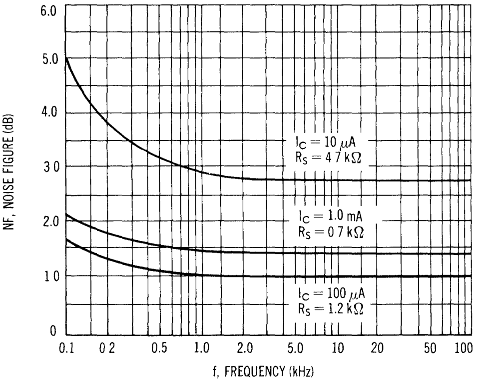
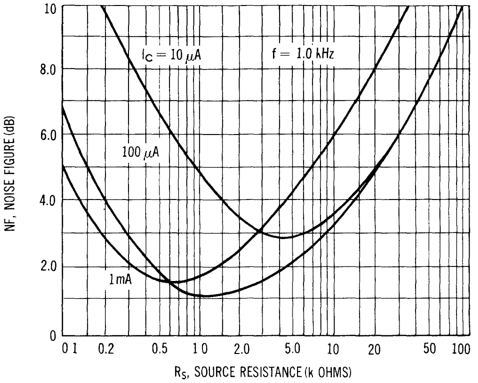


FIGURE 6 – SOURCE RESISTANCE EFFECTS



h PARAMETERS

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

This group of graphs illustrates the relationship between h_{fe} and other "h" parameters for this series of transistors. To obtain these curves, a high-gain and a low-gain unit were selected and the same units were used to develop the correspondingly numbered curves on each graph.

FIGURE 7 – INPUT IMPEDANCE

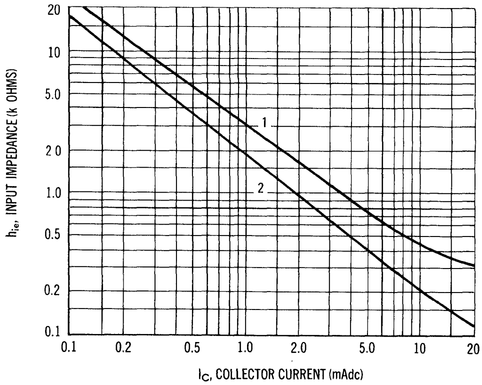


FIGURE 8 – VOLTAGE FEEDBACK RATIO

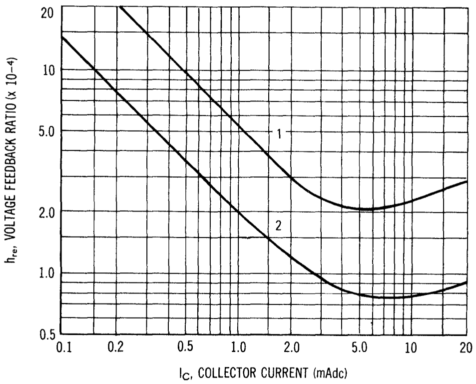


FIGURE 9 – CURRENT GAIN

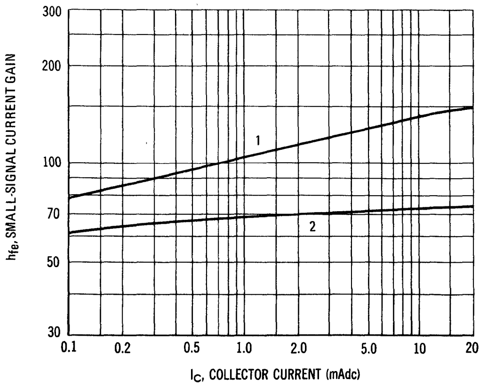


FIGURE 10 – OUTPUT ADMITTANCE

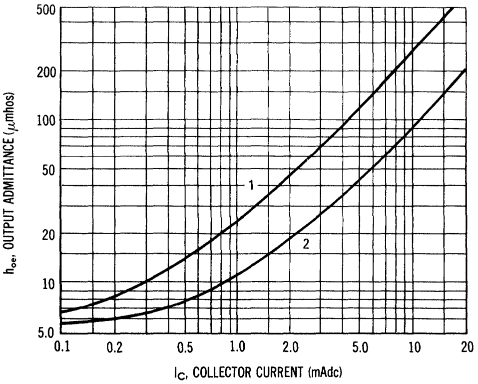


FIGURE 11 – TURN ON TIME

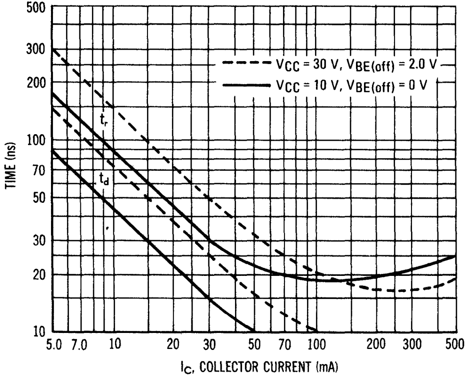


FIGURE 12 – CHARGE DATA

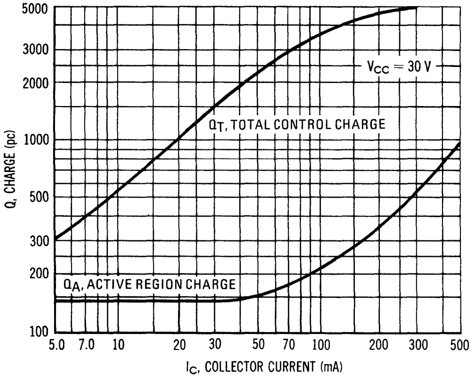


FIGURE 13 – STORAGE TIME

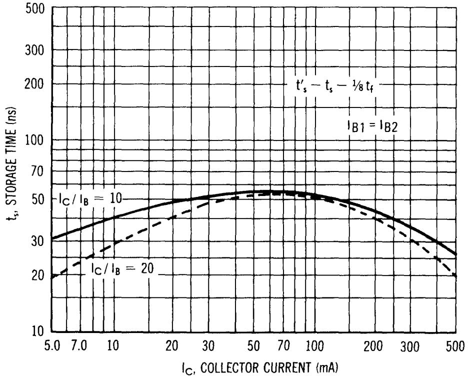


FIGURE 14 – FALL TIME

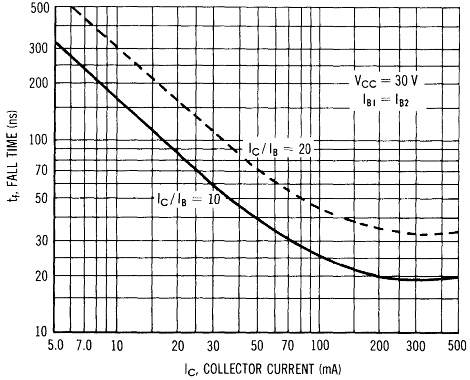


FIGURE 15a – DELAY AND RISE TIME TEST CIRCUIT

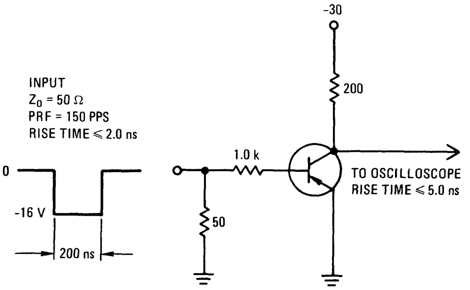


FIGURE 15b – STORAGE AND FALL TIME TEST CIRCUIT

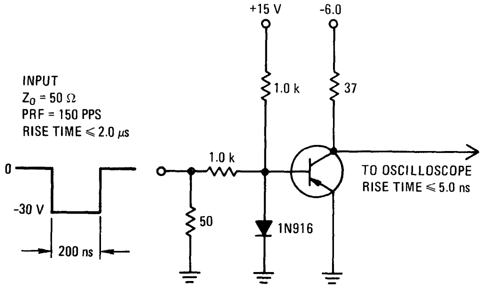


FIGURE 16 – CURRENT-GAIN–BANDWIDTH PRODUCT

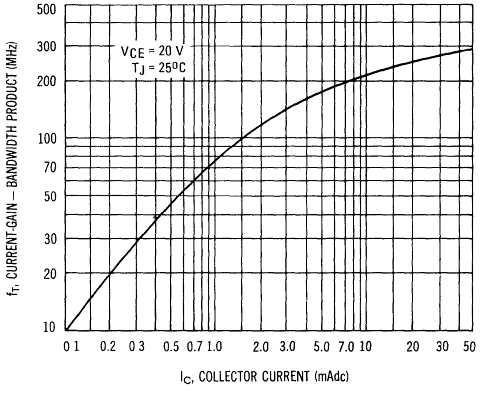


FIGURE 17 – CAPACITANCES

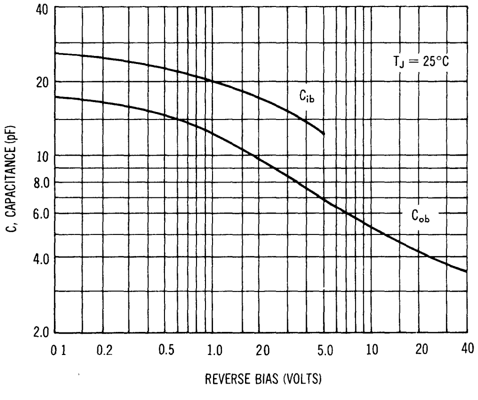
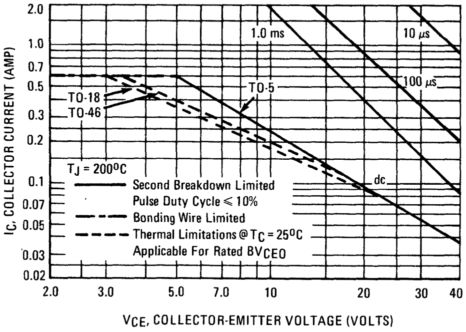


FIGURE 18 – ACTIVE REGION SAFE OPERATING AREAS

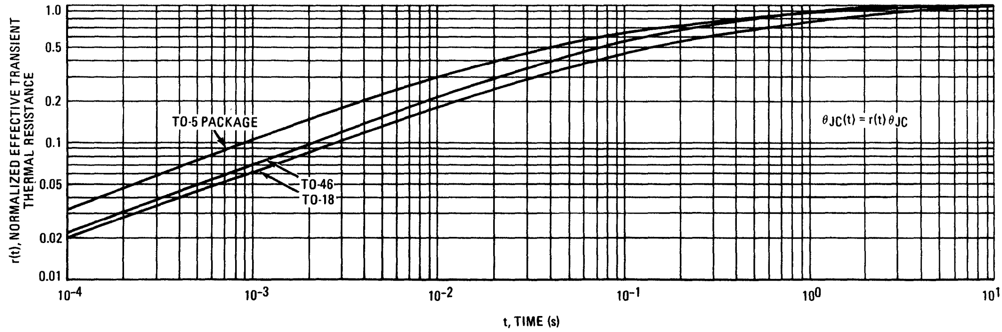


This graph shows the maximum I_C-V_{CE} limits of the device both from the standpoint of thermal dissipation (at 25°C case temperature), and secondary breakdown. For case temperatures other than 25°C, the thermal dissipation curve must be modified in accordance with the derating factor in the Maximum Ratings table.

To avoid possible device failure, the collector load line must fall below the limits indicated by the applicable curve. Thus, for certain operating conditions the device is thermally limited, and for others it is limited by secondary breakdown.

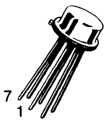
For pulse applications, the maximum I_C-V_{CE} product indicated by the dc thermal limits can be exceeded. Pulse thermal limits may be calculated by using the transient thermal resistance curve of Figure 19.

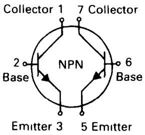
FIGURE 19 – THERMAL RESISTANCE



2N2913
thru
2N2920

JAN, JTX, JTXV, JANS AVAILABLE
CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N2913 thru 2N2918	2N2919 2N2920	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	Vdc
Collector-Base Voltage	V_{CBO}	45	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	30		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	500 2.86	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	750 4.3	1500 8.6	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	2N2913 thru 18, 2N2919, 2N2920	$V_{(BR)CEO(sus)}$	45 60	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	2N2913 thru 18, 2N2919, 2N2920	$V_{(BR)CBO}$	45 60	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 5.0 Vdc, I_B = 0)		I_{CEO}	—	—	0.002	μAdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)	2N2913 thru 18, 2N2919, 2N2920	I_{CBO}	— —	— —	0.010 0.002	μAdc
(V_{CB} = 45 Vdc, I_E = 0, T_A = 150°C)	All Types		—	—	10	
Emitter Cutoff Current (V_{EB} = 5.0 Vdc, I_C = 0)		I_{EBO}	—	—	0.002	μAdc
ON CHARACTERISTICS						
DC Current Gain(1) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N2913,15,17,19, 2N2914,16,18,20	h_{FE}	60 150	— —	240 600	—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	2N2913,15,17,19, 2N2914,16,18, 2N2920		15 30 40	— — —	— — —	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N2913,15,17,19, 2N2914,16,18,20		100 225	— —	— —	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N2913,15,17,19, 2N2914,16,18,20		150 300	— —	— —	
Collector-Emitter Saturation Voltage (I_C = 1.0 mAdc, I_B = 0.1 mAdc)		$V_{CE(sat)}$	—	—	0.35	Vdc
Base-Emitter On Voltage (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	—	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	60	—	—	MHz

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

Characteristic	Symbol	Min	Typ	Max	Unit
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	4.0	6.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ib}	25	28	32	ohms
Output Admittance (I_C = 1.0 mAdc, V_{CB} = 5.0 Vdc, f = 1.0 kHz)	h_{ob}	—	—	1.0	μmhos
Noise Figure	NF				dB
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 1.0 kHz, BW = 200 Hz) 2N2914,16,18,20,		—	2.0	3.0	
2N2913,15,17,19		—	3.0	4.0	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 kHz, BW = 10 kHz) 2N2914,16,18,20,		—	2.0	3.0	
2N2913,15,17,19		—	3.0	4.0	

MATCHING CHARACTERISTICS

DC Current Gain Ratio(2)	h_{FE1}/h_{FE2}				—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc) 2N2917,18,		0.8	—	1.0	
2N2915,16,19,20		0.9	—	1.0	
Base-Emitter Voltage Differential	$\lvert V_{BE1}-V_{BE2}\rvert$				mVdc
(I_C = 10 μAdc to 1.0 mAdc, V_{CE} = 5.0 Vdc) 2N2917,18,		—	—	10	
2N2915,16,19,20		—	—	5.0	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc) 2N2917,18,		—	—	5.0	
2N2915,16,19,20		—	—	3.0	
Base-Emitter Voltage Differential Change Due to Temperature	$\Delta(V_{BE1}-V_{BE2})$				mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +25°C) 2N2917,18,		—	—	1.6	
2N2915,16,19,20		—	—	0.8	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = +25°C to +125°C) 2N2917,18		—	—	2.0	
2N2915,16,19,20		—	—	1.0	

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

(2) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

FIGURE 1 — DC CURRENT GAIN versus COLLECTOR CURRENT

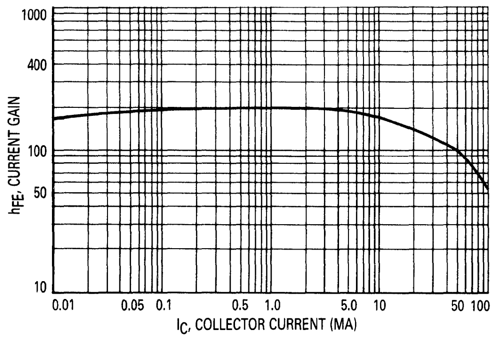


FIGURE 2 — DC CURRENT GAIN versus COLLECTOR CURRENT

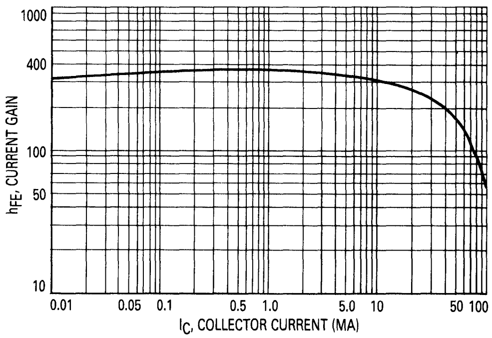


FIGURE 3 — "ON" VOLTAGES

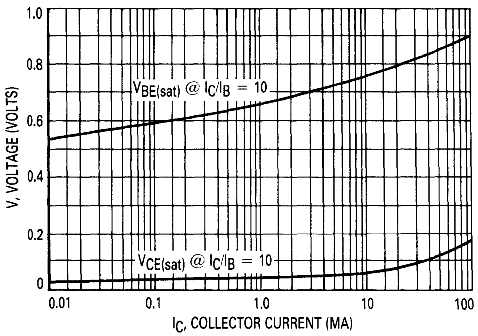
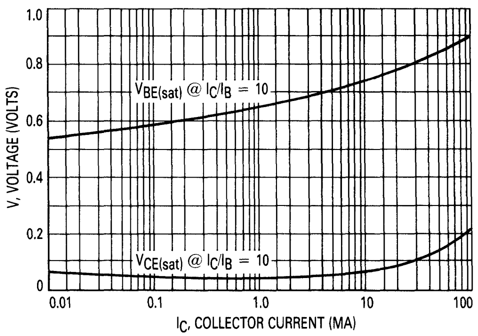
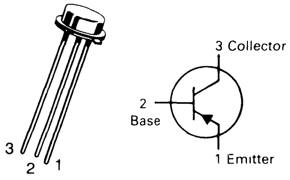


FIGURE 4 — "ON" VOLTAGES



2N2945
2N2946

CASE 26-03, STYLE 1
TO-46 (TO-206AB)



TRANSISTORS

PNP SILICON

Refer to 2N2944A for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N2945	2N2946	Unit
Emitter-Collector Voltage	V_{ECO}	20	35	Vdc
Collector-Base Voltage	V_{CBO}	25	40	Vdc
Emitter-Base Voltage	V_{EBO}	25	40	Vdc
Collector Current — Continuous	I_C	100		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.3		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.0 11.43		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	87.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	435	°C/W

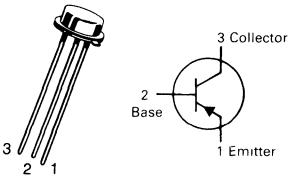
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 25 Vdc, I_E = 0)	2N2945		—	—	0.2	
(V_{CB} = 40 Vdc, I_E = 0)	2N2946		—	—	0.5	
Emitter Cutoff Current		I_{EBO}				nAdc
(V_{EB} = 25 Vdc, I_C = 0)	2N2945		—	—	0.2	
(V_{EB} = 40 Vdc, I_C = 0)	2N2946		—	—	0.5	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 1.0 mAdc, V_{CE} = 0.5 Vdc)	2N2945		40	160	—	
	2N2946		30	130	—	
*DC Current Gain (Inverted Connection)		$h_{FE(inv)}$				—
(I_B = 200 μAdc, V_{EC} = 0.5 Vdc)	2N2945		4.0	17	—	
	2N2946		3.0	15	—	
Offset Voltage		$V_{EC(ofs)}$				mVdc
(I_B = 200 μAdc, I_E = 0)	2N2945		—	0.23	0.5	
	2N2946		—	0.27	0.8	
(I_B = 1.0 mAdc, I_E = 0)	2N2945		—	0.5	1.0	
	2N2946		—	0.6	2.0	
(I_B = 2.0 mAdc, I_E = 0)	2N2945		—	0.9	1.6	
	2N2946		—	1.0	2.5	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product		f_T				MHz
(I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 MHz)	2N2945		5.0	13	—	
	2N2946		3.0	12	—	
Output Capacitance (V_{CB} = 6.0 Vdc, I_E = 0, f = 500 kHz)		C_{obo}	—	3.2	10	pF
Input Capacitance (V_{EB} = 6.0 Vdc, I_C = 0, f = 500 kHz)		C_{ibo}	—	1.9	6.0	pF
"ON" Series Resistance		r_{ec}				Ohms
(I_B = 1.0 mAdc, I_E = 0, I_c = 100 μArms, f = 1.0 kHz)	2N2945		—	4.5	35	
	2N2946		—	5.0	45	

*Indicates Data in addition to JEDEC Requirements.

2N2945A
2N2946A

JAN, JTX, JTXV AVAILABLE
CASE 26-03, STYLE 1
TO-46 (TO-206AB)



CHOPPER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N2945A	2N2946A	Unit
Emitter-Collector Voltage	V_{ECO}	20	35	Vdc
Collector-Base Voltage	V_{CBO}	25	40	Vdc
Emitter-Base Voltage	V_{EBO}	25	40	Vdc
Collector Current — Continuous	I_C	100		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	400 2.3		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.0 11.43		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Lead Temperature 1/16″ from Case for 10 seconds	T_L	240		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	435	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	87.5	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Emitter-Collector Breakdown Voltage		$V_{(BR)ECO}$				Vdc
($I_E = 10\ \mu Adc$, $I_B = 0$)	2N2945A		20	—	—	
	2N2946A		35	—	—	
Collector Cutoff Current		I_{CBO}				nAdc
($V_{CB} = 25$ Vdc, $I_E = 0$)	2N2945A		—	—	0.2	
($V_{CB} = 40$ Vdc, $I_E = 0$)	2N2946A		—	—	0.5	
($V_{CB} = 25$ Vdc, $I_E = 0$, $T_A = 100°C$)	2N2945A		—	—	20	
($V_{CB} = 40$ Vdc, $I_E = 0$, $T_A = 100°C$)	2N2946A		—	—	25	
Emitter Cutoff Current		I_{EBO}				nAdc
($V_{EB} = 25$ Vdc, $I_C = 0$)	2N2945A		—	—	0.2	
($V_{EB} = 40$ Vdc, $I_C = 0$)	2N2946A		—	—	0.5	
($V_{EB} = 25$ Vdc, $I_C = 0$, $T_A = 100°C$)	2N2945A		—	—	15	
($V_{EB} = 40$ Vdc, $I_C = 0$, $T_A = 100°C$)	2N2946A		—	—	20	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
($I_C = 1.0$ mAdc, $V_{CE} = 0.5$ Vdc)	2N2945A		70	200	—	
	2N2946A		50	200	—	
DC Current Gain (Inverted Connection)		$h_{FE(inv)}$				—
($I_B = 200\ \mu Adc$, $V_{EC} = 0.5$ Vdc)	2N2945A		30	32	—	
	2N2946A		20	25	—	
Offset Voltage		$V_{EC(ofs)}$				mVdc
($I_B = 200\ \mu Adc$, $I_E = 0$)	2N2945A		—	0.4	0.5	
	2N2946A		—	0.7	0.8	
($I_B = 1.0$ mAdc, $I_E = 0$)	2N2945A		—	0.5	1.0	
	2N2946A		—	0.6	2.0	
($I_B = 2.0$ mAdc, $I_E = 0$)	2N2945A		—	0.9	1.5	
	2N2946A		—	1.0	2.5	

SMALL-SIGNAL CHARACTERISTICS

Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 MHz) 2N2945A 2N2946A	f_T	 10 5.0	 15 8.0	 — —	MHz
Output Capacitance (V_{CB} = 6.0 Vdc, I_E = 0, f = 0.1 MHz to 1.0 MHz)	C_{obo}	—	3.2	10	pF
Input Capacitance (V_{EB} = 6.0 Vdc, I_C = 0, f = 0.1 MHz to 1.0 MHz)	C_{ibo}	—	1.9	6.0	pF
"ON" Series Resistance (I_B = 1.0 mAdc, I_E = 0, I_e = 100 µArms, f = 1.0 kHz) 2N2945A 2N2946A	$r_{ec(on)}$	 — —	 5.0 7.0	 6.0 8.0	Ohms

FIGURE 1 — $V_{EC(on)}$

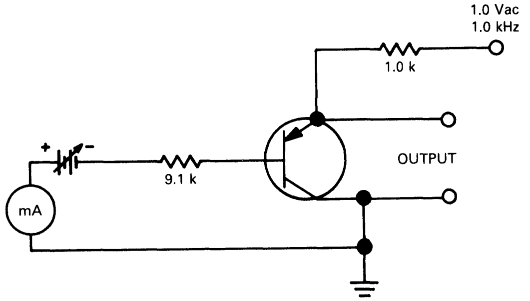
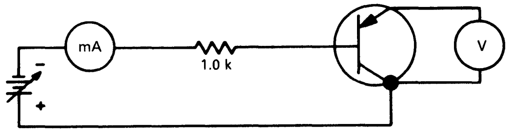


FIGURE 2 — V_{EC}(offset)



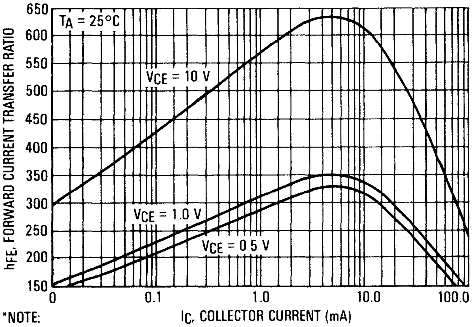
mA + + + + + - - - - - - 9.1 k 2% 1.0 Vac

10 k 2% Output Figure 1 — rec(on) $r_{ec(on)}$ $r_{ec(on)}$

mA 1.0k 2% V

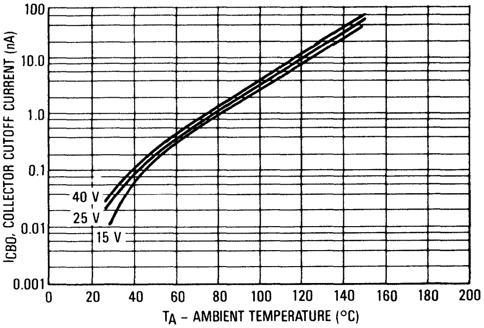
Output measured with H.P. 400D
Ac VTVM or equivalent
1.0 mV = 1.0 Ω rec(on)

h_{FE} versus I_C

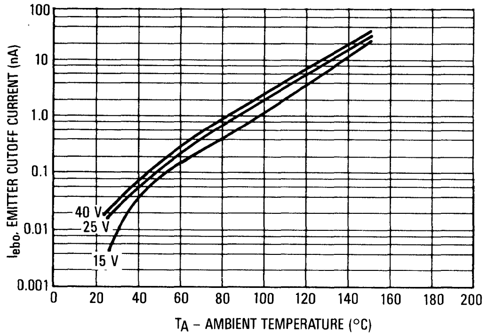


*NOTE:
PULSE WIDTH = 300 µs,
DUTY CYCLE ≤ 2%

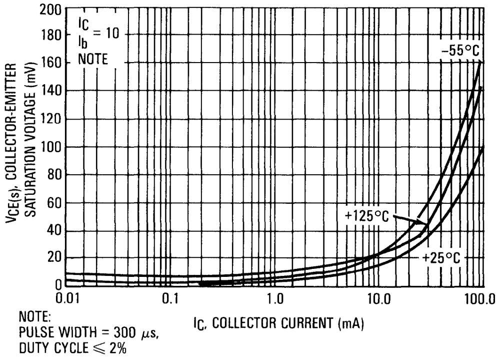
I_{CBO} versus T_A



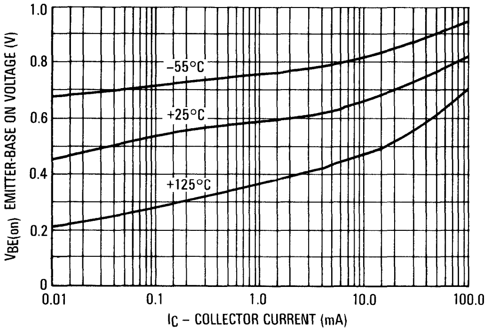
I_{ebo} versus T_A



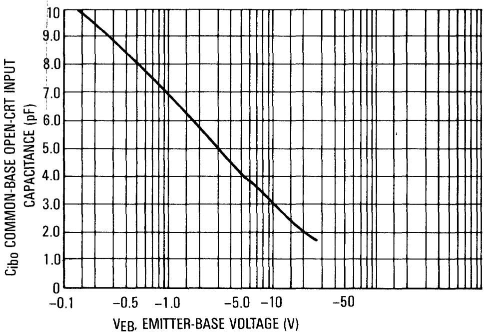
$V_{CE(s)}$ versus I_C



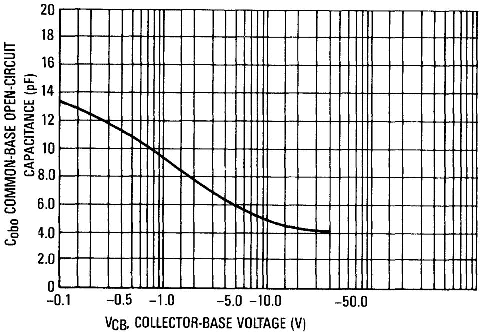
$V_{BE(on)}$ versus I_C



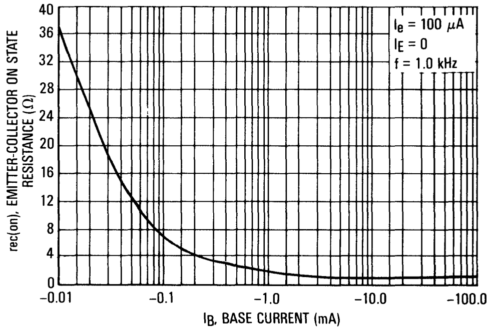
C_{ibo} versus V_{EB}



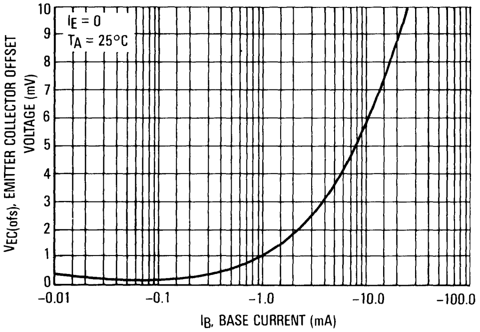
C_{obo} versus V_{CB}



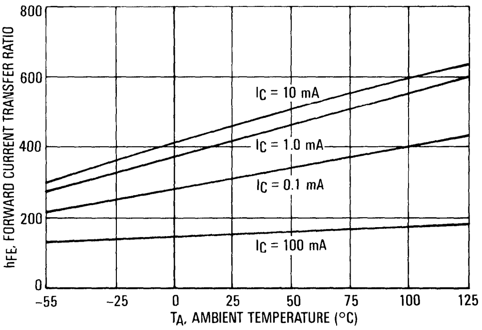
rec(on) versus I_B



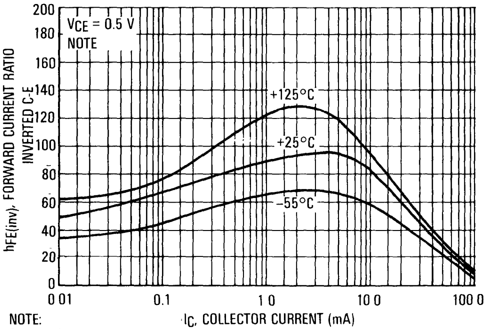
$V_{EC(ofs)}$ versus I_B



h_{FE} versus T_A



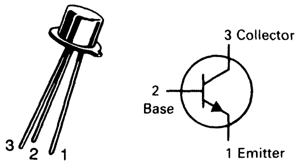
$h_{FE(inv)}$ versus I_C



NOTE:
PULSE WIDTH = 300 μs,
DUTY CYCLE ≤ 2%

2N3011

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N2368 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage(1)	V_{CEO}	12	Vdc
Collector-Emitter Voltage	V_{CES}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous Peak (10 μs Pulse)	I_C	200 500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.20 0.68 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

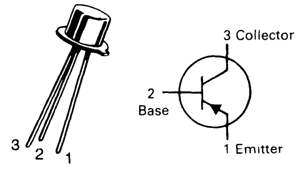
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2)	(I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Emitter Breakdown Voltage	(I_C = 10 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	Vdc
Collector-Base Breakdown Voltage	(I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage	(I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current	(V_{CE} = 20 Vdc V_{BE} = 0) (V_{CE} = 20 Vdc, V_{BE} = 0, T_A = +85°C)	I_{CES}	— —	0.4 10	μAdc
Base Cutoff Current	(V_{CE} = 20 Vdc, V_{BE} = 0)	I_{BL}	—	0.4	μAdc
ON CHARACTERISTICS (2)					
DC Current Gain	(I_C = 10 mAdc, V_{CE} = 0.35 Vdc) (I_C = 30 mAdc, V_{CE} = 0.4 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30 25 12	120 — —	—
Collector-Emitter Saturation Voltage	(I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc, T_A = +85°C)	$V_{CE(sat)}$	— — — —	0.20 0.25 0.50 0.30	Vdc
Base-Emitter Saturation Voltage	(I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	0.72 — —	0.87 1.15 1.60	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product	(I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	400	—	MHz
Output Capacitance	(V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	4.0	pF
SWITCHING CHARACTERISTICS					
Storage Time	(I_C = I_{B1} = $-I_{B2}$ = 10 mAdc)	t_s	—	13	ns
Turn-On Time	(V_{CC} = 2.0 Vdc, $V_{EB(off)}$ = 0, I_C = 30 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	—	15	ns
Turn-Off Time	(V_{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = $-I_{B2}$ = 3.0 mAdc)	t_{off}	—	20	ns

(1) Applicable from 0.01 mA to 10 mA (Pulsed).
(2) Pulse Test: Pulse Length = 30 μs, Duty Cycle ≤ 2.0%.

2N3012

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N869A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

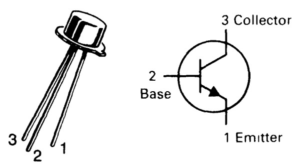
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	$V_{(BR)CES}$	12	—	Vdc
Collector-Emitter Sustaining Voltage(1) (I_C = 10 mAdc, I_B = 0) (Emitter-Base Termination — Open Base)	$V_{CEO(sus)}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = +85°C)	I_{CES}	— —	80 5.0	μAdc
Base Current (V_{CE} = 6.0 Vdc, V_{BE} = 0)	I_B	—	30	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 0.3 Vdc) (I_C = 30 mAdc, V_{CE} = 0.5 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)(1)	h_{FE}	 25 30 20	 — 120 —	—
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 30 mAdc, I_B = 3.0 mAdc, T_A = +85°C) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	 — — — —	 0.15 0.2 0.4 0.5	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 30 mAdc, I_B = 3.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	 0.78 0.85 —	 0.98 1.2 1.7	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	6.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	6.0	pF
Small-Signal Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	h_{fe}	4.0	—	—
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 2.0 Vdc, I_C≈30 mAdc, I_{B1}≈1.5 mAdc)	t_{on}	—	60	ns
Turn-Off Time (V_{CC} = 2.0 Vdc, I_C≈30 mAdc, I_{B1} = I_{B2}≈1.5 mAdc)	t_{off}	—	75	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 1.0%.

2N3013
2N3014

JAN, JTX AVAILABLE
CASE 27-02, STYLE 1
TO-52 (TO-206AC)



SWITCHING TRANSISTORS

NPN SILICON

Refer to 2N3648 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage(1) 2N3013 2N3014	V_{CEO}	 15 20	Vdc
Collector-Emitter Voltage	V_{CES}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous (10 μs pulse) Peak	I_C	200 500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ @ $T_C = 100°C$ Derate above 25°C	P_D	1.20 0.68 6.85	Watts Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

(1) Applicable from 0.01 mA to 10 mA (Pulsed)

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

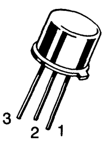
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 100\ \mu Adc, V_{BE} = 0$)		$V_{(BR)CES}$	40	—	Vdc
Collector-Emitter Sustaining Voltage(2) ($I_C = 10\ mAdc, I_B = 0$)	 2N3013 2N3014	$V_{CEO(sus)}$	 15 20	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc, I_E = 0$)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc, I_C = 0$)		$V_{(BR)EBO}$	5.0	— —	Vdc
Collector Cutoff Current ($V_{CE} = 20\ Vdc, V_{BE} = 0$) ($V_{CE} = 20\ Vdc, V_{BE} = 0, T_A = +125°C$)		I_{CES}	 — —	 0.3 40	μAdc
Base Current ($V_{CE} = 20\ Vdc, V_{BE} = 0$)		I_B	—	0.3	μAdc
ON CHARACTERISTICS(2)					
DC Current Gain ($I_C = 30\ mAdc, V_{CE} = 0.4\ Vdc$) ($I_C = 100\ mAdc, V_{CE} = 0.5\ Vdc$) ($I_C = 10\ mAdc, V_{CE} = 0.4\ Vdc$) ($I_C = 300\ mAdc, V_{CE} = 1.0\ Vdc$) ($I_C = 100\ mAdc, V_{CE} = 1.0\ Vdc$) ($I_C = 30\ mAdc, V_{CE} = 0.4\ Vdc, T_A = -55°C$)	 2N3013 2N3014 2N3013 2N3014 	h_{FE}	 30 25 25 15 25 12	 120 — — — — —	—
Collector-Emitter Saturation Voltage ($I_C = 30\ mAdc, I_B = 3.0\ mAdc$) ($I_C = 100\ mAdc, I_B = 10\ mAdc$) ($I_C = 100\ mAdc, I_B = 10\ mAdc$) ($I_C = 300\ mAdc, I_B = 30\ mAdc$) ($I_C = 10\ mAdc, I_B = 1.0\ mAdc$) ($I_C = 30\ mAdc, I_B = 3.0\ mAdc, T_A = +125°C$)	 2N3013 2N3014 2N3013 2N3014 	$V_{CE(sat)}$	 — — — — — —	 0.18 0.28 0.35 0.50 0.18 0.25	Vdc
Base-Emitter Saturation Voltage ($I_C = 30\ mAdc, I_B = 3.0\ mAdc$) ($I_C = 100\ mAdc, I_B = 10\ mAdc$) ($I_C = 300\ mAdc, I_B = 30\ mAdc$) ($I_C = 10\ mAdc, I_B = 1.0\ mAdc$)	 2N3013 2N3014	$V_{BE(sat)}$	 0.75 — — 0.70	 0.95 1.20 1.70 0.80	Vdc

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

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	350	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	8.0	pF
SWITCHING CHARACTERISTICS				
Storage Time (I_C = I_{B1} = I_{B2} = 10 mAdc)	t_s	—	18	ns
Turn-On Time	t_{on}			ns
($V_{EB(off)}$ = 5.0 V, V_{CC} = 15 V, I_C = 300 mAdc, I_{B1} = 30 mAdc) 2N3013		—	15	
($V_{EB(off)}$ = 0, V_{CC} = 2.0 V, I_C = 30 mAdc, I_{B1} = 3.0 mAdc) 2N3014		—	16	
Turn-Off Time	t_{off}			ns
(V_{CC} = 15 V, I_C = 300 mAdc, I_{B1} = I_{B2} = 30 mAdc) 2N3013		—	25	
(V_{CC} = 2.0 V, I_C = 30 mAdc, I_{B1} = I_{B2} = 3.0 mAdc) 2N3014		—	25	

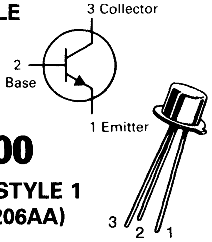
(2) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

2N3019
2N3020



CASE 79-04, STYLE 1
TO-39 (TO-205AD)

JAN, JTX, JTXV
AVAILABLE



2N3700

CASE 22-03, STYLE 1
TO-18 (TO-206AA)

GENERAL TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3019 2N3020	2N3700	Unit
Collector-Emitter Voltage	V_{CEO}	80	80	Vdc
Collector-Base Voltage	V_{CBO}	140	140	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	7.0	Vdc
Collector Current — Continuous	I_C	1.0	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.6	0.5 2.85	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	1.8 10.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N3019 2N3020	2N3700	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	16.5	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	89.5	245	°C/W

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

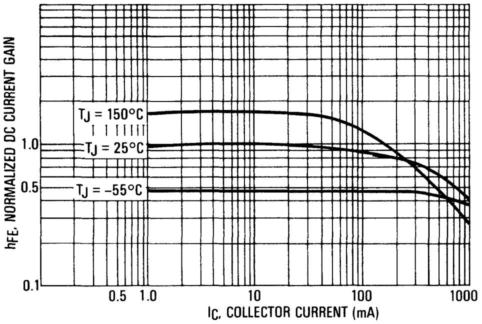
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 30$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	140	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
($V_{CB} = 90$ Vdc, $I_E = 0$)			—	0.01	
($V_{CB} = 90$ Vdc, $I_E = 0$, $T_A = +150°C$)			—	10	
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.010	μAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)	2N3700, 2N3019		50	—	
	2N3020		30	100	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	2N3700, 2N3019		90	—	
	2N3020		40	120	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	2N3700, 2N3019		100	300	
	2N3020		40	120	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc, $T_C = -55°C$)	2N3700, 2N3019		40	—	
($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)	2N3700, 2N3019		50	—	
	2N3020		30	100	
($I_C = 1.0$ Adc, $V_{CE} = 10$ Vdc)	All Types		15	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)			—	0.2	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)			—	0.5	
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{BE(sat)}$	—	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	2N3020		80	—	
	2N3019, 2N3700		100	400	

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

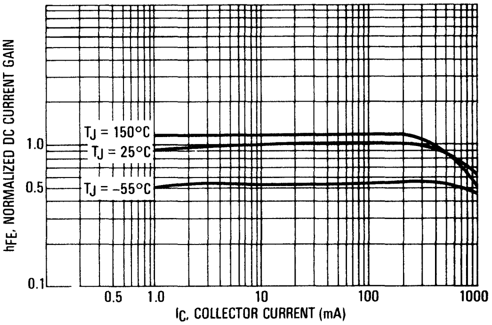
Characteristic		Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	12	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	60	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N3700, 2N3019 2N3020	h_{fe}	80 30	400 200	—
Collector Base Time Constant (I_E = 10 mAdc, V_{CB} = 10 Vdc, f = 79.8 MHz)	2N3019, 2N3020 2N3700	$r_b'C_c$	— 15	400 400	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 k ohms, f = 1.0 kHz)	2N3019, 2N3700	NF	—	4	dB

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

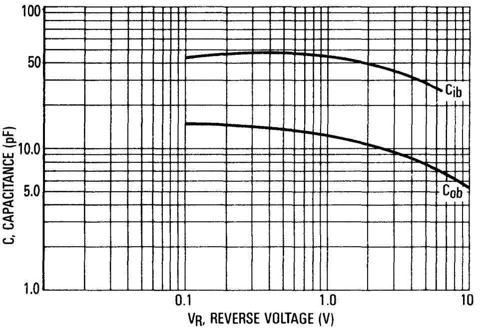
DC CURRENT GAIN
2N3019, 2N3700



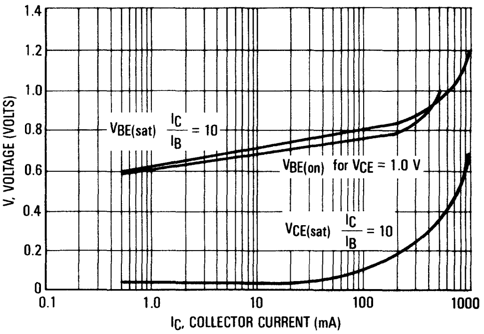
DC CURRENT GAIN
2N3020



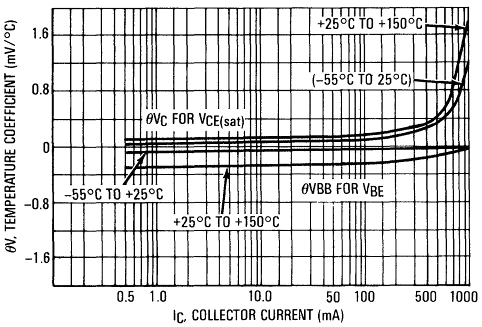
CAPACITANCE



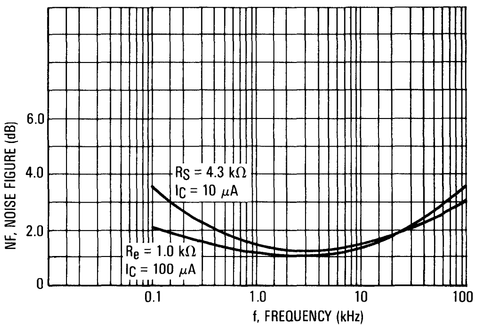
"ON" VOLTAGES



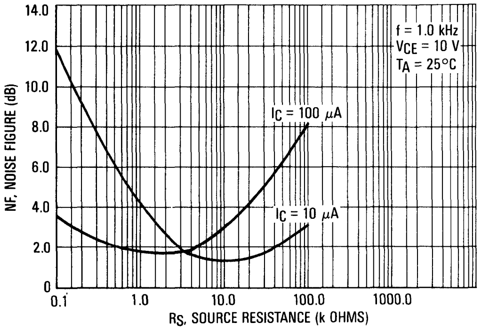
TEMPERATURE COEFFICIENTS



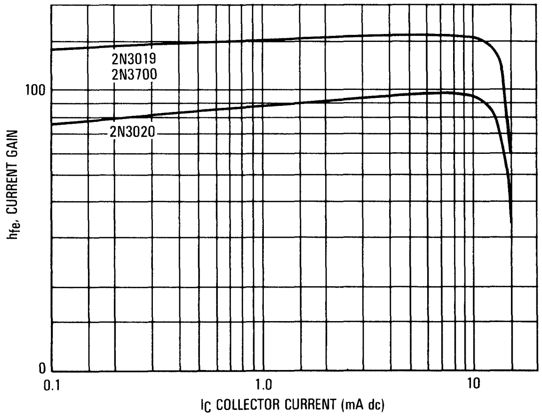
FREQUENCY EFFECTS



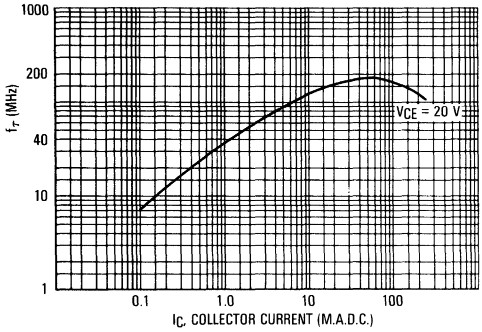
SOURCE RESISTANCE EFFECTS



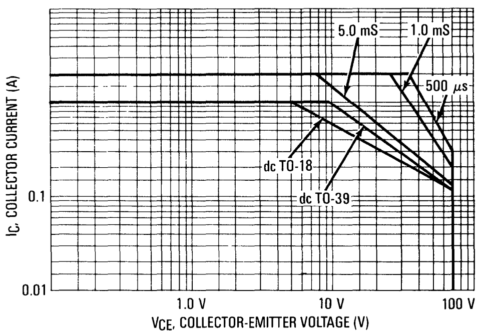
CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT — 1 kHz h_{fe}



CURRENT GAIN — BANDWIDTH PRODUCT

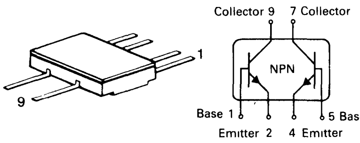


ACTIVE REGION SAFE OPERATING AREA



2N3043
thru
2N3045
2N3048

CASE 610A-04, STYLE 1



DUAL AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	45		Vdc
Collector-Base Voltage	V_{CBO}	45		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	30		mAdc
		One Die	Both Die	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	250 1.67	350 2.33	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.7 4.67	1.4 9.33	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 45 Vdc, I_E = 0)			—	0.010	
(V_{CB} = 45 Vdc, I_E = 0, T_A = +150°C)			—	10	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	0.010	μAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N3043, 2N3044, 2N3045		100	300	
	2N3048		50	200	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N3043, 2N3044, 2N3045		130	—	
	2N3048		65	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 0.5 mAdc)		$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)		V_{BE}	0.6	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	30	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	8.0	pF
Input Impedance		h_{ie}			Ohms
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N3043, 2N3044, 2N3045		3.2k	19k	
	2N3048		1.6k	13k	
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N3043, 2N3044, 2N3045		130	600	
	2N3048		65	400	
Output Admittance		h_{oe}			μmhos
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)			—	100	
			—	70	
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, Bandwidth = 10 Hz to 15.7 kHz)		NF	—	5.0	dB

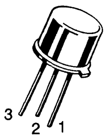
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

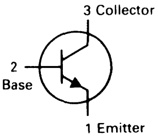
Characteristic		Symbol	Min	Max	Unit
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(2)		h_{FE1}/h_{FE2}			—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N3043		0.9	1.0	
	2N3044		0.8	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$			mVdc
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N3043		—	5.0	
	2N3044		—	10	
Base-Emitter Voltage Differential Temperature Gradient		$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$			μV/°C
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +125°C)	2N3043		—	10	
	2N3044		—	20	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) The lowest h_{FE} reading is taken as h_{FE1} for this test.

2N3053, A

CASE 79-04, STYLE 1
TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N3053	2N3053A	Unit
Collector-Emitter Voltage(1)	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	700		mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Lead Temperature 1/16″, ±1/32″ From Case for 10 s	T_L	+235		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

(1) Applicable 0 to 100 mA (Pulsed):
Pulse Width ≤ 300 μsec., Duty Cycle ≤ 2.0%.
0 to 700 mA; Pulse Width ≤ 10 μsec., Duty Cycle ≤ 2.0%.

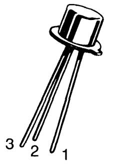
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

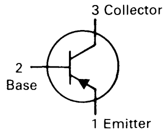
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 100 μAdc, I_B = 0)	 2N3053 2N3053A	$V_{(BR)CEO}$	 40 60	 — —	Vdc
Collector-Emitter Breakdown Voltage(2) (I_C = 100 mAdc, R_{BE} = 10 ohms)	 2N3053 2N3053A	$V_{(BR)CER}$	 50 70	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	 2N3053 2N3053A	$V_{(BR)CBO}$	 60 80	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 1.5 Vdc) (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	 2N3053 2N3053A	I_{CEX}	—	0.25	μAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)	 2N3053	I_{EBO}	—	0.25	μAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	 2N3053A	I_{BL}	—	0.25	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 2.5 Vdc) (I_C = 150 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25 50	— 250	—
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	 2N3053 2N3053A	$V_{CE(sat)}$	 — —	 1.4 0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	 2N3053 2N3053A	$V_{BE(sat)}$	 — 0.6	 1.7 1.0	Vdc
Base-Emitter On Voltage (I_C = 150 mAdc, V_{CE} = 2.5 Vdc)	 2N3053 2N3053A	$V_{BE(on)}$	 — —	 1.7 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	100	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)		C_{obo}	—	15	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)		C_{ibo}	—	80	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

2N3073

CASE 22-03, STYLE 1
TO-18 (TO-206AA)





SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.06	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 30$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 0$) ($V_{CE} = 30$ Vdc, $V_{BE} = 0$, $T_A = 125°C$)	I_{CES}	— —	10 10	nAdc μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	100	μAdc
Base Current ($V_{CE} = 30$ Vdc, $V_{BE} = 0$)	I_B	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$) ($I_C = 300$ mAdc, $V_{CE} = 2.0$ Vdc)	h_{FE}	30 12 15	130 — —	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 2.5$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{CE(sat)}$	— —	0.25 1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 2.5$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{BE(sat)}$	— —	1.2 2.0	Vdc
Base-Emitter On Voltage ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	$V_{BE(on)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	130	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	10	pF
Input Impedance ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ie}	—	1.5	kohms
Voltage Feedback Ratio ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{re}	—	26	$X\ 10^{-4}$
Small-Signal Current Gain ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	25	180	—
Output Admittance ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{oe}	—	1200	μmhos

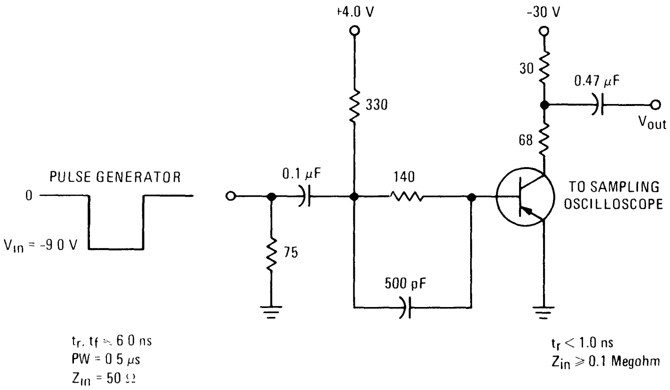
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS				
Turn-On Time ($I_C \approx$ 300 mAdc, $I_{B1} \approx$ 30 mAdc)	t_{on}	—	40	ns
Turn-Off Time ($I_C \approx$ 300 mAdc, $I_{B1} \approx I_{B2} \approx$ 30 mAdc)	t_{off}	—	100	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

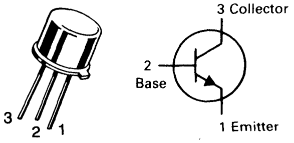
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — TURN-ON AND TURN-OFF SWITCHING TIMES TEST CIRCUIT



2N3114

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3498 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage(1)	V_{CEO}	150	Vdc
Collector-Base Voltage	V_{CBO}	150	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

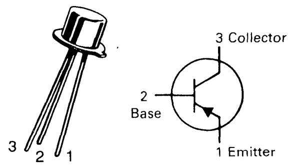
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) (I_C = = 30 mAdc, $I_B = 0$)	$V_{(BR)CEO}$	150	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	150	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 100$ Vdc, $I_E = 0$) ($V_{CB} = 100$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	 — —	 0.010 10	μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.10	μAdc
ON CHARACTERISTICS				
DC Current Gain(2) ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc, $T_A = -55°C$)	h_{FE}	 15 30 12	 — 120 —	—
Collector-Emitter Saturation Voltage(2) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage(2) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	9.0	pF
Input Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	80	pF
Small-Signal Current Gain ($I_C = 1.0$ mA, $V_{CE} = 5.0$ V, f = 1 kHz)	h_{fe}	25	—	—
Current Gain — High Frequency ($V_{CE} = 10$ Vdc, $I_C = 30$ mAdc, f = 20 MHz)	$\|h_{fe}\|$	2.0	—	—
Real Part of Input Impedance ($I_C = 10$ mA, $V_{CE} = 10$ V, f = 100 MHz)	$Re(h_{ie})$	—	30	Ohms

(1) Between 0 and 30 mA.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

2N3135

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	600	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 2.28	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

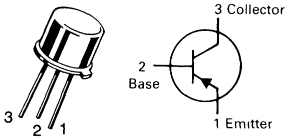
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	35	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 30$ V, $V_{BE} = 0.5$ V)	I_{CEX}	—	0.1	μAdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$) ($V_{CB} = 30$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	 — —	 0.05 30	μAdc
Base Cutoff Current ($V_{CE} = 30$ V, $V_{BE} = 0.5$ V)	I_{BL}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)	h_{FE}	 25 40	 — 120	—
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.6	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	10	pF
Input Capacitance ($V_{BE} = 2$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	40	pF
SWITCHING CHARACTERISTICS				
Turn-On Time ($V_{CC} = 30$ V, $I_C = 150$ mA, $I_{B1} = 15$ mA)	t_{on}	26	75	ns
Turn-Off Time ($V_{CC} = 6.0$ V, $I_C = 150$ mA, $I_{B1} = I_{B2} = 15$ mA)	t_{off}	70	150	ns

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

2N3227 For Specifications, See 2N2368 Data.

2N3244
2N3245

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3244	2N3245	Unit
Collector-Emitter Voltage	V_{CEO}	40	50	Vdc
Collector-Base Voltage	V_{CBO}	40	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.175	°C/mW

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	 2N3244 2N3245	$V_{(BR)CEO}$	 40 50	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	 2N3244 2N3245	$V_{(BR)CBO}$	 40 50	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 3.0 Vdc)		I_{BEV}	—	80	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 3.0 Vdc)		I_{CEX}	—	50	nAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = 100°C)		I_{CBO}	 — —	 0.050 10	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0) (V_{EB} = 4.0 Vdc, I_C = 0)	 2N3245 2N3244	I_{EBO}	 — —	 30 30	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	 2N3244 2N3245 2N3244 2N3245 2N3244 2N3245	h_{FE}	 60 35 50 30 25 20	 — — 150 90 — —	—
Collector-Emitter Saturation Voltage(1) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	 2N3244 2N3245 2N3244 2N3245 2N3244 2N3245	$V_{CE(sat)}$	 — — — — — —	 0.3 0.35 0.5 0.6 1.0 1.2	Vdc

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

Characteristic	Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage(1)	$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)		—	1.1	
(I_C = 500 mAdc, I_B = 50 mAdc)		0.75	1.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)		—	2.0	

SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N3244		175	—	
	2N3245		150	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	25	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	100	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Max	Unit
Delay Time	(I_C = 500 mA, I_{B1} = 50 mA V_{EB} = 2.0 V, V_{CC} = 30 V)	2N3244 2N3245	t_d	—	15	ns
Rise Time			t_r	— —	35 40	ns
Storage Time	(I_C = 500 mA, V_{CC} = 30 V I_{B1} = I_{B2} = 50 mA)	2N3244 2N3245	t_s	—	140 120	ns
Fall Time			t_f	—	45	ns
Total Control Charge			Q_T			pC
(I_C = 500 mA, I_B = 50 mA, V_{CC} = 30 V)		2N3244		—	14	
		2N3245		—	12	

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — MINIMUM CURRENT GAIN CHARACTERISTICS

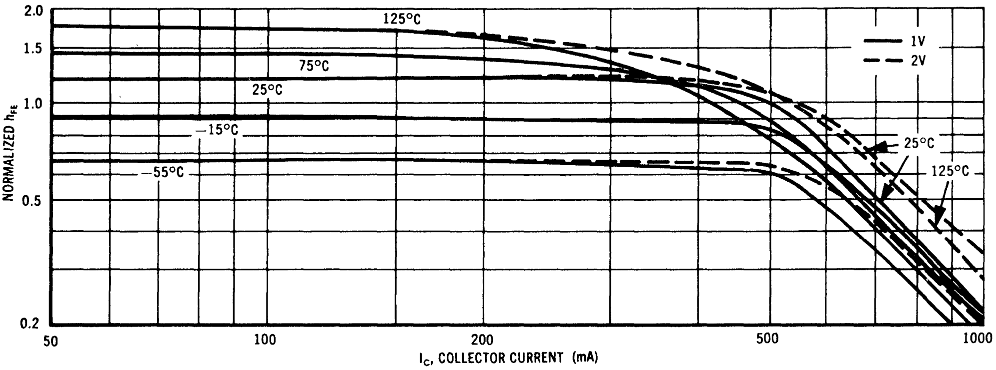
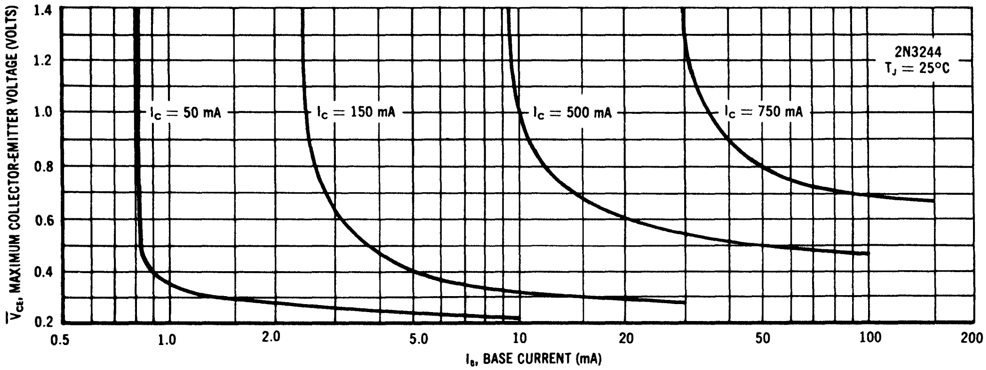


FIGURE 2 — COLLECTOR-EMITTER SATURATION VOLTAGE CHARACTERISTICS

2N3244



2N3245

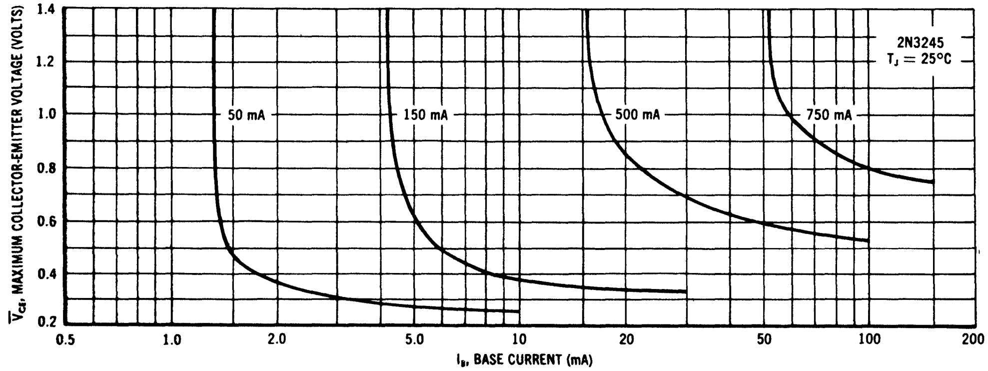


FIGURE 3 — MAXIMUM SATURATION VOLTAGES

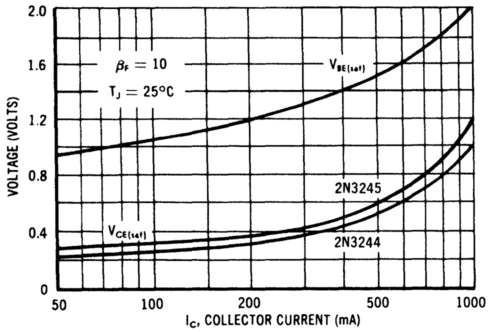


FIGURE 4 — TYPICAL TEMPERATURE COEFFICIENTS

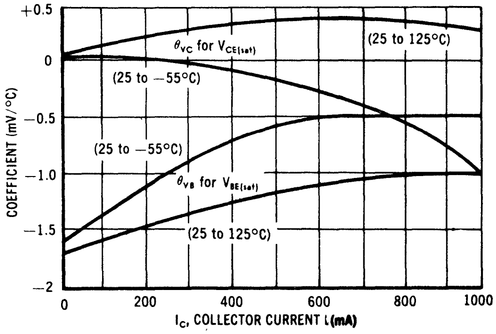


FIGURE 5 — JUNCTION CAPACITANCE

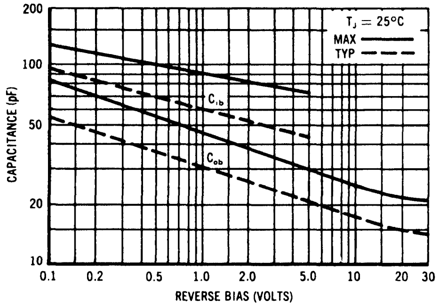


FIGURE 6 — TYPICAL SWITCHING TIMES

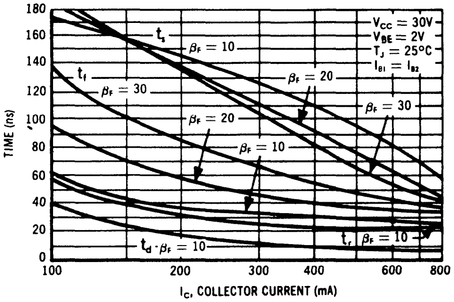


FIGURE 7 — CHARGE DATA

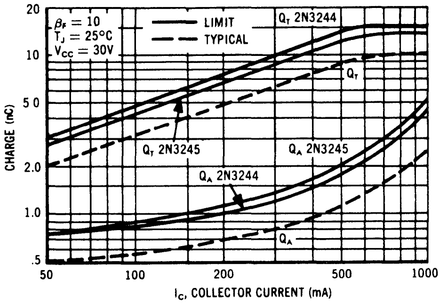


FIGURE 8 — TURN-ON EQUIVALENT TEST CIRCUIT

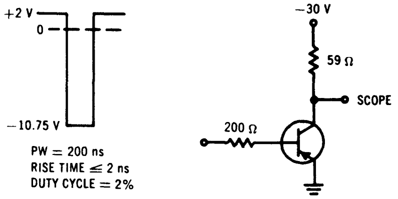


FIGURE 9 — TURN-OFF EQUIVALENT TEST CIRCUIT

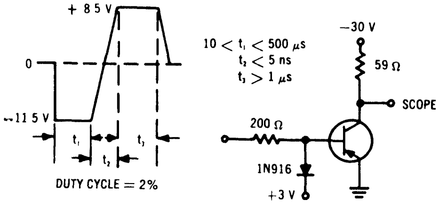


FIGURE 10 — Q_T TEST CIRCUIT

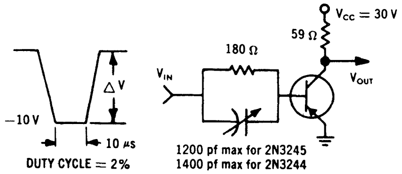
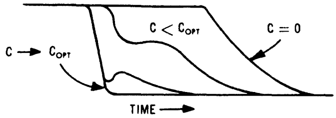
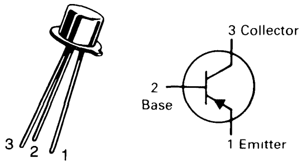


FIGURE 11 — TURN-OFF WAVEFORM



2N3249

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	200	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE} = 1.0$ Vdc)	I_{BEV}	—	50	nAdc
Collector Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE} = 1.0$ Vdc) ($V_{CE} = 10$ Vdc, $V_{BE} = 1.0$ Vdc, $T_A = 100°C$)	I_{CEX}	 — —	 0.05 5.0	μAdc
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 100 100 100 75 35	 300 — — — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{CE(sat)}$	 — — —	 0.125 0.25 0.45	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{BE(sat)}$	 0.6 0.7 —	 0.9 1.1 1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	8.0	pF
Input Capacitance ($V_{BE} = 1.0$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	8.0	pF

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	I_C = 100 mA, I_B = 10 mA, V_{BE} = 0.5 V, V_{CC} = 10 V	t_d	—	5.0	ns
Rise Time		t_r	—	15	ns
Storage Time	I_C = 100 mA, I_{B1} = I_{B2} = 10 mA, V_{CC} = 10 V	t_s	—	60	ns
Fall Time		t_f	—	20	ns
Turn-On Time	I_C = 10 mA, I_{B1} = 1.0 mA, V_{BE} = 0.5 V, V_{CC} = 3.0 V	t_{on}	—	90	ns
Turn-Off Time	I_C = 10 mA, I_{B1} = I_{B2} = 1.0 mA, V_{CC} = 3.0 V	t_{off}	—	100	ns
Total Control Charge (I_C = 10 mA, I_B = 0.25 mA, V_{CC} = 3.0 V)		Q_T	—	150	pC

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — t_{on} CIRCUIT

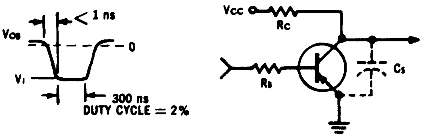
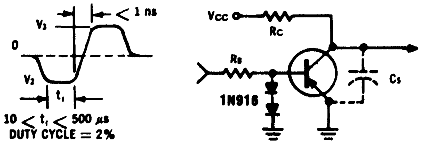


FIGURE 2 — t_{off} CIRCUIT



I_C mA	V_{CC} volts	R_B ohms	R_C ohms	$C_{S(max)}$* pF	V_{OB} volts	V_1 volts	V_2 volts	V_3 volts
10	3	10 K	285	4	+0.5	−10.6	−10.9	+9.1
100	10	1 K	95	12	+0.5	−10.7	−11.3	+8.7

*Total shunt capacitance of test jig and connectors.

FIGURE 3 — TYPICAL SWITCHING TIMES

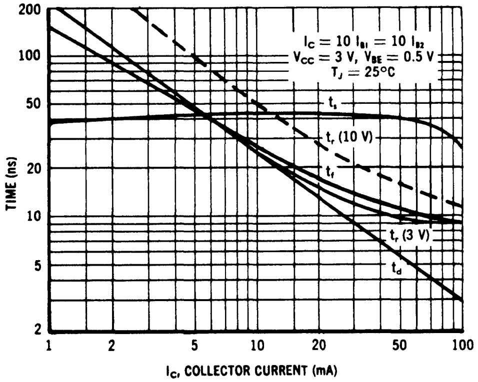


FIGURE 4 — MINIMUM CURRENT GAIN CHARACTERISTICS

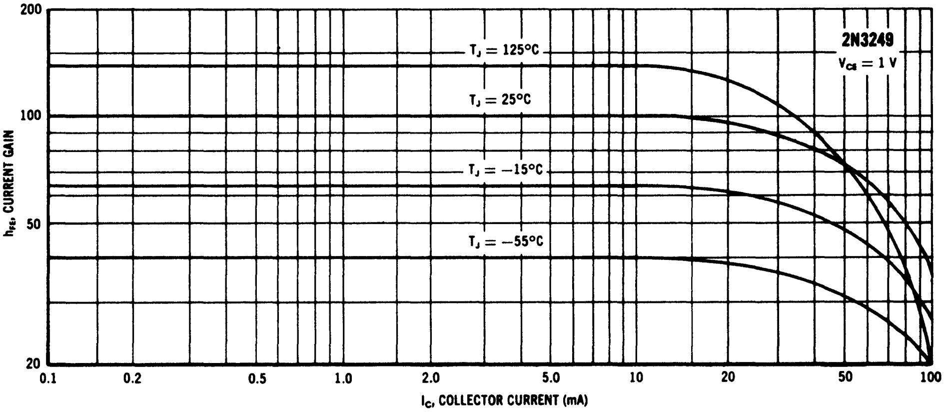


FIGURE 5 — MAXIMUM CHARGE DATA

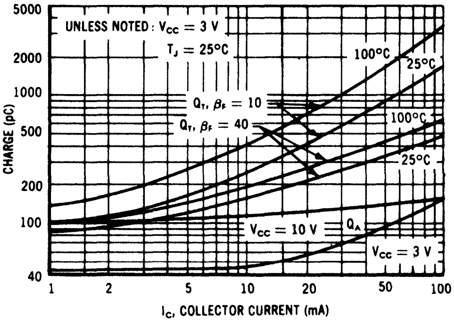


FIGURE 6 — JUNCTION CAPACITANCE

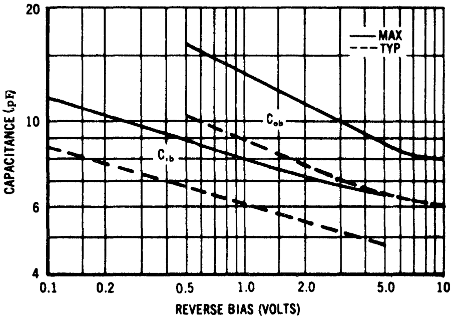


FIGURE 7 — COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

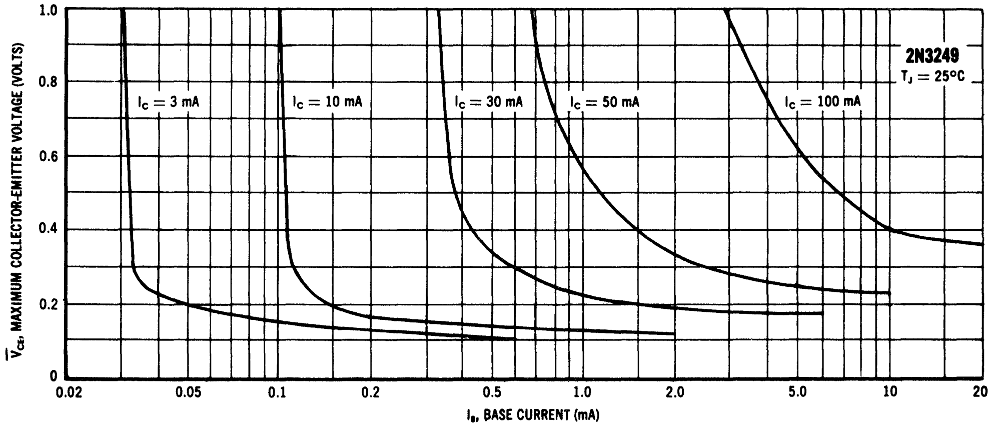


FIGURE 8 — SATURATION VOLTAGE LIMITS

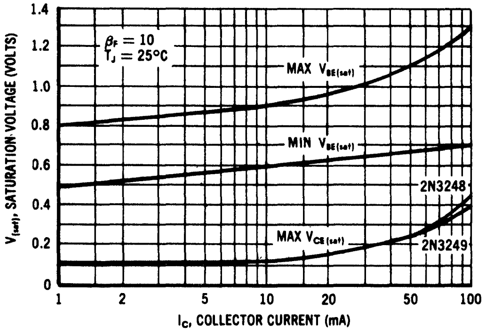
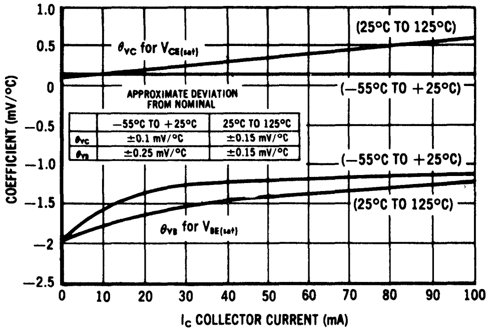


FIGURE 9 — TYPICAL TEMPERATURE COEFFICIENTS



APPROXIMATE DEVIATION FROM NOMINAL

	−55°C TO +25°C	25°C TO 125°C
θ_{VC}	±0.1 mV/°C	±0.15 mV/°C
θ_{VB}	±0.25 mV/°C	±0.15 mV/°C

FIGURE 10 — Q_T TEST CIRCUIT

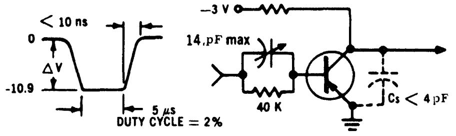
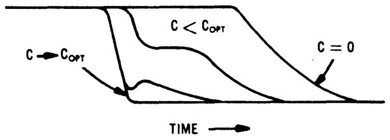


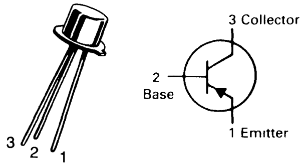
FIGURE 11 — TURN-OFF WAVEFORM



2N3250, A
2N3251, A

2N3250A,2N3251A
JAN, JTX, JTXV AVAILABLE

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS
PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3250 2N3251	2N3250A 2N3251A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	50	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current	I_C	200		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.06		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9		Watts mW/°C
Operating and Storage Temperature Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.15	mW/°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.49	mW/°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) ($I_C = 10$ mAdc)	2N3250, 2N3251 2N3250A, 2N3251A	$V_{(BR)CEO}$	40 60	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc)	2N3250, 2N3251 2N3250A, 2N3251A	$V_{(BR)CBO}$	50 60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 40$ Vdc, $V_{BE} = 3.0$ Vdc)		I_{CEX}	—	20	nA
Base Cutoff Current ($V_{CE} = 40$ Vdc, $V_{BE} = 3.0$ Vdc)		I_{BL}	—	50	nAdc
ON CHARACTERISTICS					
DC Forward Current Transfer Radio (1)		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	2N3250, 2N3250A 2N3251, 2N3251A		40 80	— —	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	2N3250, 2N3250A 2N3251, 2N3251A		45 90	— —	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	2N3250, 2N3250A 2N3251, 2N3251A		50 100	150 300	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	2N3250, 2N3250A 2N3251, 2N3251A		15 30	— —	
Collector-Emitter Saturation Voltage (1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{CE(sat)}$	— —	0.25 0.5	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{BE(sat)}$	0.6 —	0.9 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	2N3250, 2N3250A 2N3251, 2N3251A	f_T	250 300	— —	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)		C_{obo}	—	6.0	pF
Input Capacitance ($V_{CB} = 1.0$ Vdc, $I_C = 0$, f = 100 kHz)		C_{ibo}	—	8.0	pF

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

Characteristic		Symbol	Min	Max	Unit
Input Impedance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3250, 2N3250A 2N3251, 2N3251A	h_{ie}	1.0 2.0	6.0 12	kohms
Voltage Feedback Ratio (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3250, 2N3250A 2N3251, 2N3251A	h_{re}	— —	10 20	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3250, 2N3250A 2N3251, 2N3251A	h_{fe}	50 100	200 400	—
Output Admittance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3250, 2N3250A 2N3251, 2N3251A	h_{oe}	4.0 10	40 60	μmhos
Collector Base Time Constant (I_C = 10 mA, V_{CE} = 20 V, f = 31.8 MHz)		$rb'C_C$	—	250	ps
Noise Figure (I_C = 100 μA, V_{CE} = 5.0 V, R_S = 1.0 k Ω, f = 100 Hz)		NF	—	6.0	dB

SWITCHING CHARACTERISTICS

Characteristic			Symbol	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc I_C = 10 mAdc, I_{B1} = 1.0 mA)		t_d	35	ns
Rise Time			t_r	35	ns
Storage Time	(I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc V_{CC} = 3.0 V)	2N3250, 2N3250A 2N3251, 2N3251A	t_s	175 200	ns
Fall Time			t_f	50	ns

(1) Pulse Test: PW = 300 μs, Duty Cycle = 2.0%.

SWITCHING TIME CHARACTERISTICS

FIGURE 1 — DELAY AND RISE TIME

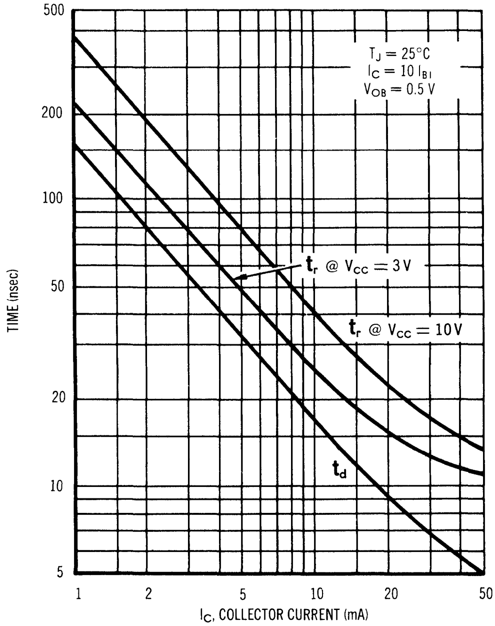
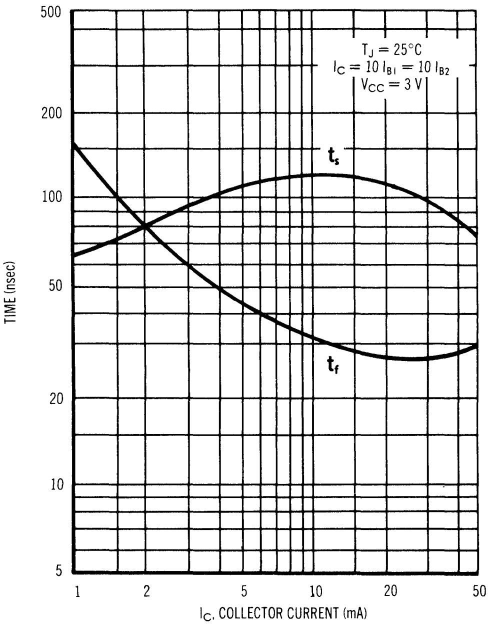


FIGURE 2 — STORAGE AND FALL TIME



AUDIO SMALL-SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS
(V_{CE} = 6.0 V, T_A = 25°C)

FIGURE 3 — FREQUENCY

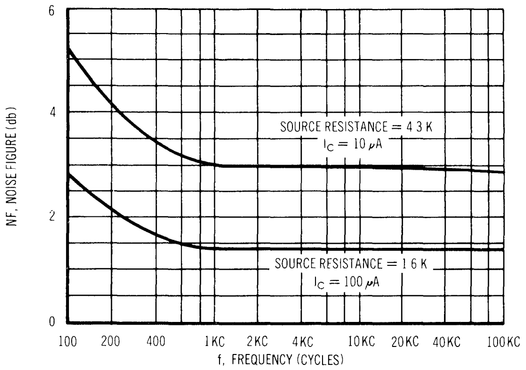
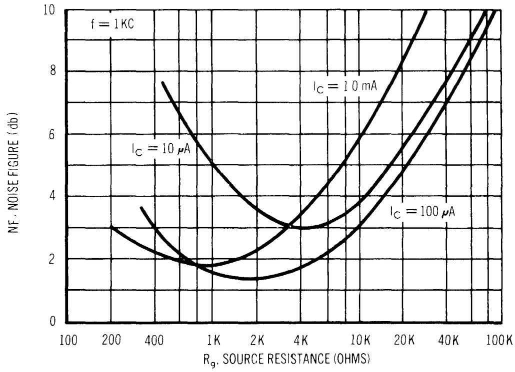


FIGURE 4 — SOURCE RESISTANCE



h PARAMETERS
V_{CE} = 10 V, f = 1.0 kc, T_A = 25°C

FIGURE 5 — CURRENT GAIN

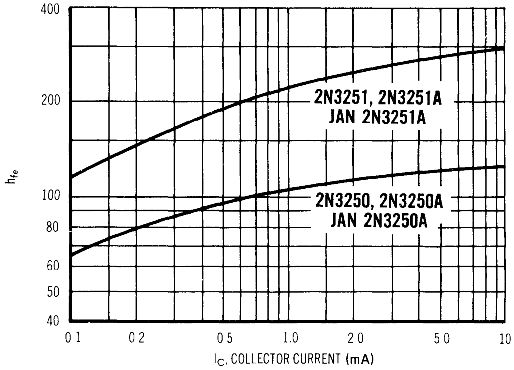


FIGURE 6 — OUTPUT ADMITTANCE

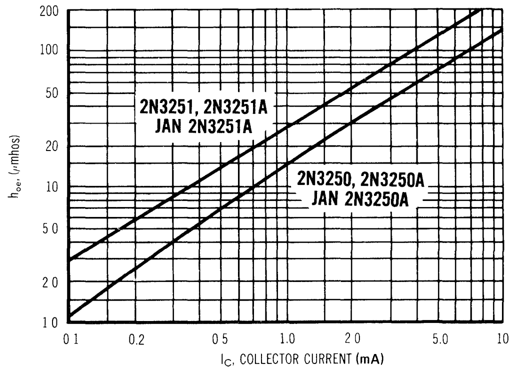


FIGURE 7 — VOLTAGE FEEDBACK RATIO

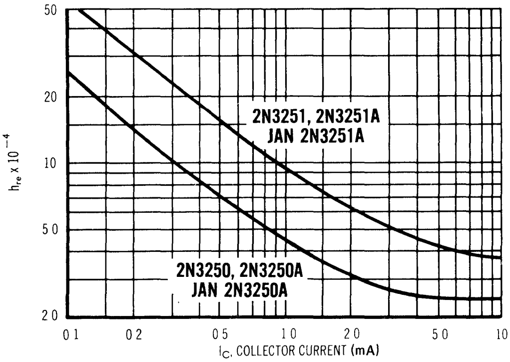


FIGURE 8 — INPUT IMPEDANCE

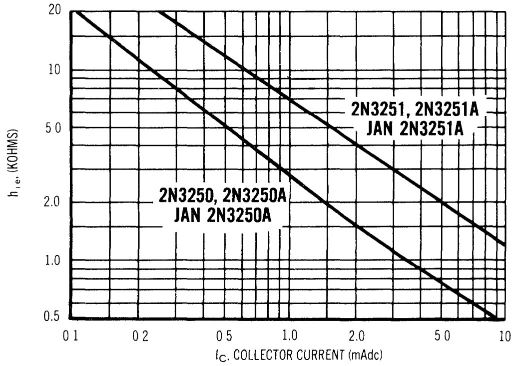


FIGURE 9 — NORMALIZED CURRENT GAIN CHARACTERISTICS

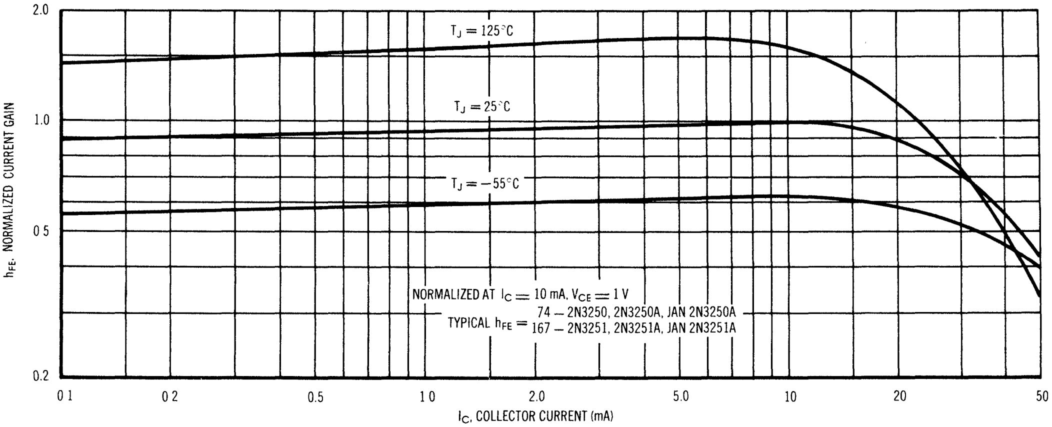
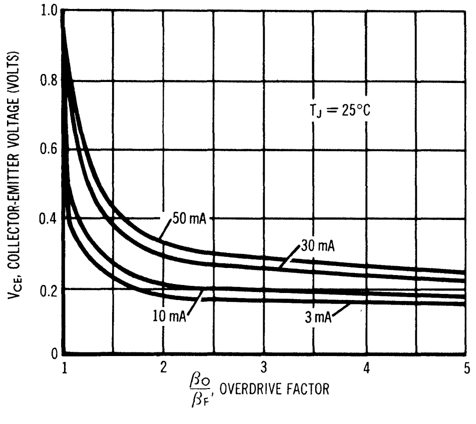


FIGURE 10 — COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current β_O is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit. EXAMPLE: For type 2N3251, estimate a base current (I_{BF}) to insure saturation at a temperature of 25°C and a collector current of 10 mA.

Observe that at I_C - 10 mA an overdrive factor of at least 2.5 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h_{FE} @ 1 volt is typically 167 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design) . . .

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE} \text{ @ 1 Volt}}{I_C/I_{BF}} \qquad 2.5 = \frac{167}{10\,\text{mA}/I_{BF}} \qquad I_{BF} \approx 6.68\,\text{mA typ}$$

FIGURE 11 — SATURATION VOLTAGES

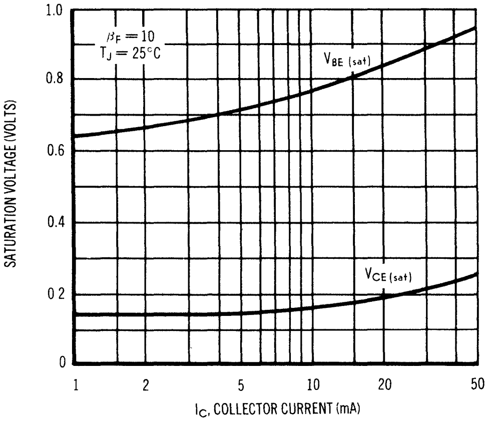


FIGURE 12 — TEMPERATURE COEFFICIENTS

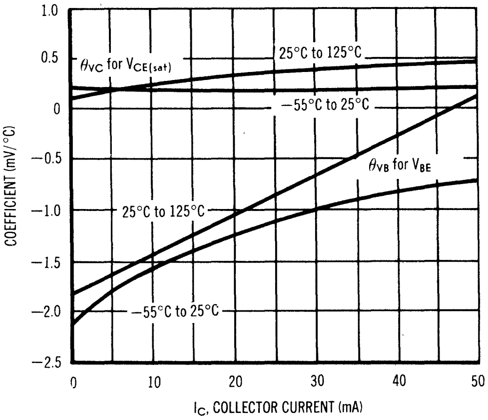


FIGURE 13 — f_T AND $r_b'C_c$ versus I_C

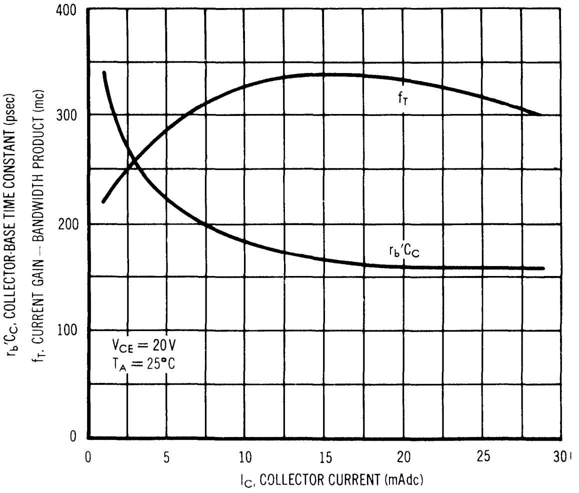


FIGURE 14 — 30 MC EQUIVALENT CIRCUIT

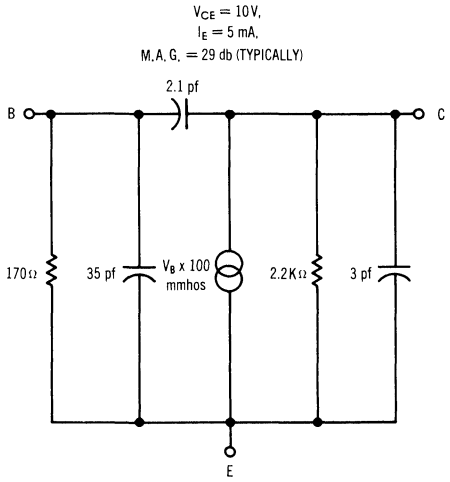


FIGURE 15 — JUNCTION CAPACITANCE

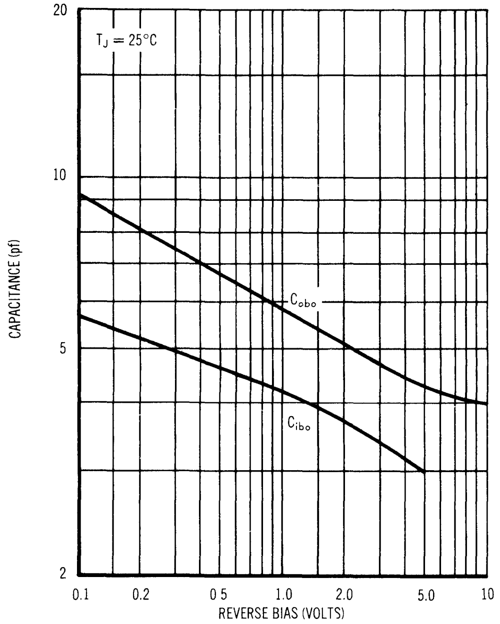
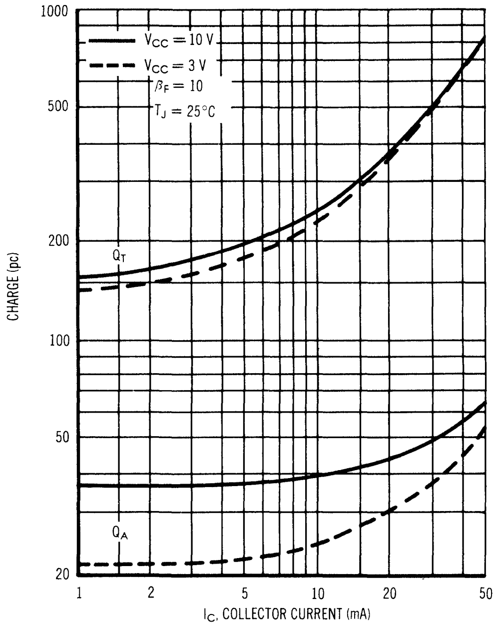
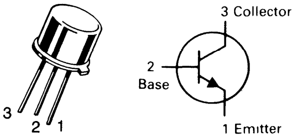


FIGURE 16 — CHARGE DATA



2N3252
2N3253
2N3444

JAN, JTX AVAILABLE
2N3253, 2N3444
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3252	2N3253	2N3444	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	50	Vdc
Collector-Base Voltage	V_{CBO}	60	75	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71			Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$ $R_{\theta JA}$	35 0.175	°C/W °C/mW

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, pulsed, I_B = 0)	2N3252	$V_{(BR)CEO}$	30	—	Vdc
	2N3253		40	—	
	2N3444		50	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	2N3252	$V_{(BR)CBO}$	60	—	Vdc
	2N3253		75	—	
	2N3444		80	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CE} = 40 Vdc, $V_{EB(off)}$ = 4.0 Vdc)	2N3252	I_{CEX}	—	0.5	μAdc
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 4.0 Vdc)	2N3253, 2N3444		—	0.5	
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	2N3252	I_{CBO}	—	0.50	μAdc
(V_{CB} = 40 Vdc, I_E = 0, T_A = 100°C)	2N3252			75.0	
(V_{CB} = 60 Vdc, I_E = 0)	2N3253, 2N3444			0.50	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 100°C)	2N3253, 2N3444			75.0	
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	0.05	μAdc
Base Cutoff Current (V_{CE} = 40 Vdc, $V_{EB(off)}$ = 4.0 Vdc)	2N3252	I_{BL}	—	0.50	μAdc
(V_{CE} = 60 Vdc, $V_{EB(off)}$ = 4.0 Vdc)	2N3253, 2N3444		—	0.50	
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	2N3252	h_{FE}	30	—	—
	2N3253		25	—	
	2N3444		20	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	2N3252		30	90	
	2N3253		25	75	
	2N3444		20	60	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	2N3252		25	—	
	2N3253		20	—	
	2N3444		15	—	

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

Characteristic		Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	2N3252		—	0.3	
	2N3253, 2N3444		—	0.35	
(I_C = 500 mAdc, I_B = 500 mAdc)	2N3252		—	0.5	
	2N3253, 2N3444		—	0.60	
(I_C = 1.0 Adc, I_B = 100 mAdc)	2N3252		—	1.0	
	2N3253, 2N3444		—	1.2	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.0	
(I_C = 500 mAdc, I_B = 50 mAdc)			0.7	1.3	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	1.8	

SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N3252		200	—	
	2N3253, 2N3444		175	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	12	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	80	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Max	Unit
Delay Time	I_C = 500 mAdc, I_{B1} = 50 mAdc		t_d	—	15	ns
Rise Time	V_{CC} = 30 V, V_{BE} = 2.0 V	2N3252	t_r	—	30	ns
		2N3253, 2N3444		—	35	
Storage Time	I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc		t_s	—	40	ns
Fall Time	V_{CC} = 30 V		t_f	—	30	ns
Total Control Charge (I_C = 500 mAdc, I_{B1} = 50 mAdc, V_{CC} = 30 V)			Q_T	—	5.0	nC

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

FIGURE 1 — TYPICAL STORAGE TIME VARIATIONS

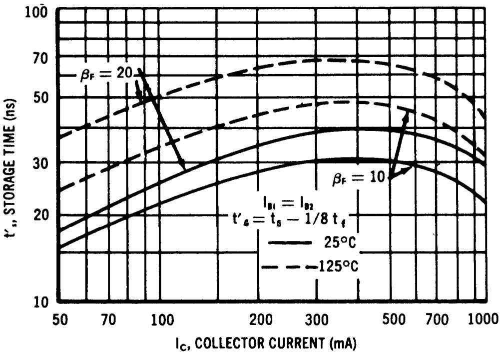


FIGURE 2 — TYPICAL FALL TIME VARIATIONS

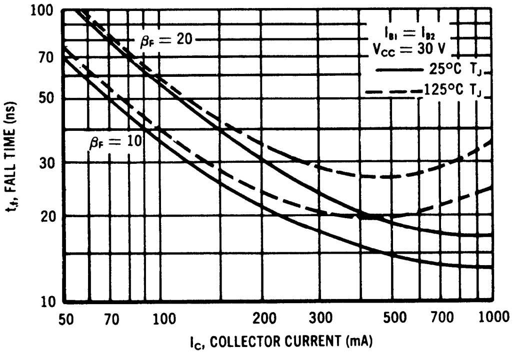
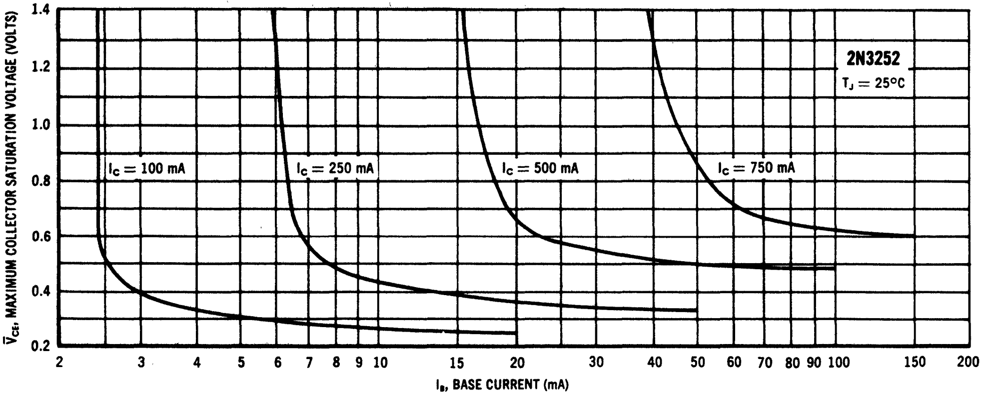
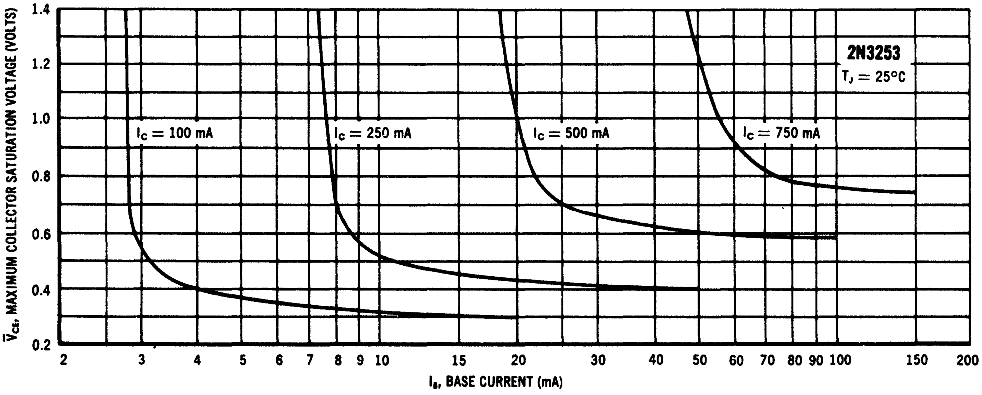


FIGURE 3 — COLLECTOR SATURATION VOLTAGE CHARACTERISTICS

2N3252



2N3253



2N3444

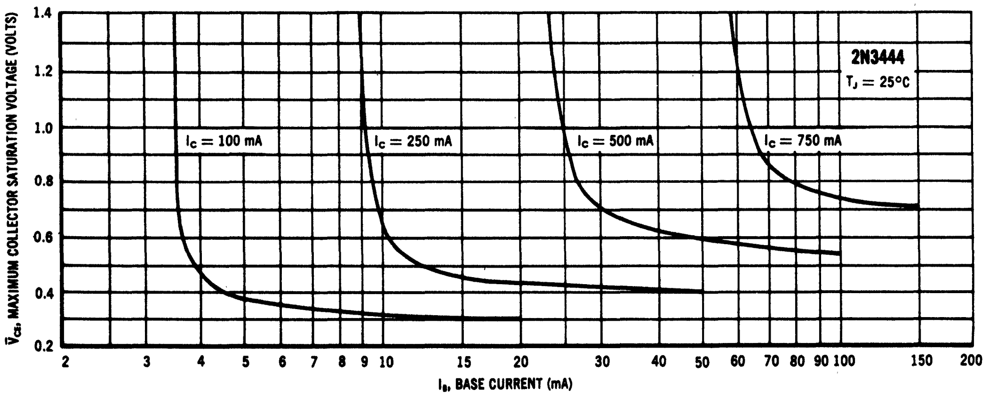
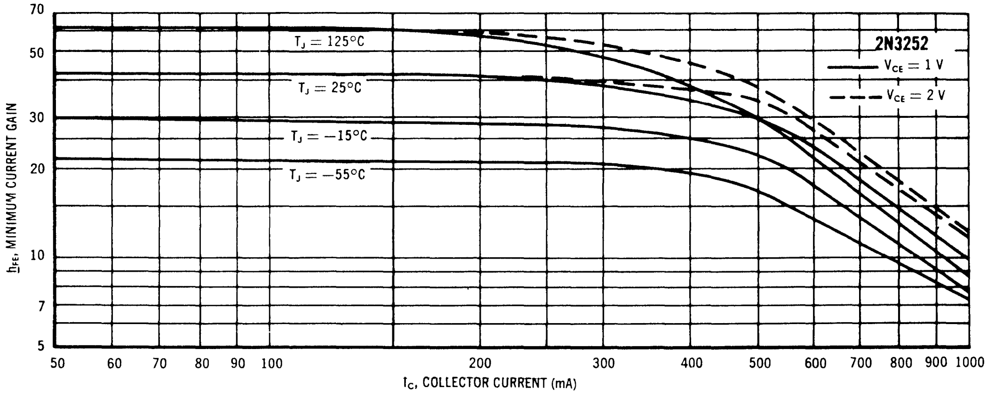
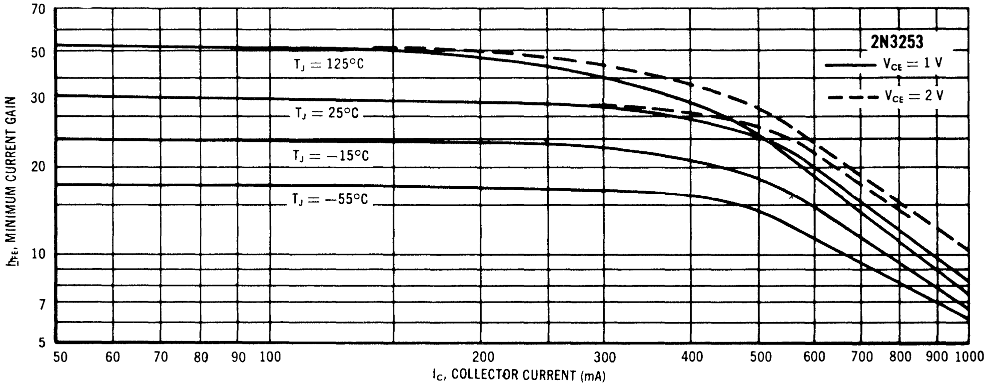


FIGURE 4 — MINIMUM CURRENT GAIN CHARACTERISTICS

2N3252



2N3253



2N3444

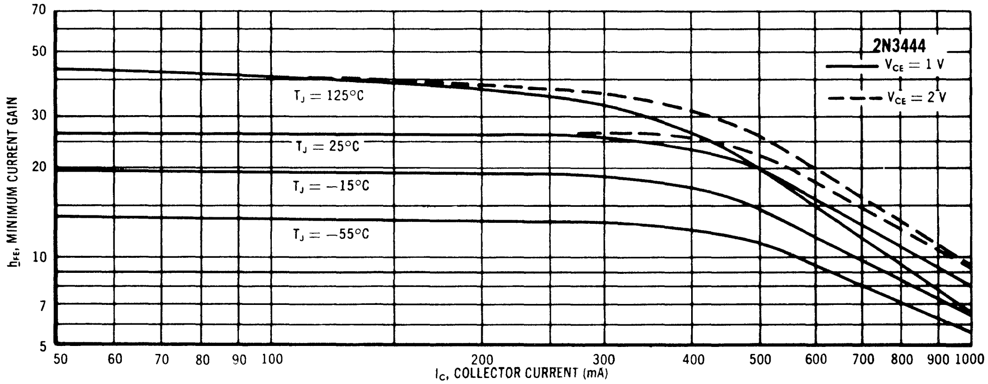


FIGURE 5 — TYPICAL TURN-ON TIME VARIATIONS WITH VOLTAGE

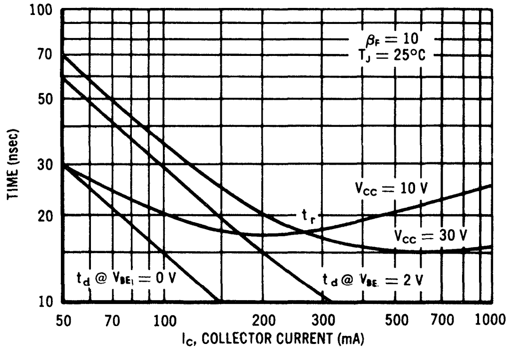


FIGURE 6 — TYPICAL RISE TIME VARIATIONS WITH TEMPERATURE

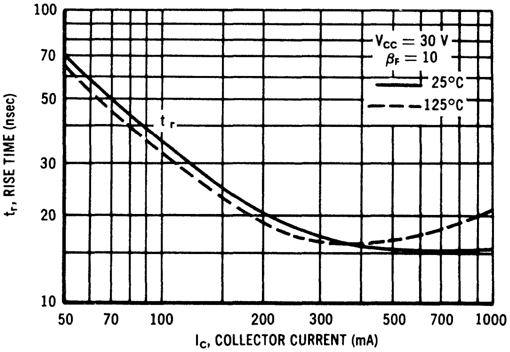


FIGURE 7 — JUNCTION CAPACITANCE VARIATIONS

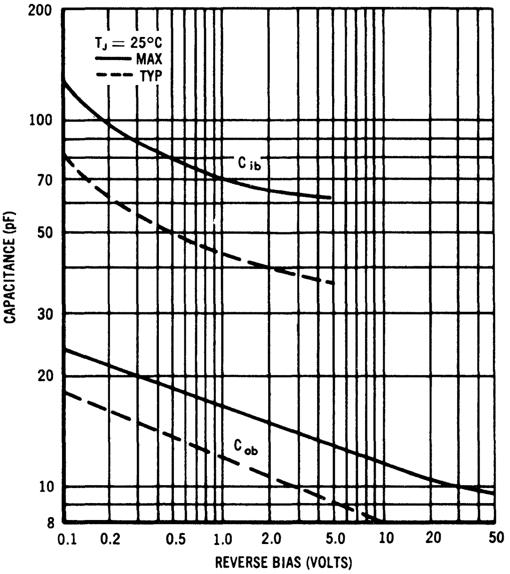


FIGURE 8 — MAXIMUM CHARGE DATA

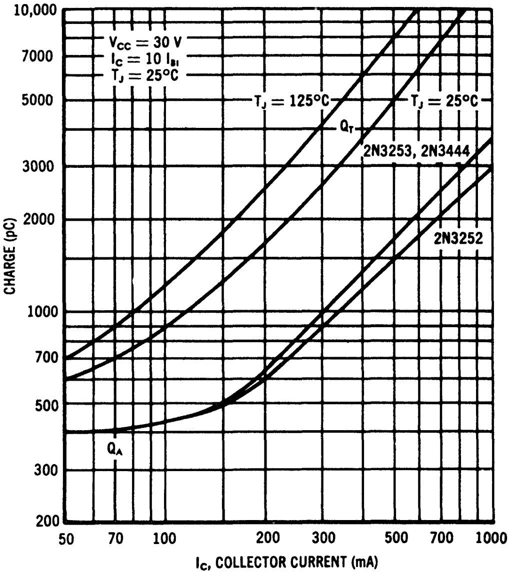


FIGURE 9 — LIMITS OF SATURATION VOLTAGES

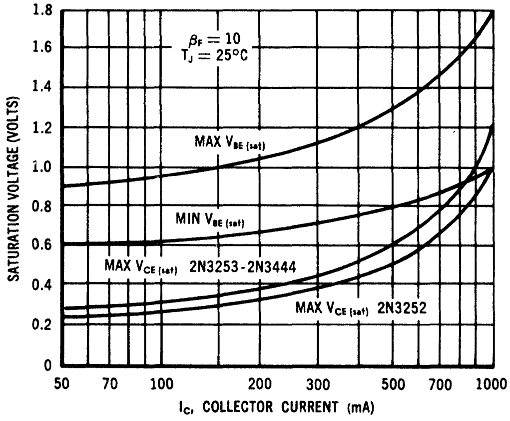
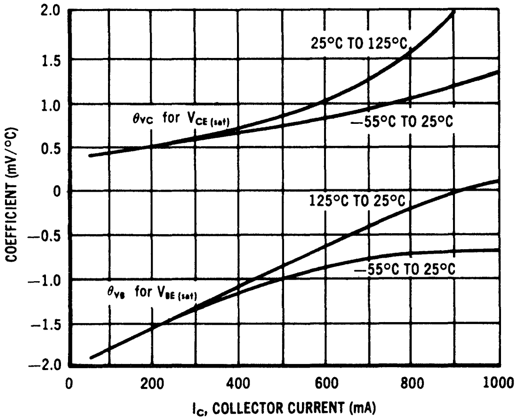
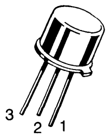


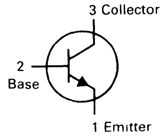
FIGURE 10 — TYPICAL TEMPERATURE COEFFICIENTS



2N3300

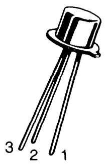
CASE 79-04, STYLE 1
TO-39 (TO-205AD)





2N3302

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage (Applicable 0 to 10 mAdc)	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		2N3300	2N3302	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.56	0.36 2.06	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.0 17.2	1.8 10.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

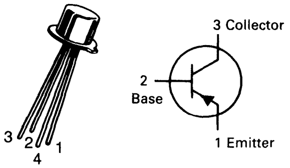
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	30	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 50$ Vdc, $V_{BE} = 0$) ($V_{CE} = 50$ Vdc, $V_{BE} = 0$, $T_A = 150°C$)	I_{CES}	— —	0.01 10	μAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	10	nAdc
Base Current ($V_{CE} = 50$ Vdc, $V_{BE} = 0$)	I_B	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) 2N3300, 2N3302 ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) 2N3300, 2N3302 ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N3300, 2N3302 ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1) 2N3300, 2N3302 ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N3300, 2N3302 ($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N3300, 2N3302	h_{FE}	 35 50 75 50 100 50	 — — — — 300 —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	— — —	0.22 0.45 0.6	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{BE(sat)}$	— — —	1.1 1.3 1.5	Vdc
Base Emitter Voltage ($I_C = 150$ mA, $V_{CE} = 10$ V)	$V_{BE(on)}$	—	1.1 V	Max
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	250	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	8.0	pF
Input Capacitance ($V_{BE} = 2.0$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	20	pF
SWITCHING CHARACTERISTICS				
Turn-On Time ($V_{CC} = 25$ Vdc, $I_C = 300$ mAdc, $I_{B1} = 30$ mAdc)	t_{on}	—	60	ns
Turn-Off Time ($V_{CC} = 25$ Vdc, $I_C = 300$ mAdc, $I_{B1} = I_{B2} = 30$ mAdc)	t_{off}	—	150	ns

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

2N3307
2N3308

CASE 20-03, STYLE 10
TO-72 (TO-206AF)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3307	2N3308	Unit
Collector-Emitter Voltage	V_{CEO}	35	25	Vdc
Collector-Emitter Voltage	V_{CES}	40	30	Vdc
Collector-Base Voltage	V_{CBO}	40	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	200 1.14		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	300 1.71		mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 2.0 mAdc, I_B = 0)	2N3307 2N3308	$V_{(BR)CEO}$	35 25	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	2N3307 2N3308	$V_{(BR)CES}$	40 30	— —	Vdc
Collector-Base Breakdown Voltage(1) (I_C = 10 μAdc, I_E = 0)	2N3307 2N3308	$V_{(BR)CBO}$	40 30	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc) (V_{CB} = 15 Vdc, T = 150°C)	 2N3307	I_{CBO}	— —	0.010 3.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (V_{CE} = 10 Vdc, I_C = 2.0 mAdc)	2N3307 2N3308	h_{FE}	40 25	250 250	—
Collector-Emitter Saturation Voltage (I_C = 3.0 mAdc, I_B = 0.6 mAdc)		$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 3.0 mAdc, I_B = 0.6 mAdc		$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 100 MHz		f_T	300	1200	MHz
Maximum Frequency of Operation (V_{CE} = 10 Vdc, I_C = 2.0 mAdc)		f_{max}	Typical 2000		MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 MHz	2N3307 2N3308	C_{obo}	— —	1.3 1.6	pF
Small-Signal Current Gain (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 1 kHz)	2N3307 2N3308	h_{fe}	40 25	250 250	—
Collector Base Time Constant (V_{CB} = 10 Vdc, I_C = 2.0 mAdc, f = 31.8 MHz)	2N3307 2N3308	$r_b'C_c$	2.0 2.0	15 20	ps

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

Characteristic		Symbol	Min	Max	Unit
Noise Figure (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 200 MHz)	 2N3307 2N3308	NF	 — —	 4.5 6.0	dB

SWITCHING CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Power Gain(2) (V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 200 MHz)		G_e	17	—	dB
Power Gain (AGC)(2) (V_{CE} = 5.0 Vdc, I_C = 20 mAdc, f = 200 MHz)	 2N3307 2N3308	G_e	 — —	 0 —	dB

(1) C_{obo} is measured in guarded circuit such that the can capacitance is not included.

(2) AGC is obtained by increasing I_C. The circuit remains adjusted for V_{CE} = −10 Vdc, I_C = −2 mAdc operation.

FIGURE 1 — COMMON EMITTER AVERAGE SMALL POWER GAIN & NOISE FIGURE versus COLLECTOR CURRENT

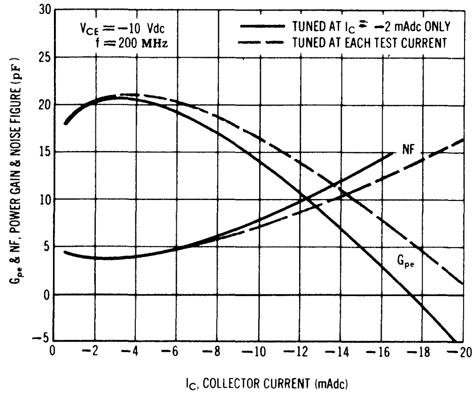
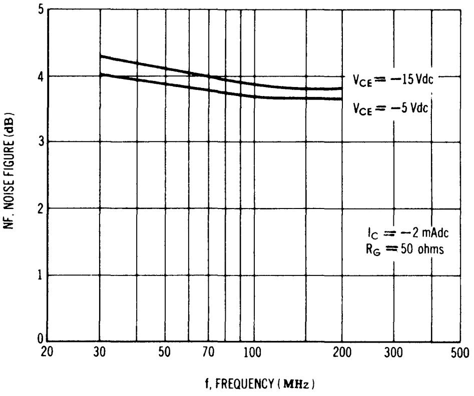
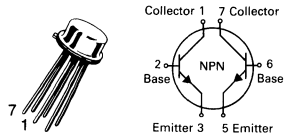


FIGURE 2 — NOISE FIGURE versus FREQUENCY



2N3425

CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2369,A,B for graphs.

3

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Emitter Voltage	V_{CER}	20		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
		One Die	**Both Die**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.3 1.72	0.4 2.28	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.75 4.3	1.5 8.55	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 30$ mAdc, $R_{BE} \leqslant 10$ ohms)	$V_{CER(sus)}$	20	—	Vdc
Collector-Emitter Sustaining Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 20$ Vdc, $V_{EB(off)} = 0.25$ Vdc, $T_A = 125°C$)	I_{CEX}	—	15	μAdc
Collector Cutoff Current ($V_{CB} = 20$ Vdc, $I_E = 0$) ($V_{CB} = 20$ VDc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	0.025 15	μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.2	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.5$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$)	h_{FE}	12 30 12	— 120 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 7.0$ mAdc, $I_B = 0.7$ mAdc, $T_A = -55°C$ to $+125°C$)	$V_{CE(sat)}$	 — —	 0.4 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 7.0$ mAdc, $I_B = 0.7$ mAdc, $T_A = -55°C$)	$V_{BE(sat)}$	0.7 —	0.85 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	300	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	6.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	9.0	pF
Small-Signal Current Gain ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, f = 1.0 kHz)	h_{fe}	20	—	—
Real Part of Input Impedance ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 300 MHz)	$Re(h_{ie})$	—	50	Ohms
SWITCHING CHARACTERISTICS				
Storage Time ($I_C = 10$ mAdc, $I_{B1} = 10$ mAdc, $I_{B2} = 10$ mAdc)	t_s	—	40	ns
Turn-On Time ($V_{CC} = 3.0$ Vdc, $V_{EB(off)} = 2.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc)	t_{on}	—	50	ns
Turn-Off Time ($V_{CC} = 3.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 3.0$ mAdc, $I_{B2} = 1.0$ mAdc)	t_{off}	—	90	ns

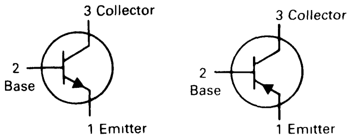
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

MAXIMUM RATINGS

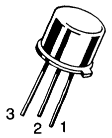
Rating	Symbol	PNP 2N5415	 2N5416	NPN 2N3439	 2N3440	Unit
Collector-Emitter Voltage	V_{CEO}	200	300	350	250	Vdc
Collector-Base Voltage	V_{CBO}	200	350	450	300	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	6.0	7.0	7.0	Vdc
Base Current	I_B	0.5				Adc
Collector Current — Continuous	I_C	1.0				Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 — —		 1.0 5.7		 Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 10 57		 5.0 28.6		 Watts mW/°C
Total Device Dissipation @ T_A = 50°C Derate above 50°C	P_D	 1.0 6.7		 — —		 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200				°C

NPN 2N3439 2N3440

PNP 2N5415 2N5416



JAN, JTX, JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



HIGH VOLTAGE AMPLIFIERS

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N5415 2N5416	2N3439 2N3440	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	150	175	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1)		$V_{CEO(sus)}$			Vdc
(I_C = 50 mAdc, I_B = 0)	2N5415		200	—	
	2N5416		300	—	
	2N3439		350	—	
	2N3440		250	—	
*Collector Cutoff Current		I_{CEO}			μAdc
(V_{CE} = 300 Vdc, I_B = 0)	2N3439		—	20	
(V_{CE} = 200 Vdc, I_B = 0)	2N3440		—	50	
*Collector Cutoff Current		I_{CEX}			μAdc
(V_{CE} = 450 Vdc, V_{BE} = 1.5 Vdc)	2N3439		—	500	
(V_{CE} = 300 Vdc, V_{BE} = 1.5 Vdc)	2N3440		—	500	
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 175 Vdc, I_E = 0)	2N5415		—	50	
(V_{CB} = 280 Vdc, I_E = 0)	2N5416		—	50	
(V_{CB} = 360 Vdc, I_E = 0)	2N3439		—	20	
(V_{CB} = 250 Vdc, I_E = 0)	2N3440		—	20	
Emitter Cutoff Current		I_{EBO}			μAdc
(V_{EB} = 4.0 Vdc, I_C = 0)	2N5415		—	20	
(V_{EB} = 6.0 Vdc, I_C = 0)	2N5416, 2N3439, 2N3440		—	20	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	2N3439		30	—	
*(I_C = 20 mAdc, V_{CE} = 10 Vdc)	2N3439, 2N3440		40	160	
*(I_C = 50 mAdc, V_{CE} = 10 Vdc)	2N5415		30	150	
	2N5416		30	120	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	—	0.5	Vdc
(I_C = 50 mAdc, I_B = 4.0 mAdc)	2N3439, 2N3440				
Base-Emitter Saturation Voltage		$V_{BE(sat)}$	—	1.3	Vdc
(I_C = 50 mAdc, I_B = 4.0 mAdc)	2N3439, 2N3440				

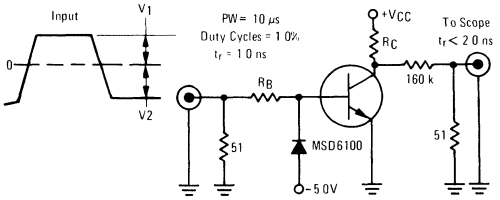
*Indicates Data in Addition to JEDEC Requirements.

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 5.0 MHz)	2N3439, 2N3440	f_T	15	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N5415, 2N5416, 2N3439, 2N3440	C_{obo}	— —	15 10	pF
Input Capacitance (V_{EB} = 5.0 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	75	pF
Small-Signal Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10.0 mAdc, V_{CE} = 10 Vdc, f = 5.0 MHz)	2N5415, 2N5416	h_{fe}	25	—	—
Real Part of Input Impedance (V_{CE} = 10 Vdc, I_C = 5.0 mAdc, f = 1.0 MHz)		$Re(h_{ie})$	—	300	Ohms

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
CAUTION: The sustaining voltage *must not* be measured on a curve tracer. (See Fig. 15.)

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



NOTE: V_{CC} and R_C adjusted for $V_{CE(off)}$ = 150 V and I_C as desired, R_B chosen for desired I_{B1}, $V_1 \approx 10$ V, $V_2 \approx 8.0$ V

For t_d and t_r, D1 is disconnected and V_2 = 2.0 V

For PNP test circuit, reverse all polarities.

PNP
2N5415, 2N5416

NPN
2N3439, 2N3440

FIGURE 2 — TURN-ON TIME

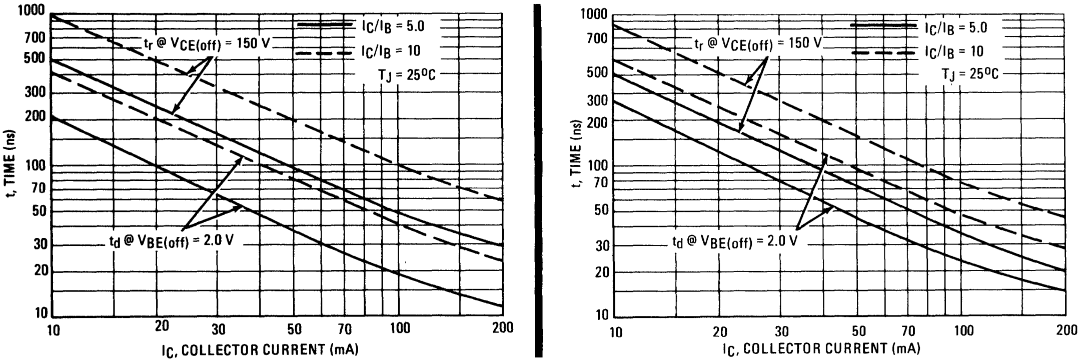


FIGURE 3 — TURN-OFF TIME

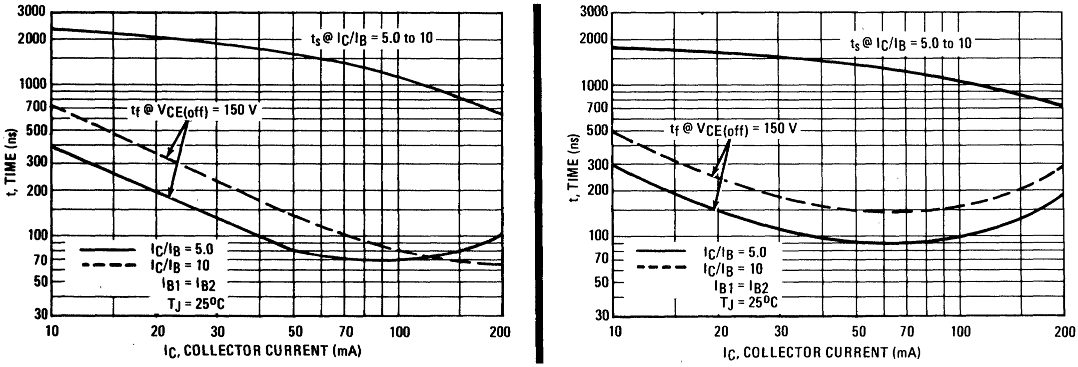


FIGURE 4 — CURRENT-GAIN — BANDWIDTH PRODUCT

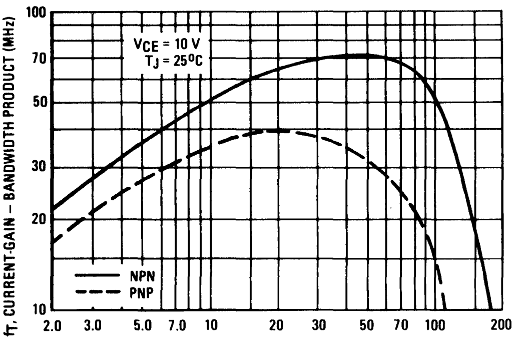


FIGURE 5 — CAPACITANCE

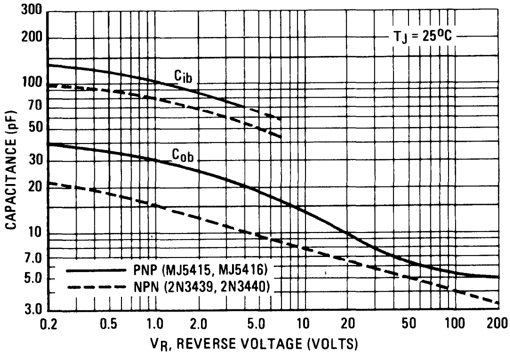


FIGURE 6 — THERMAL RESPONSE

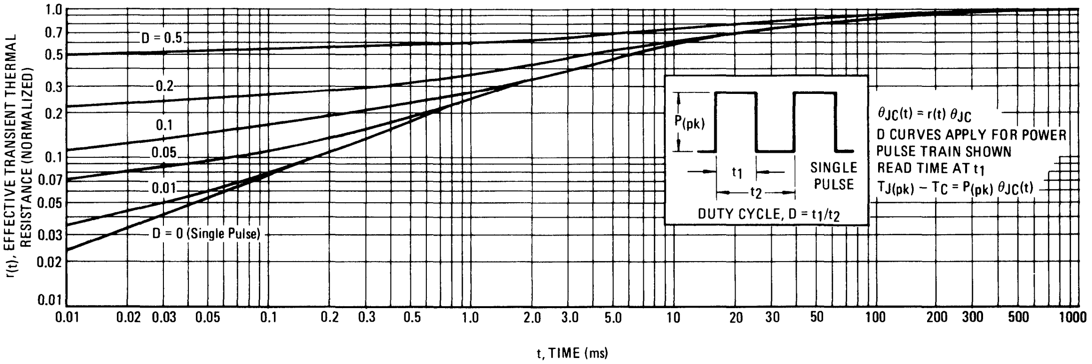
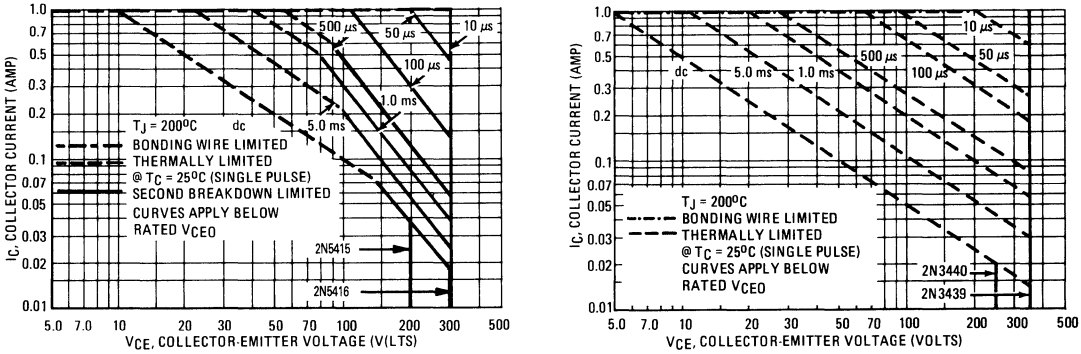
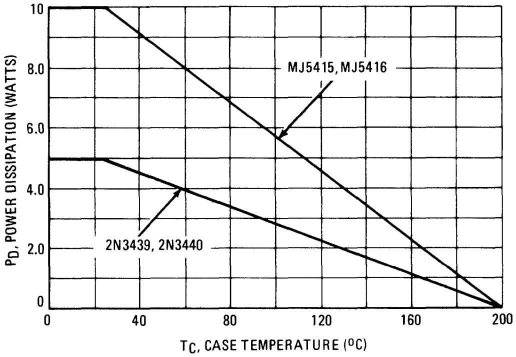


FIGURE 7 — ACTIVE-REGION SAFE OPERATING AREA


PNP — 2N5415, 2N5416

NPN – 2N3439, 2N3440

FIGURE 8 — POWER DERATING



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

The data of Figure 7 is based on $T_{J(pk)} = 200°C$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 200°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. (See AN-415).

PNP
2N5415, 2N5416

NPN
2N3439 2N3440

FIGURE 9 — DC CURRENT GAIN

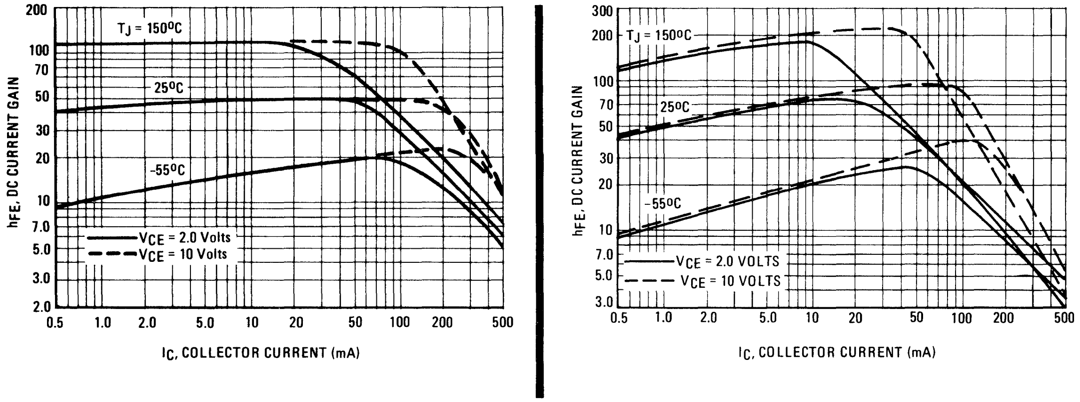


FIGURE 10 — COLLECTOR SATURATION REGION

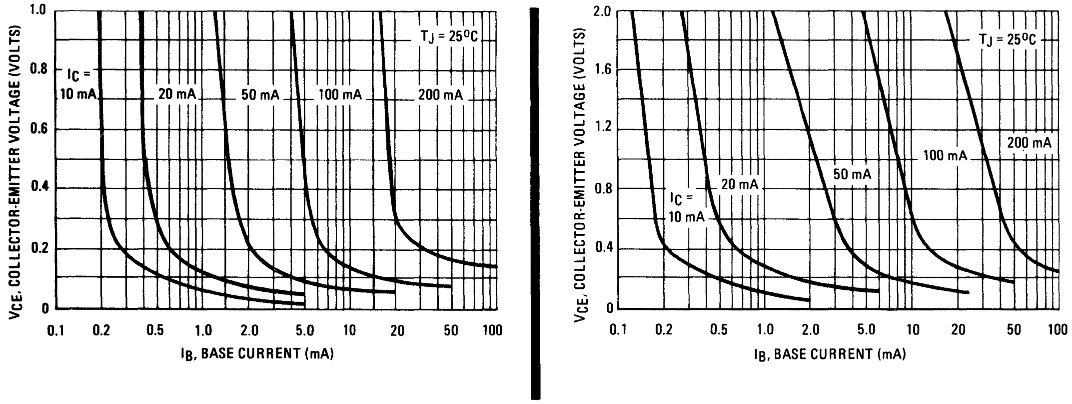


FIGURE 11 — "ON" VOLTAGES

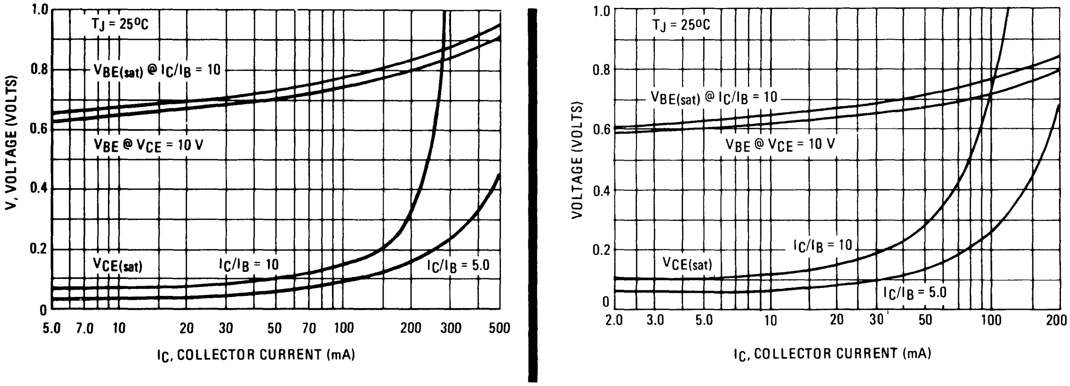


FIGURE 12 — TEMPERATURE COEFFICIENTS

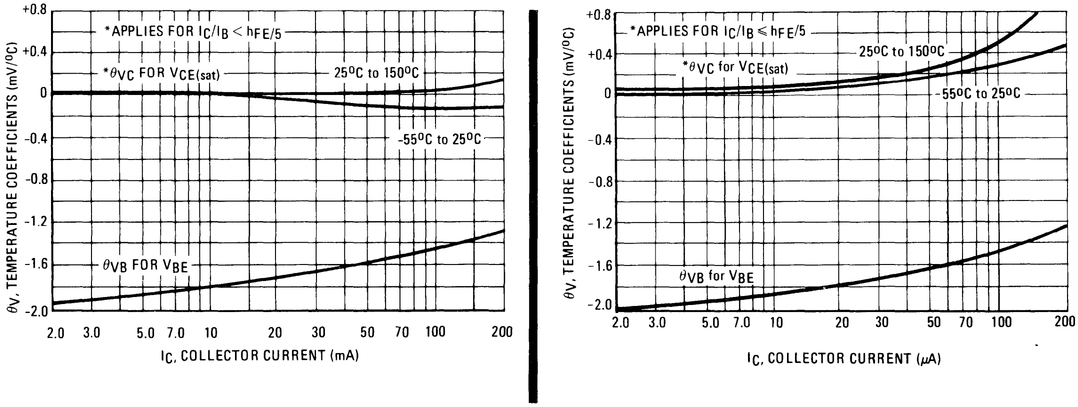


FIGURE 13 — COLLECTOR CUTOFF REGION

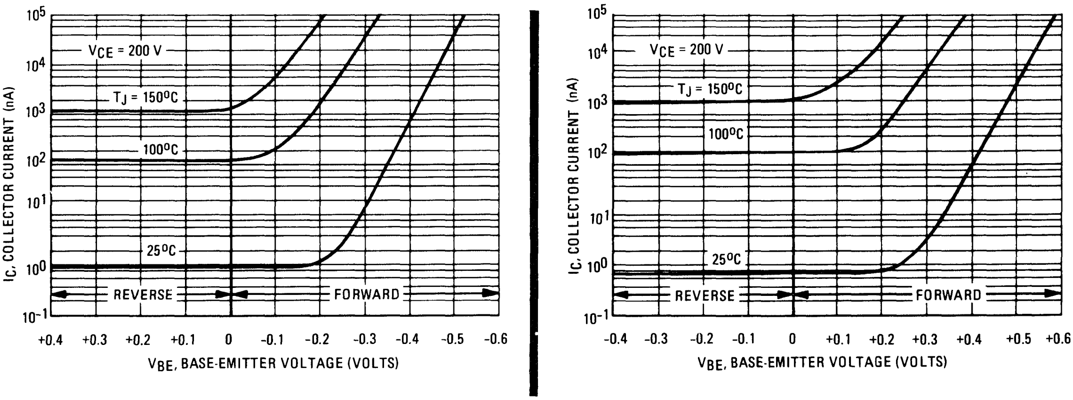


FIGURE 14 — BASE CUTOFF REGION

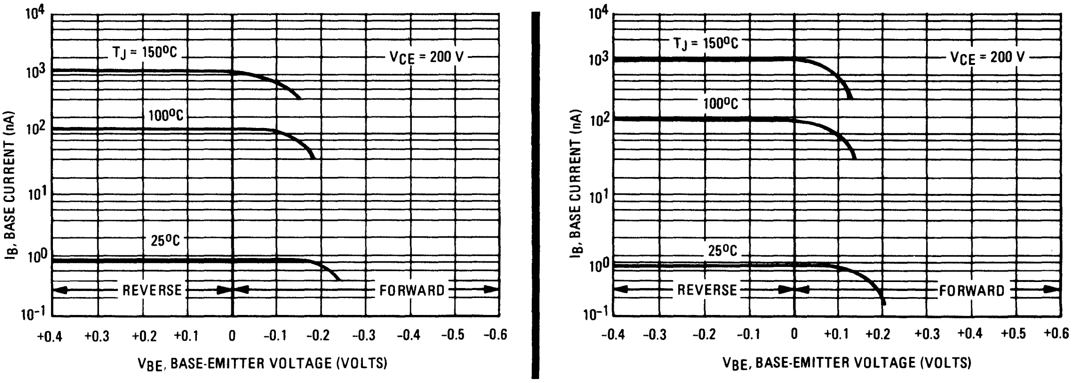
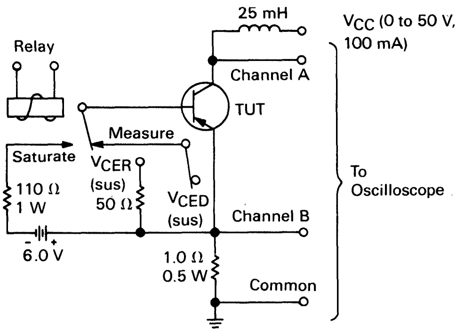


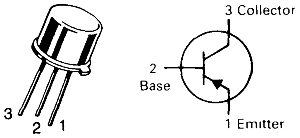
FIGURE 15 — CIRCUIT USED TO MEASURE SUSTAINING VOLTAGES



2N3444 For Specifications, See 2N3252 Data.

2N3467
2N3468

JAN, JTX, JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3467	2N3468	Unit
Collector-Emitter Voltage	V_{CEO}	40	50	Vdc
Collector-Base Voltage	V_{CBO}	40	50	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.175	°C/mW

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	2N3467		40	—	
	2N3468		50	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	2N3467		40	—	
	2N3468		50	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current (V_{CE} = −30 Vdc, V_{BE} = 3.0 Vdc)		I_{BEV}	—	120	nAdc
Collector Cutoff Current (V_{CE} = −30 Vdc, V_{BE} = 3.0 Vdc)		I_{CEX}	—	100	nAdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 30 Vdc, I_E = 0)			—	0.10	
(V_{CB} = 30 Vdc, I_E = 0, T_A = 100°C)			—	15	
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	2N3467		40	—	
	2N3468		25	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	2N3467		40	120	
	2N3468		25	75	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	2N3467		40	—	
	2N3468		20	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	2N3467		—	0.3	
	2N3468		—	0.36	
(I_C = 500 mAdc, I_B = 50 mAdc)	2N3467		—	0.5	
	2N3468		—	0.6	
(I_C = 1.0 Adc, I_B = 100 mAdc)	2N3467		—	1.0	
	2N3468		—	1.2	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.0	
(I_C = 500 mAdc, I_B = 50 mAdc)			0.8	1.2	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	1.6	

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N3467 2N3468	f_T	175 150	— —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	25	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	100	pF
SWITCHING CHARACTERISTICS					
Delay Time	(I_C = 500 mA, I_{B1} = 50 mA, V_{BE} = 2.0 V, V_{CC} = 30 V)	t_d	—	10	ns
Rise Time		t_r	—	30	ns
Storage Time	(I_C = 500 mA, I_{B1} = I_{B2} = 50 mA, V_{CC} = 30 V)	t_s	—	60	ns
Fall Time		t_f	—	30	ns
Total Control Charge (I_C = 500 mA, I_B = 50 mA, V_{CC} = 30 V)		Q_T	—	6.0	nC

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — STORAGE TIME VARIATION WITH TEMPERATURE

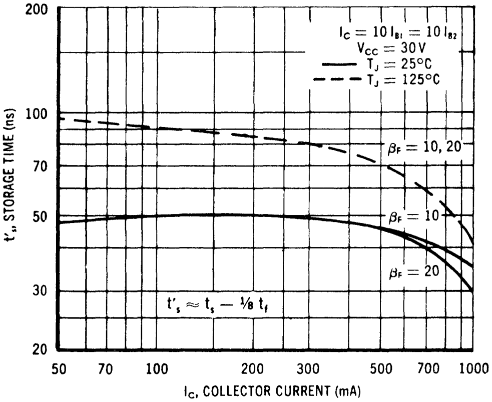


FIGURE 2 — LIMITS OF SATURATION VOLTAGE

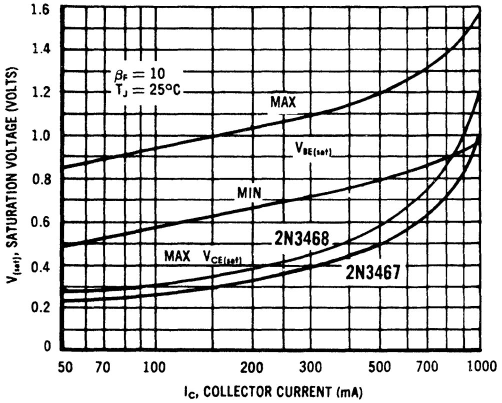
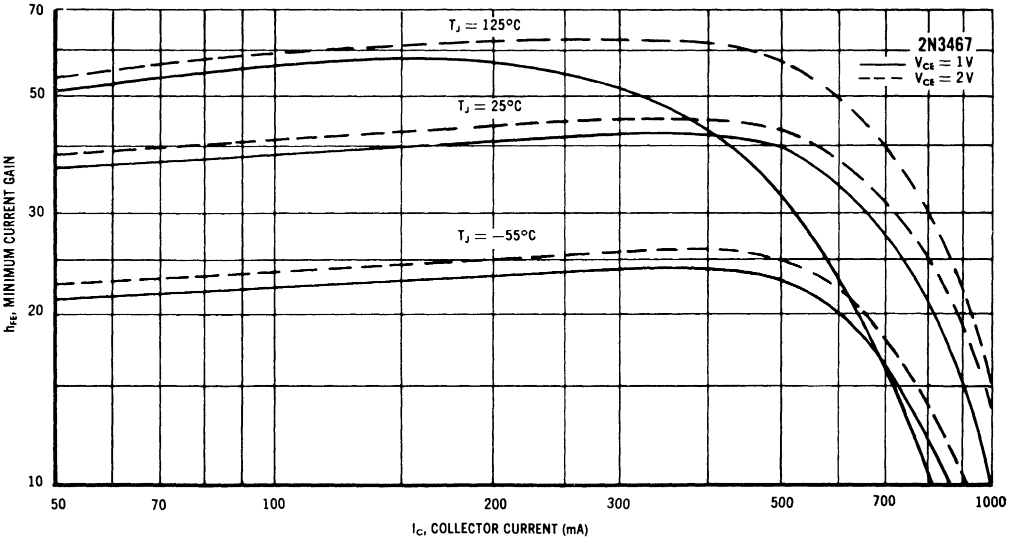
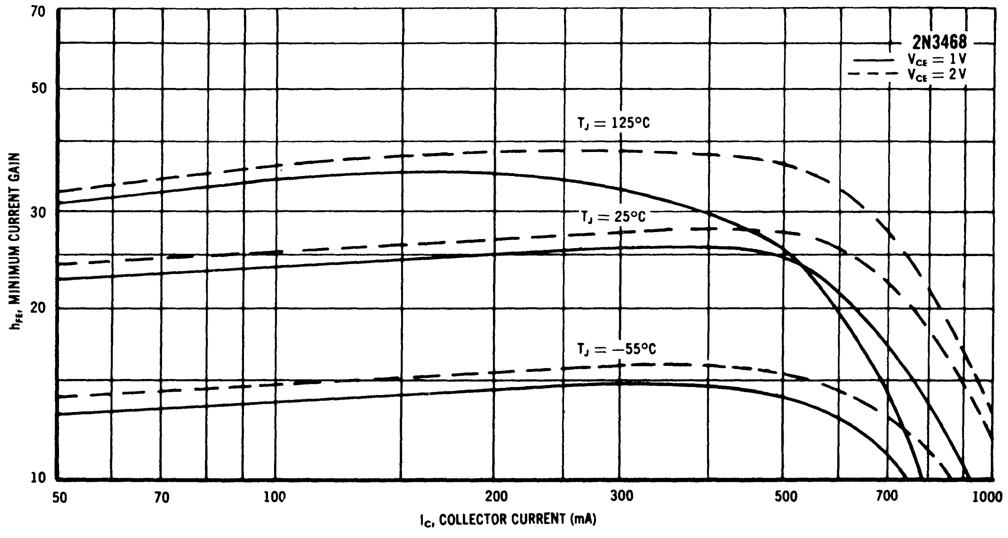


FIGURE 3 — MINIMUM CURRENT GAIN CHARACTERISTICS

2N3467



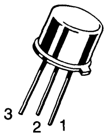
2N3468



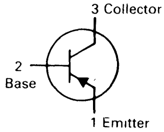
2N3485, A/2N3486, A

For Specifications, See 2N2904,A Data.

2N3494
2N3495

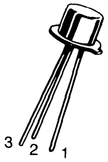


CASE 79-04, STYLE 1
TO-39 (TO-205AD)



2N3496
2N3497

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3494 2N3496	2N3495 2N3497	Unit
Collector-Emitter Voltage	V_{CEO}	80	120	Vdc
Collector-Base Voltage	V_{CBO}	80	120	Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	100		mAdc
		2N3494 2N3495	**2N3496 2N3497**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	600 3.43	400 2.28	mW mW/°C
Total Device Dissipation @ T_C = 25°C* Derate above 25°C	P_D	3.0 17.2	1.2 6.85	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

*Indicates Data in addition to JEDEC Requirements.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	 2N3494, 2N3496 2N3495, 2N3497	$V_{(BR)CEO}$	 80 120	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	 2N3494, 2N3496 2N3495, 2N3497	$V_{(BR)CBO}$	 80 120	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.5	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 90 Vdc, I_E = 0)	 2N3494, 2N3496 2N3495, 2N3497	I_{CBO}	 — —	 100 100	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	25	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 100 μAdc, V_{CE} = 10 Vdc) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 50 mAdc, V_{CE} = 10 Vdc) (I_C = 100 mAdc, V_{CE} = 10 Vdc)	 2N3494, 2N3496	h_{FE}	 35 40 40 40 35	 — — — — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	 2N3494, 2N3496 2N3495, 2N3497	$V_{CE(sat)}$	 — —	 0.3 0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	0.6	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	 2N3494, 2N3496 2N3495, 2N3497	f_T	 200 150	 — —	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	 2N3494, 2N3496 2N3495, 2N3497	C_{obo}	 — —	 7.0 6.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	30	pF

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

Characteristic	Symbol	Min	Max	Unit
Input Impedance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	0.1	1.2	k ohms
Voltage Feedback Ratio (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	—	2.0	X 10^{-4}
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	40	300	—
Output Admittance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	—	300	μmhos
Real Part of Input Impedance (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 300 MHz)	$Re(h_{ie})$	—	30	Ohms
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 30 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	300	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_{off}	—	1000	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

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

FIGURE 1 — TURN-ON TIME TEST CIRCUIT

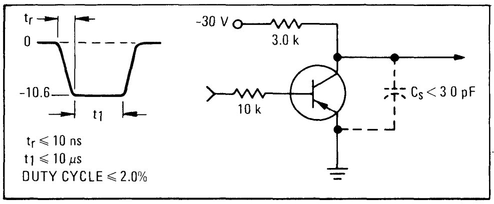


FIGURE 2 — TURN-OFF TIME TEST CIRCUIT

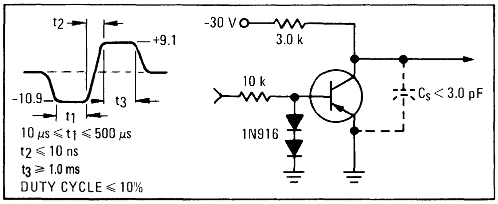


FIGURE 3 — V_{CE} (sat) versus I_C

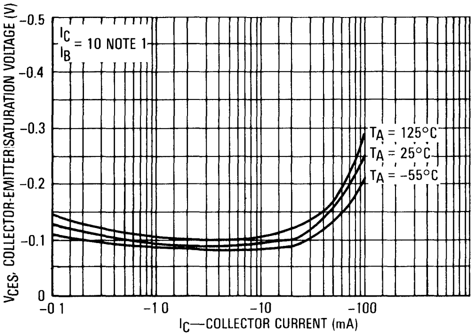


FIGURE 4 — I_{CBO} versus T_A

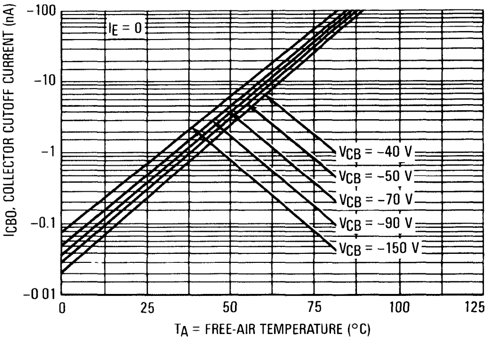


FIGURE 5 — h_{FE} versus I_C

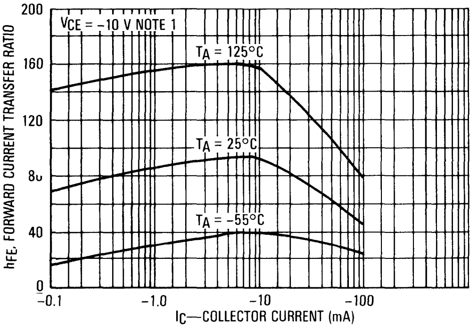
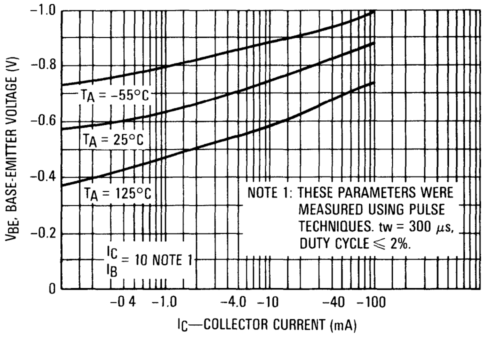


FIGURE 6 — V_{BE} versus I_C



NOTE 1: THESE PARAMETERS WERE MEASURED USING PULSE TECHNIQUES. tw = 300 μs, DUTY CYCLE ≤ 2%.

FIGURE 7 — f_T versus I_C

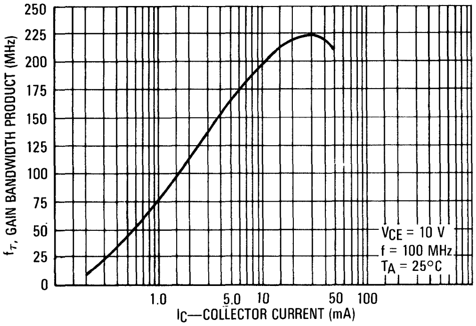


FIGURE 8 — C_{OBO} versus V_{CB}

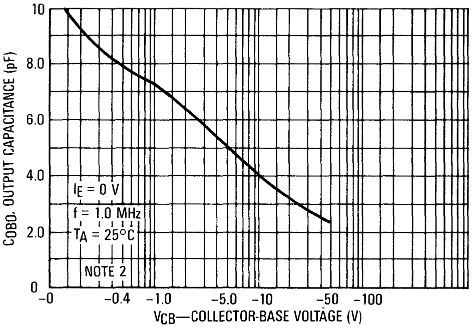
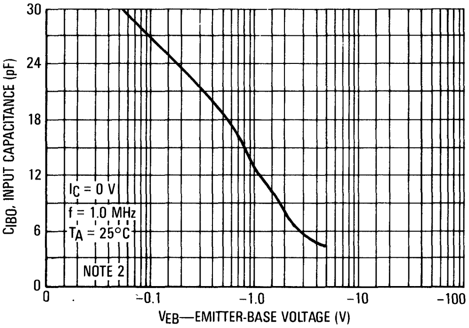


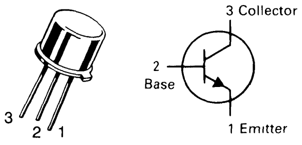
FIGURE 9 — C_{IBO} versus V_{EB}



NOTE 2: CAPACITANCE MEASURE MADE WITH TO-18 PACKAGE.

2N3498 thru 2N3501

JAN, JTX, JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3498 2N3499	2N3500 2N3501	Unit
Collector-Emitter Voltage	V_{CEO}	100	150	Vdc
Collector-Base Voltage	V_{CBO}	100	150	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	500	300	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (1)	2N3498, 2N3499	$V_{(BR)CEO}$	100	—	—	Vdc
($I_C = 10$ mAdc, $I_B = 0$)	2N3500, 2N3501		150	—	—	
Collector-Base Breakdown Voltage	2N3498, 2N3499	$V_{(BR)CBO}$	100	—	—	Vdc
($I_C = 10$ μAdc, $I_E = 0$)	2N3500, 2N3501		150	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$	6.0	—	—	Vdc
($I_E = 10$ μAdc, $I_C = 0$)				—	—	
Collector Cutoff Current		I_{CBO}				μAdc
($V_{CB} = 50$ Vdc, $I_E = 0$)	2N3498, 2N3499		—	—	0.050	
($V_{CB} = 50$ Vdc, $I_E = 0$, $T_A = 150°C$)			—	—	50	
($V_{CB} = 75$ Vdc, $I_E = 0$)	2N3500, 2N3501		—	—	0.050	
($V_{CB} = 75$ Vdc, $I_E = 0$, $T_A = 150°C$)			—	—	50	
Emitter Cutoff Current ($V_{BE(off)} = 4.0$ Vdc, $I_C = 0$)		I_{EBO}	—	—	25	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)	2N3498, 2N3500		20	—	—	
	2N3499, 2N3501		35	—	—	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	2N3498, 2N3500		25	—	—	
	2N3499, 2N3501		50	—	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	2N3498, 2N3500		35	—	—	
	2N3499, 2N3501		75	—	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	2N3498, 2N3500		40	—	120	
	2N3499, 2N3501		100	—	300	
($I_C = 300$ mAdc, $V_{CE} = 10$ Vdc)	2N3500		15	—	—	
	2N3501		20	—	—	
($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)	2N3498		15	—	—	
	2N3499		20	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	All Types		—	—	0.2	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	All Types		—	—	0.25	
($I_C = 150$ mAdc, $I_B = 15$ mAdc)	2N3500, 2N3501		—	—	0.4	
($I_C = 300$ mAdc, $I_B = 30$ mAdc)	2N3498, 2N3499		—	—	0.6	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	All Types		—	—	0.8	
(I_C = 50 mAdc, I_B = 5.0 mAdc)	All Types		—	—	0.9	
(I_C = 150 mAdc, I_B = 15 mAdc)	2N3500, 2N3501		—	—	1.2	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N3498, 2N3499		—	—	1.4	

SMALL-SIGNAL CHARACTERISTICS

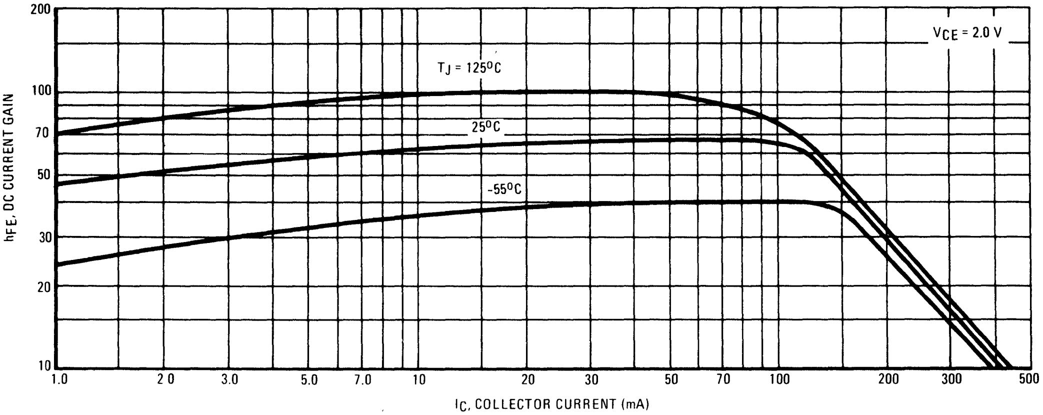
Characteristic		Symbol	Min	Typ	Max	Unit
Current-Gain — Bandwidth Product(2) (V_{CE} = 20 Vdc, I_C = 20 mAdc, f = 100 MHz)		f_T	150	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	2N3498, 2N3499 2N3500, 2N3501	C_{obo}	— —	— —	10 8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	—	80	pF
Input Impedance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3498, 2N3500 2N3499, 2N3501	h_{ie}	0.2 0.25	— —	1.0 1.25	k ohms
Voltage Feedback Ratio (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3498, 2N3500 2N3499, 2N3501	h_{re}	— —	— —	2.5 4.0	$X\ 10^{-4}$
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3498, 2N3500 2N3499, 2N3501	h_{fe}	50 75	— —	300 375	—
Output Admittance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3498, 2N3500 2N3499, 2N3501	h_{oe}	— —	— —	100 200	μmhos

SWITCHING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Delay Time (I_C = 150 mAdc, I_{B1} = 15 mAdc, V_{CC} = 100 Vdc, $V_{BE(off)}$ = 2.0 Vdc)	t_d	—	20	—	ns
Rise Time (I_C = 150 mAdc, I_{B1} = 15 mAdc, V_{CC} = 100 Vdc, $V_{BE(off)}$ = 2.0 Vdc)	t_r	—	35	—	ns
Storage Time (I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc, V_{CC} = 100 Vdc)	t_s	—	800	—	ns
Fall Time (I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc, V_{CC} = 100 Vdc)	t_f	—	80	—	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

FIGURE 1 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE
2N3498



2N3499

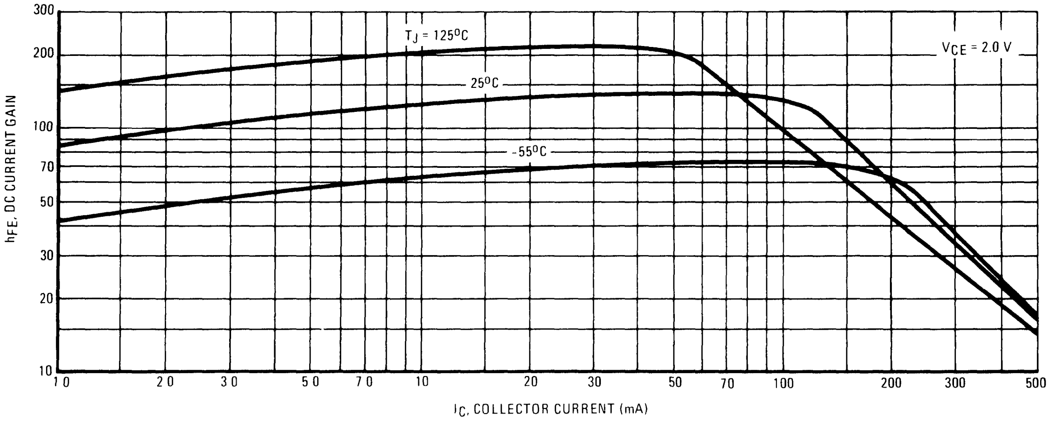


FIGURE 2 – CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

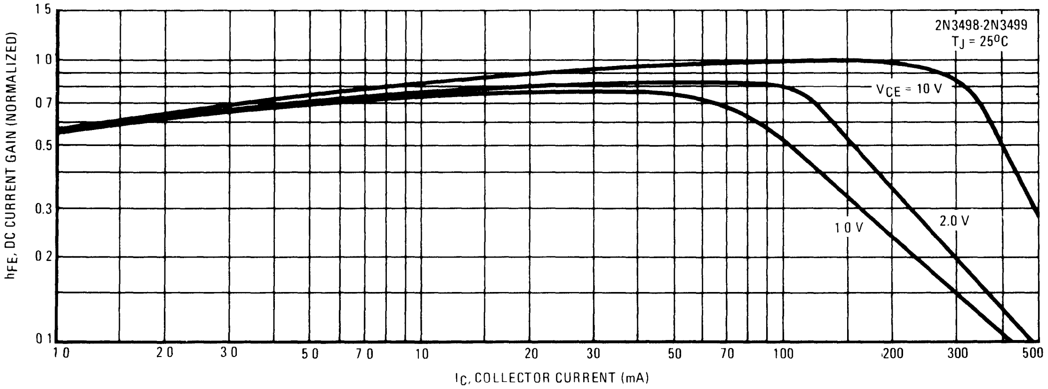
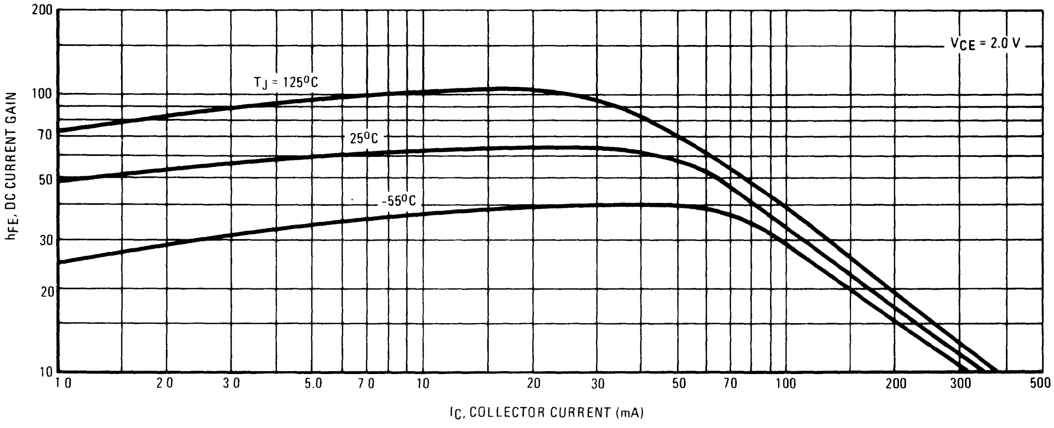


FIGURE 3 – CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE

2N3500



2N3501

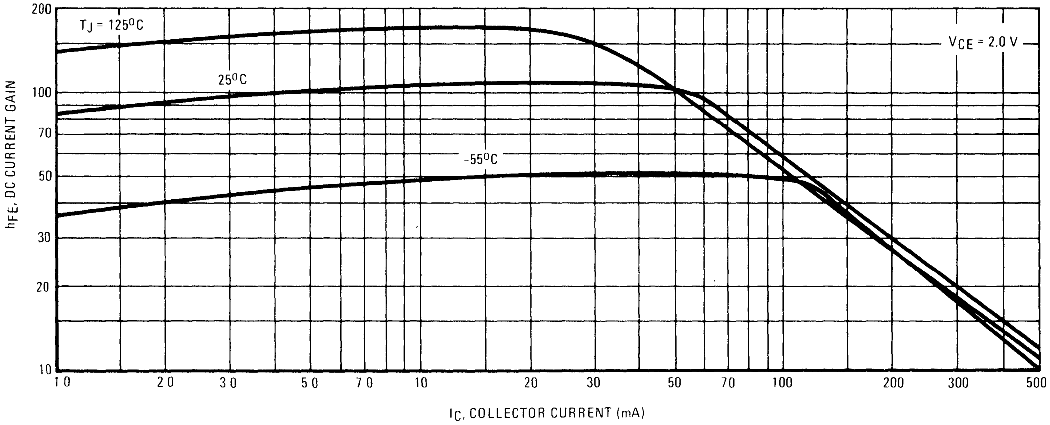


FIGURE 4 – CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

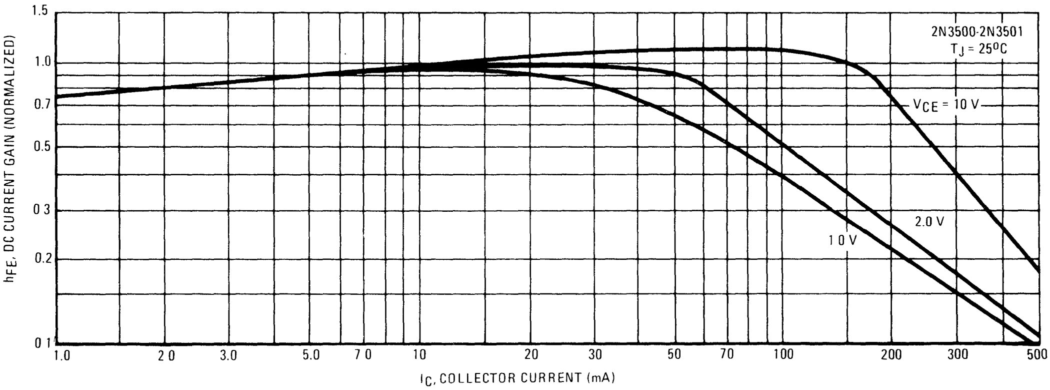


FIGURE 5 – "ON" VOLTAGES

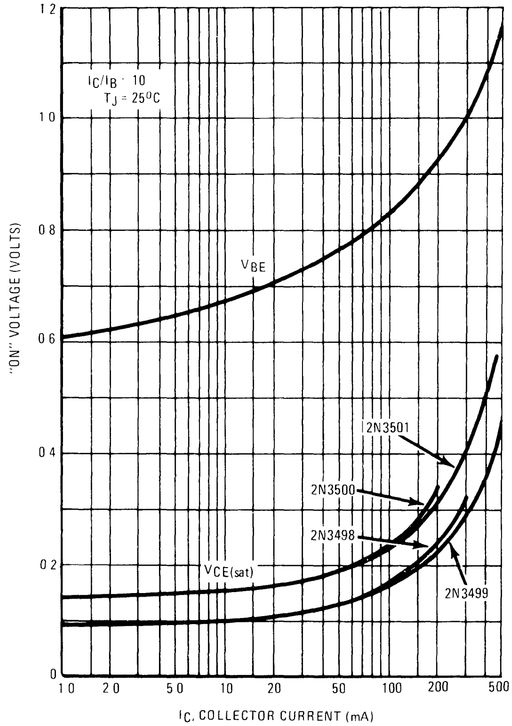


FIGURE 6 – TEMPERATURE COEFFICIENTS

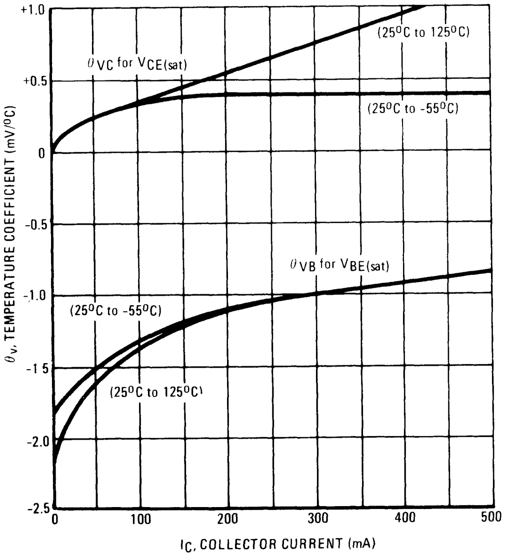
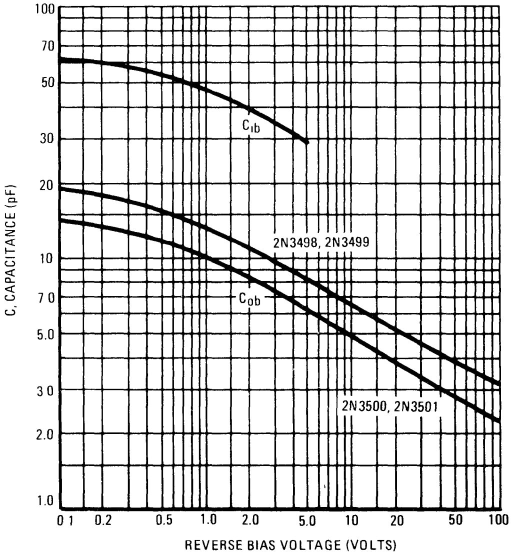


FIGURE 7 – CAPACITANCE



AUDIO SMALL-SIGNAL h PARAMETER CHARACTERISTICS

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

FIGURE 8 – CURRENT GAIN

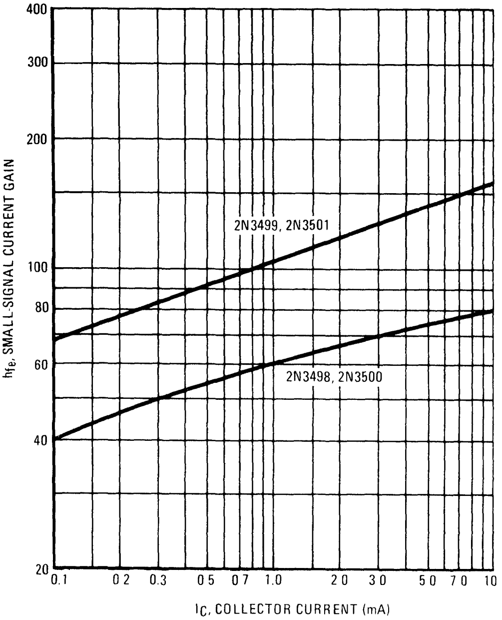


FIGURE 9 – OUTPUT IMPEDANCE

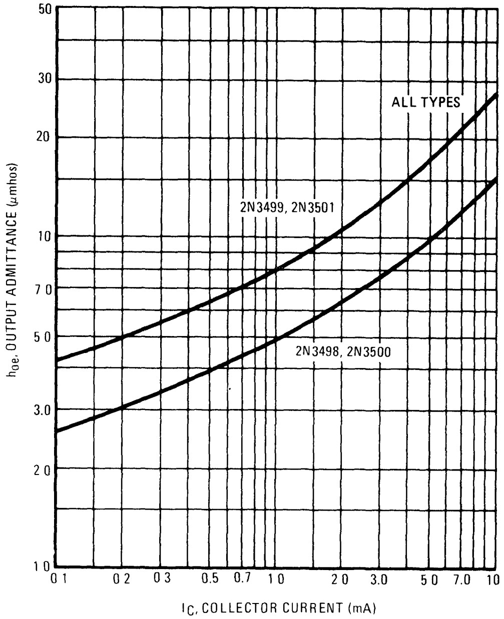


FIGURE 10 – INPUT IMPEDANCE

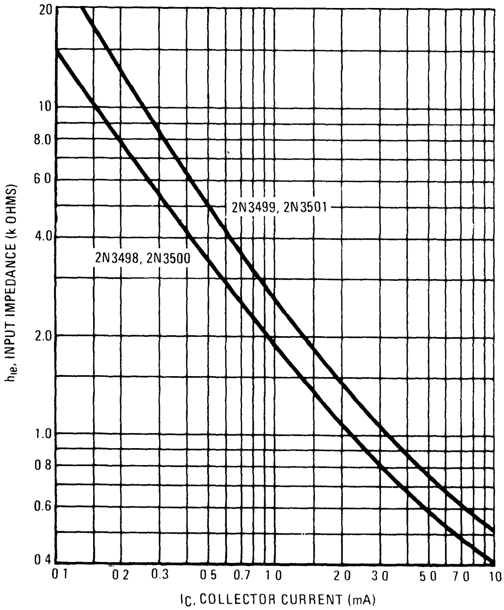
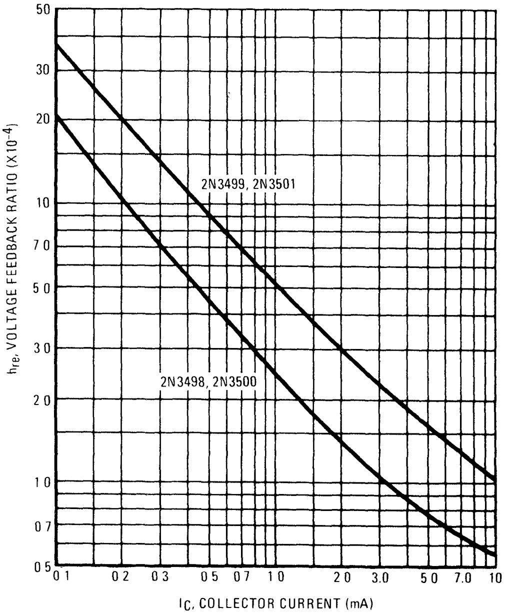


FIGURE 11 – VOLTAGE FEEDBACK RATIO

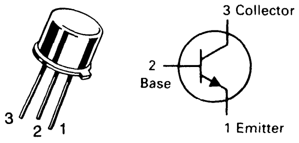


2N3506
2N3507

JAN, JTX, JTXV AVAILABLE

CASE 79-04, STYLE 1

TO-39 (TO-205AD)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3506	2N3507	Unit
Collector-Emitter Voltage	V_{CEO}	40	50	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	3.0		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, pulsed, $I_B = 0$)	2N3506 2N3507	$V_{(BR)CEO}$	40 50	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	2N3506 2N3507	$V_{(BR)CBO}$	60 80	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 40$ Vdc, $V_{EB(off)} = 4.0$ Vdc) ($V_{CE} = 40$ Vdc, $V_{EB(off)} = 4.0$ Vdc, $T_A = 100°C$) ($V_{CE} = 60$ Vdc, $V_{EB(off)} = 4.0$ Vdc) ($V_{CE} = 60$ Vdc, $V_{EB(off)} = 4.0$ Vdc, $T_A = 100°C$)	 2N3506 2N3507 	I_{CEX}	 — — — —	 1.0 150 1.0 150	μAdc
Base Cutoff Current ($V_{CE} = 40$ Vdc, $V_{EB(off)} = 4.0$ Vdc) ($V_{CE} = 60$ Vdc, $V_{EB(off)} = 4.0$ Vdc)	 2N3506 2N3507	I_{BL}	 — —	 1.0 1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.5$ Adc, $V_{CE} = 2.0$ Vdc) ($I_C = 2.5$ Adc, $V_{CE} = 3.0$ Vdc) ($I_C = 3.0$ Adc, $V_{CE} = 5.0$ Vdc) 	 2N3506 2N3507 2N3506 2N3507 2N3506 2N3507 2N3506 2N3507	h_{FE}	 50 35 40 30 30 25 25 20	 — — 200 150 — — — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 500$ mAdc, $I_B = 50$ mAdc) ($I_C = 1.5$ Adc, $I_B = 150$ mAdc) ($I_C = 2.5$ Adc, $I_B = 250$ mAdc)		$V_{CE(sat)}$	— — —	0.5 1.0 1.5	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 500$ mAdc, $I_B = 50$ mAdc) ($I_C = 1.5$ Adc, $I_B = 150$ mAdc) ($I_C = 2.5$ Adc, $I_B = 250$ mAdc)		$V_{BE(sat)}$	— 0.9 —	1.0 1.4 2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 100$ mAdc, $V_{CE} = 5$ Vdc, f = 20 MHz)		f_T	60	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)		C_{obo}	—	40	pF
Input Capacitance ($V_{BE} = 3$ Vdc, $I_C = 0$, f = 100 kHz)		C_{ibo}	—	300	pF

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	I_C = 1.5 Adc, I_{B1} = 150 mAdc V_{CC} = 30 V, V_{EB} = 0 V	t_d	—	15	ns
Rise Time		t_r	—	30	ns
Storage Time	I_C = 1.5 Adc, I_{B1} = I_{B2} = 150 mAdc V_{CC} = 30 V	t_s	—	55	ns
Fall Time		t_f	—	35	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

FIGURE 1 — SATURATION VOLTAGES

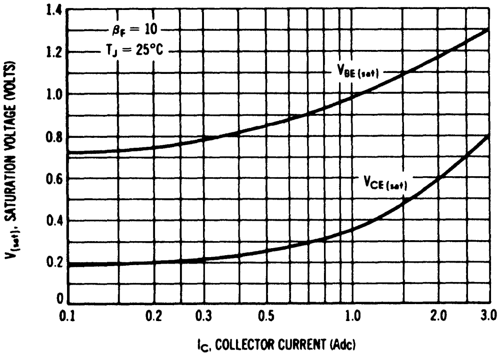


FIGURE 2 — SWITCHING TIMES

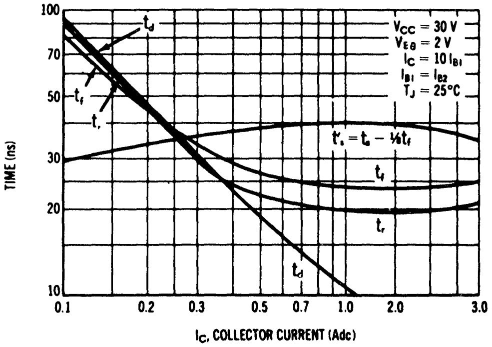
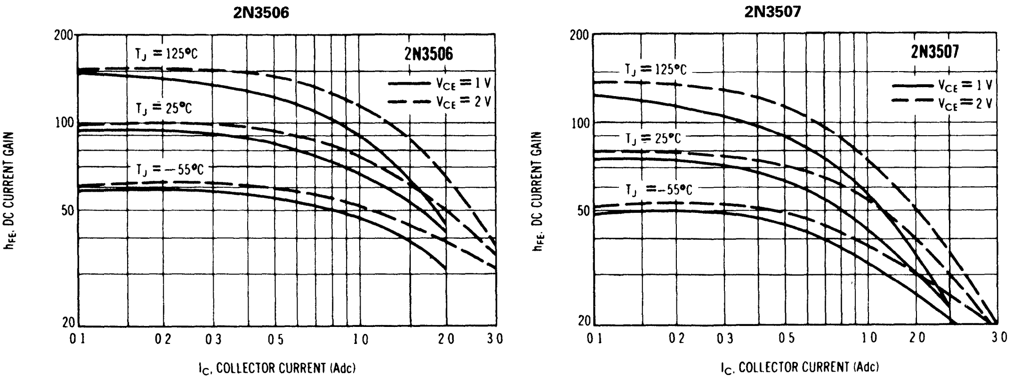
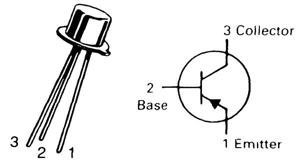


FIGURE 3 — CURRENT GAIN CHARACTERISTICS



2N3546

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
DC Collector Current	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9	Watts mW/°C
Operating and Storage Temperature Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.15	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.49	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	Vdc
Base Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE(off)} = 3.0$ Vdc)	I_{BEV}	—	0.10	μAdc
Collector Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE(off)} = 3.0$ Vdc)	I_{CEX}	—	0.010	μAdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc) ($V_{CB} = 10$ Vdc, $T_A = 150°C$)	I_{CBO}	— —	0.010 10	μAdc
ON CHARACTERISTICS				
DC Current Gain (1) ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 20 30 15 25 15	 — 120 — — —	—
Collector-Emitter Saturation Voltage (1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{CE(sat)}$	 — — —	 0.15 0.25 0.50	Vdc
Base-Emitter Saturation Voltage (1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc) ($I_C = 100$ mAdc, $I_B = 10$ mAdc)	$V_{BE(sat)}$	 0.7 0.8 —	 0.9 1.3 1.6	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	700	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	5.0	pF

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	I_C = 50 mA, I_{B1} = 5 .0 mA V_{BE} = 2.0 V, V_{CC} = 3.0 V	t_d	—	10	ns
Rise Time		t_r	—	15	ns
Storage Time	I_C = 50 mA, I_{B1} = I_{B2} = 5.0 mA V_{CC} = 3.0 V	t_s	—	20	ns
Fall Time		t_f	—	15	ns
Turn-On Time		t_{on}	—	40	ns
Turn-Off Time		t_{off}	—	30	ns
Total Control Charge (I_C = 50 mA, I_B = 5.0 mA, V_{CC} = 3.0 V)		Q_T	—	400	pC

(1) Pulse Test: PW = 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — LIMITS OF SATURATION VOLTAGES

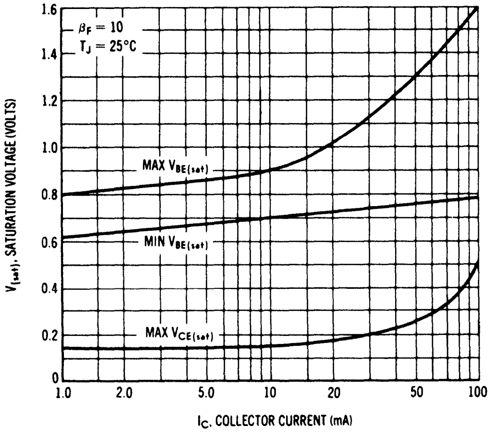


FIGURE 2 — STORAGE TIME BEHAVIOR

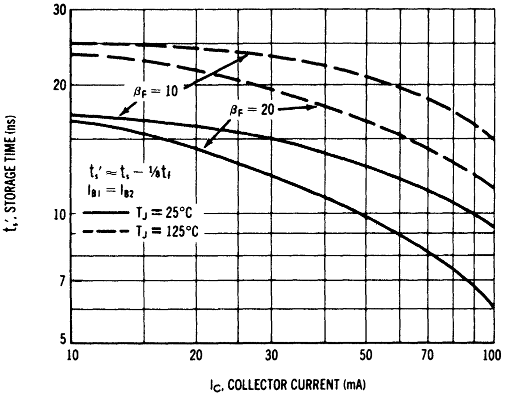
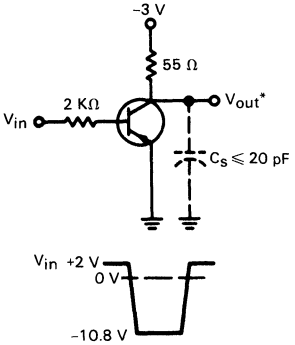


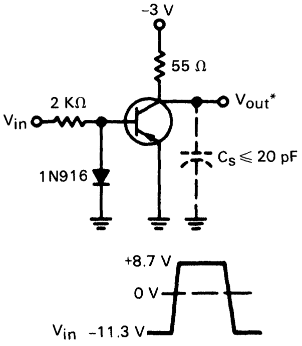
FIGURE 3 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT



PULSE WIDTH = 200 ns
RISE TIME ≤ 2 ns
DUTY CYCLE ≤ 10%

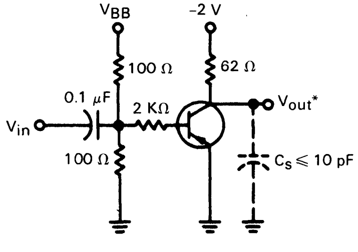
*OSCILLOSCOPE RISE TIME ≤ 1 ns

FIGURE 4 — STORAGE AND FALL TIME EQUIVALENT TEST CIRCUIT



PULSE WIDTH = 200 ns
RISE TIME ≤ 2 ns
DUTY CYCLE ≤ 10%

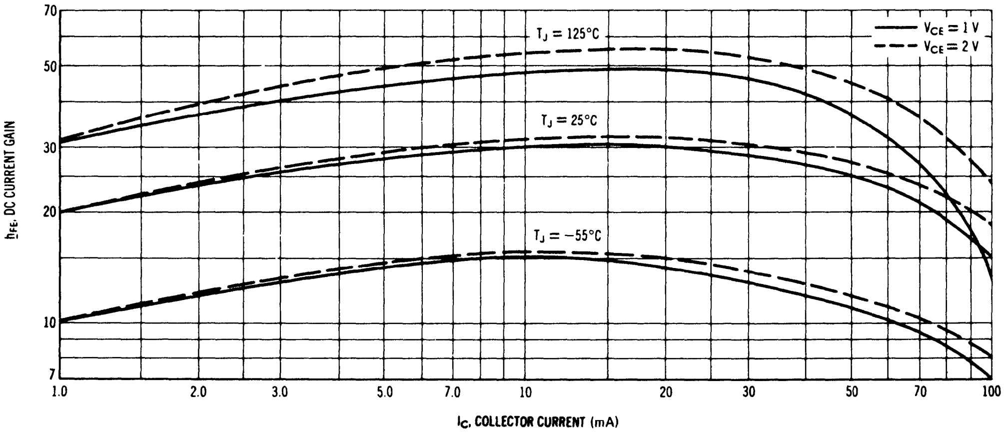
FIGURE 5 — SWITCHING TIME TEST CIRCUIT



PULSE WIDTH > 200 ns
RISE TIME < 2 ns
Z_{in} = 50 Ω

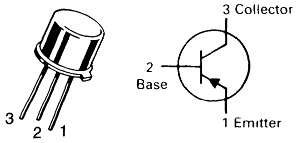
t_{on}: V_{BB} = +3 V, V_{in} = -7 V
t_{off}: V_{BB} = -4 V, V_{in} = +6 V

FIGURE 6 — MINIMUM CURRENT GAIN CHARACTERISTICS



2N3634
thru
2N3637

JAN, JTX AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3634 2N3635	2N3636 2N3637	Unit
Collector-Emitter Voltage	V_{CEO}	140	175	Vdc
Collector-Base Voltage	V_{CBO}	140	175	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	 2N3634, 2N3635 2N3636, 2N3637	$V_{(BR)CEO}$	 140 175	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	 2N3634, 2N3635 2N3636, 2N3637	$V_{(BR)CBO}$	 140 175	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 100$ Vdc, $I_E = 0$)		I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)	 2N3634, 2N3636 2N3635, 2N3637	h_{FE}	 40 80	 — —	—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	2N3634, 2N3636 2N3635, 2N3637		45 90	— —	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	2N3634, 2N3636 2N3635, 2N3637		50 100	— —	
($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc)	2N3634, 2N3636 2N3635, 2N3637		50 100	150 300	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	2N3634, 2N3636 2N3635, 2N3637		25 50	— —	
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{CE(sat)}$	 — —	 0.3 0.5	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{BE(sat)}$	 — 0.65	 0.8 0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($V_{CE} = 30$ Vdc, $I_C = 30$ mAdc, f = 100 MHz)	 2N3634, 2N3636 2N3635, 2N3637	f_T	 150 200	 — —	MHz

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

Characteristic		Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	10	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	75	pF
Input Impedance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	 2N3634, 2N3636 2N3635, 2N3637	h_{ie}	 100 200	 600 1200	ohms
Voltage Feedback Ratio (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	—	3.0	X 10^{-4}
Small-Signal Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	 2N3634, 2N3636 2N3635, 2N3637	h_{fe}	 40 80	 160 320	—
Output Admittance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	—	200	μmhos
Noise Figure (I_C = 0.5 mAdc, V_{CE} = 10 Vdc, R_S = 1.0 k ohms, f = 1.0 kHz)		NF	—	3.0	dB

SWITCHING CHARACTERISTICS

Turn-On Time	(V_{CC} = 100 Vdc, V_{BE} = 4.0 Vdc, I_C = 50 mAdc, I_{B1} = I_{B2} = 5.0 mAdc)	t_{on}	—	400	ns
Turn-Off Time		t_{off}	—	600	ns

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

FIGURE 1 — JUNCTION CAPACITANCE VARIATIONS

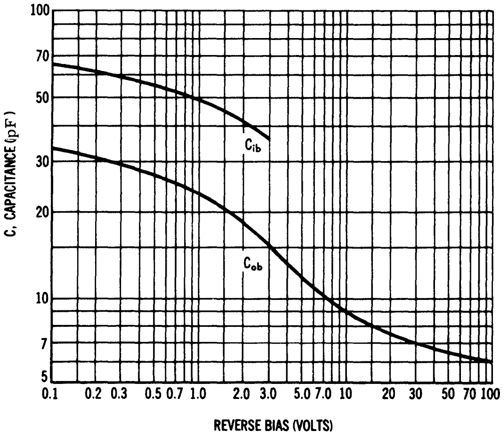


FIGURE 2 — GAIN-BANDWIDTH PRODUCT

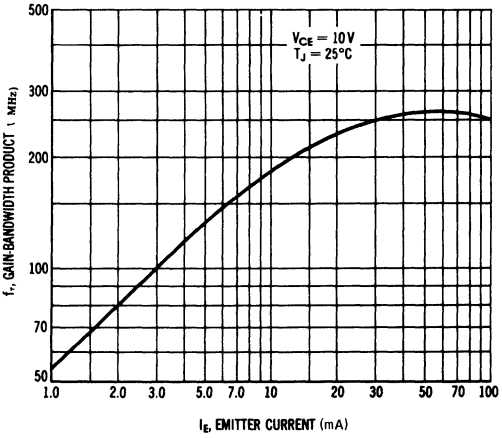
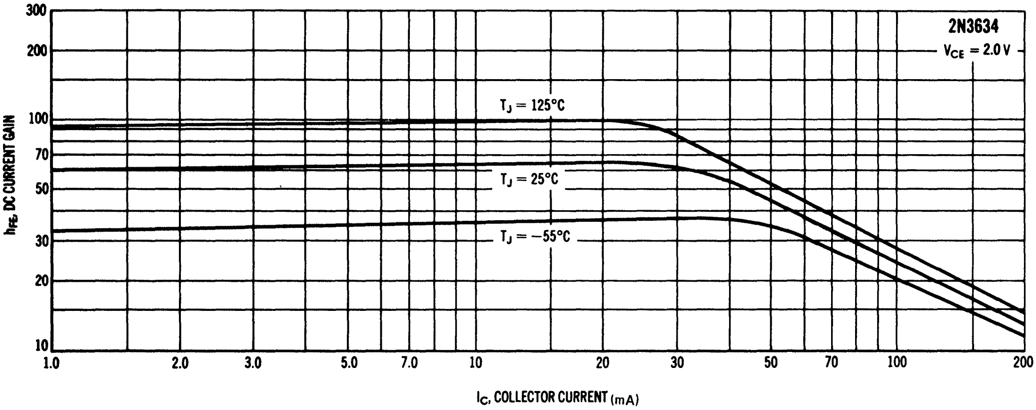


FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE

2N3634



2N3637

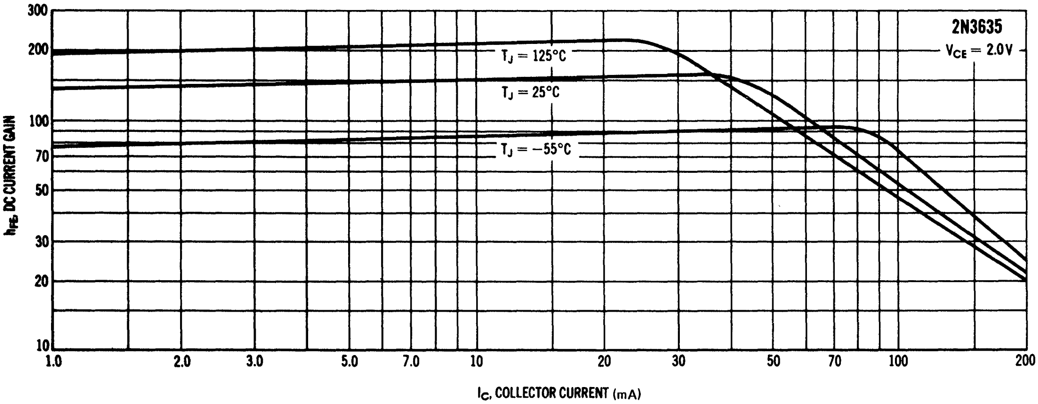


FIGURE 4 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR EMITTER VOLTAGE

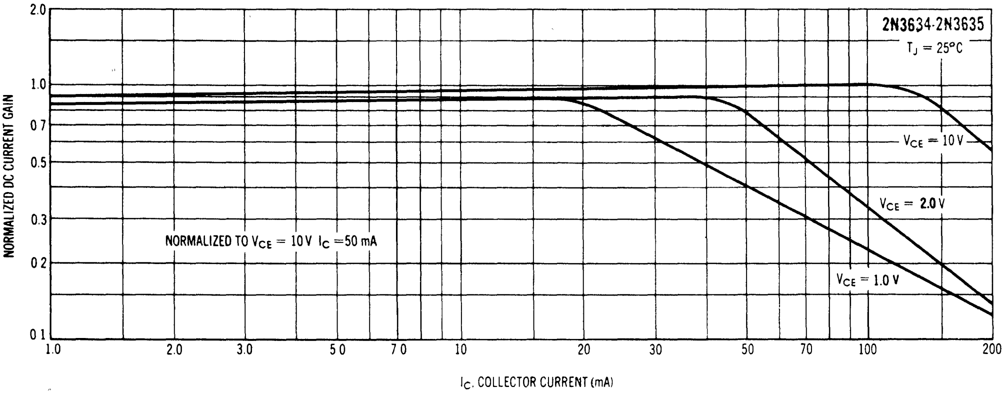
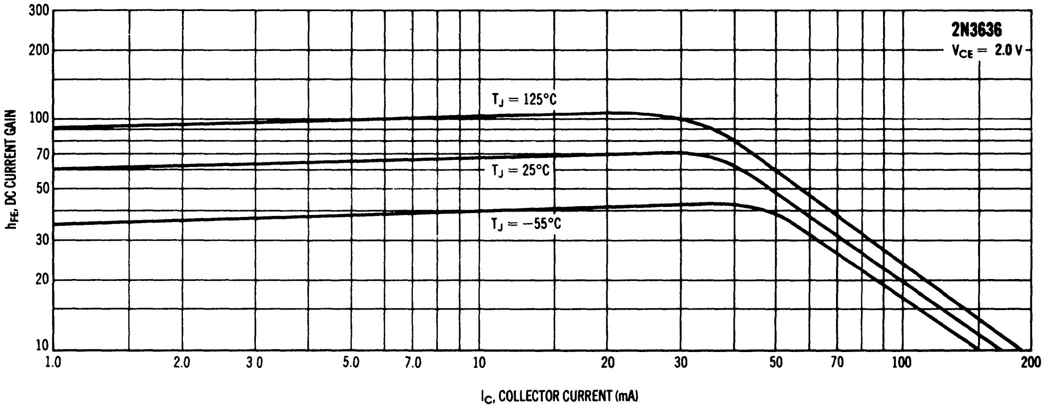


FIGURE 5 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE

2N3636



2N3637

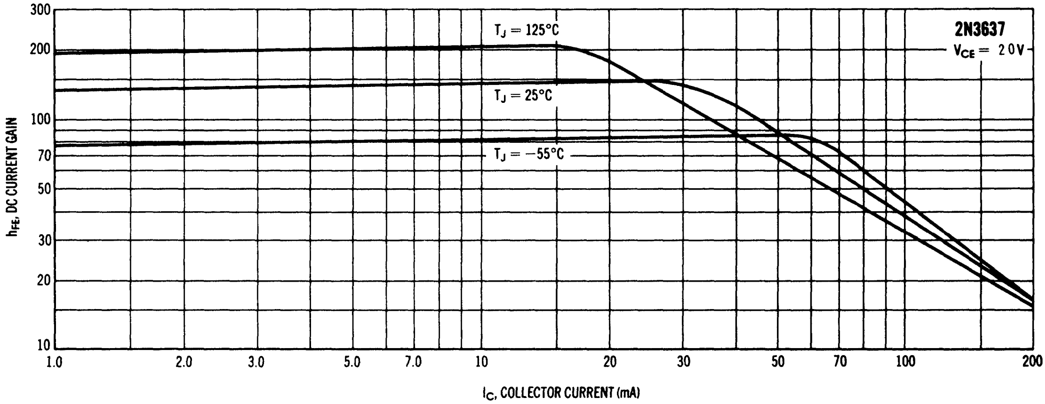


FIGURE 6 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR EMITTER VOLTAGE

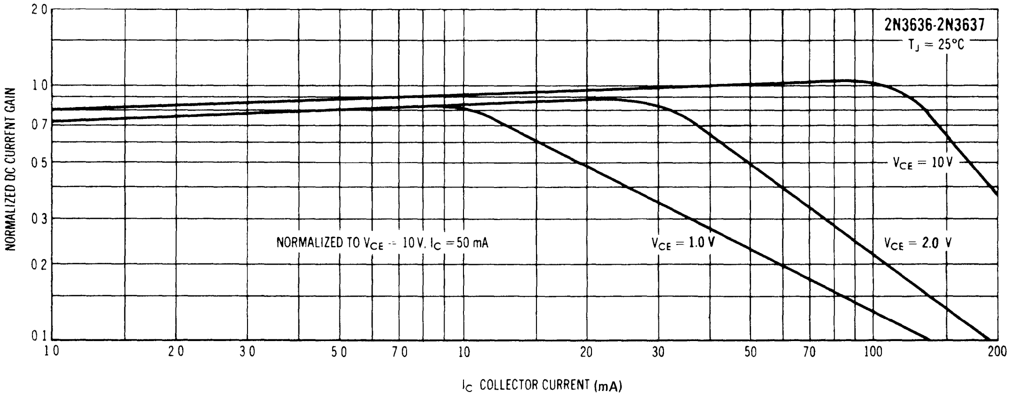


FIGURE 7 — INPUT IMPEDANCE

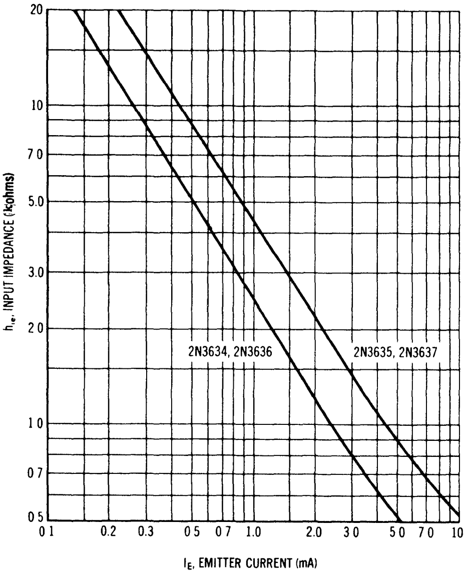


FIGURE 8 — OUTPUT IMPEDANCE

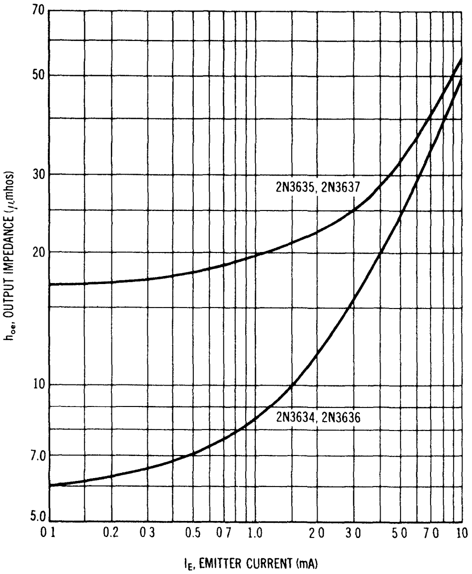


FIGURE 9 — CURRENT GAIN

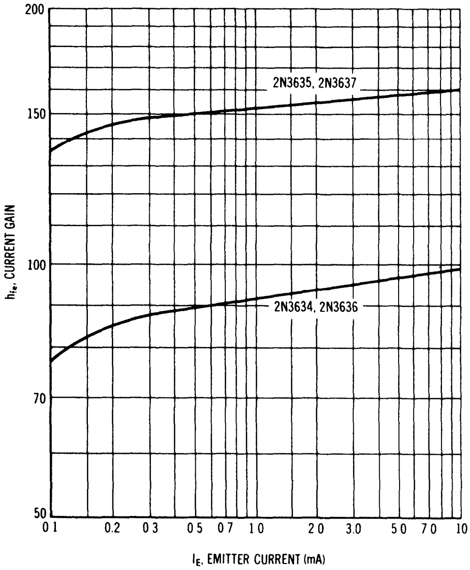


FIGURE 10 — VOLTAGE FEEDBACK RATIO

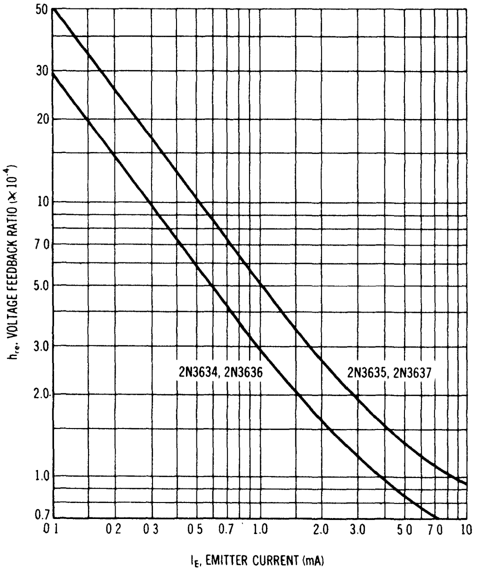


FIGURE 11 — SATURATION VOLTAGES

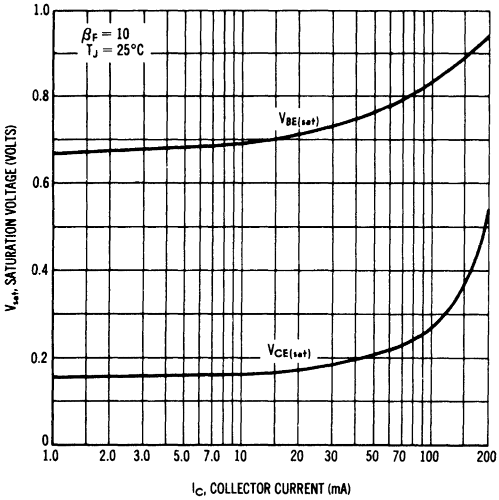


FIGURE 12 — TEMPERATURE COEFFICIENTS

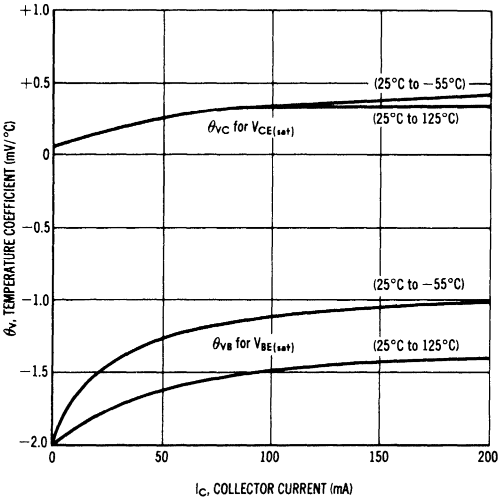
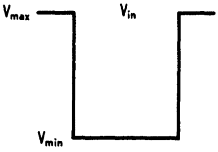


FIGURE 13 — SWITCHING TIME TEST CIRCUIT



P.W. ≅ 20 μs
DUTY CYCLE ≤ 2%
RISE TIME ≤ 20 ns

	V_{max}	V_{min}
TURN-ON	+4.0 V	−5.65 V
TURN-OFF	+4.1 V	−5.9 V

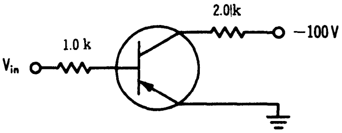


FIGURE 14 — TURN-ON TIME VARIATIONS WITH VOLTAGE

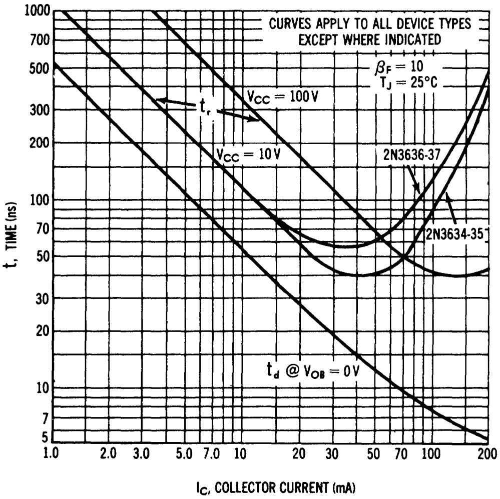
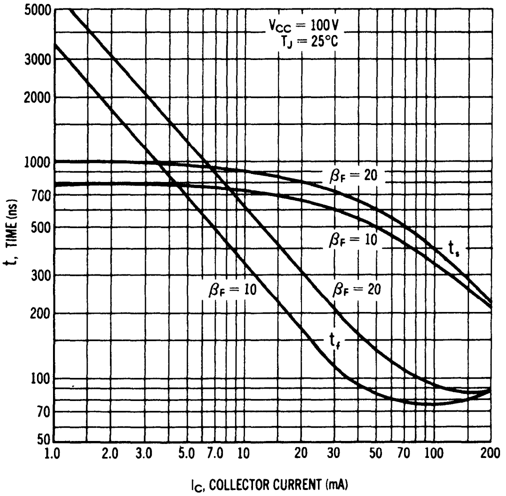
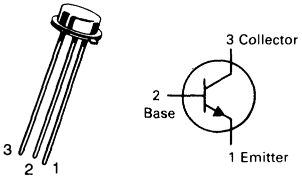


FIGURE 15 — TURN-OFF TIME VARIATIONS WITH CIRCUIT GAIN



2N3648

CASE 26-03, STYLE 1
TO-46 (TO-206AB)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	400 2.28	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.0 11.43	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 10$ Vdc, $V_{EB(off)} = 1.0$ Vdc) ($V_{CE} = 10$ Vdc, $V_{EB(off)} = 1.0$ Vdc, $T_A = 150°C$)	I_{CEX}	 — —	 0.025 50	μAdc
Base Cutoff Current ($V_{CE} = 10$ Vdc, $V_{OB} = 1.0$ Vdc)	I_{BL}	—	0.025	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 15 25 30 12 12	 — — 120 — —	—
Collector-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	 — — —	 0.25 0.4 0.8	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{BE(sat)}$	 — 0.8 —	 0.8 1.0 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	4.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	8.0	pF
Input Impedance ($I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz)	h_{ie}	0.6	4.5	kohms
Voltage Feedback Ratio ($I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz)	h_{re}	—	25	X 10^{-4}
Small-Signal Current Gain ($I_C = 15$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz) ($I_C = 1.0$ mA, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	 4.5 20	 — 150	—
Output Admittance ($I_C = 1.0$ mA, $V_{CE} = 10$ V, f = 1.0 kHz)	h_{oe}	10	100	μmhos

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

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	(I_C = 150 mA, I_{B1} = 15 mA, V_{EB} = 0.5 V, V_{CC} = 6.0 V)	t_d	—	8.0	ns
Rise Time		t_r	—	10	ns
Storage Time	(I_C = 150 mA, I_{B1} = $-I_{B2}$ = 15 mA, V_{CC} = 6.0 V)	t_s	—	12	ns
Fall Time		t_f	—	8.0	ns
Turn-On Time	(I_C = 150 mA, I_{B1} = 15 mA, V_{EB} = 0.5 V, V_{CC} = 6.0 V)	t_{on}	—	16	ns
Turn-Off Time	(I_C = 150 mA, I_{B1} = $-I_{B2}$ = 15 mA, V_{CC} = 6.0 V)	t_{off}	—	18	ns
Total Control Charge (I_C = 150 mA, I_B = 15 mA, V_{CC} = 6.0 V)		Q_T	—	300	pC

FIGURE 1 — STORAGE TIME VARIATION

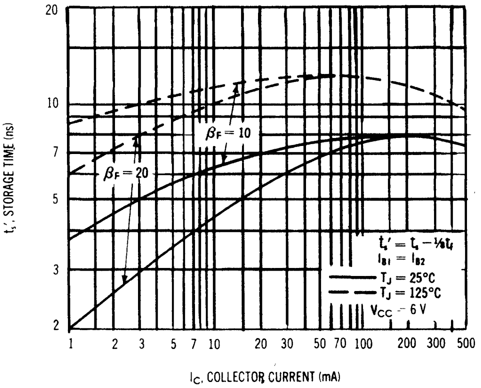


FIGURE 2 — LIMITS OF SATURATION VOLTAGE

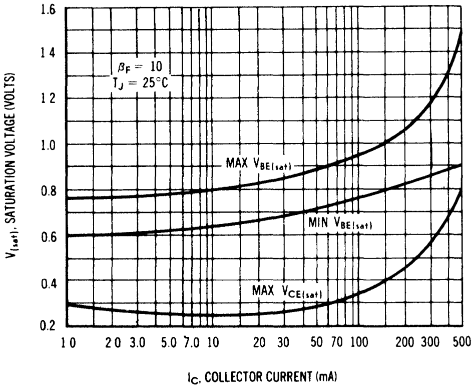
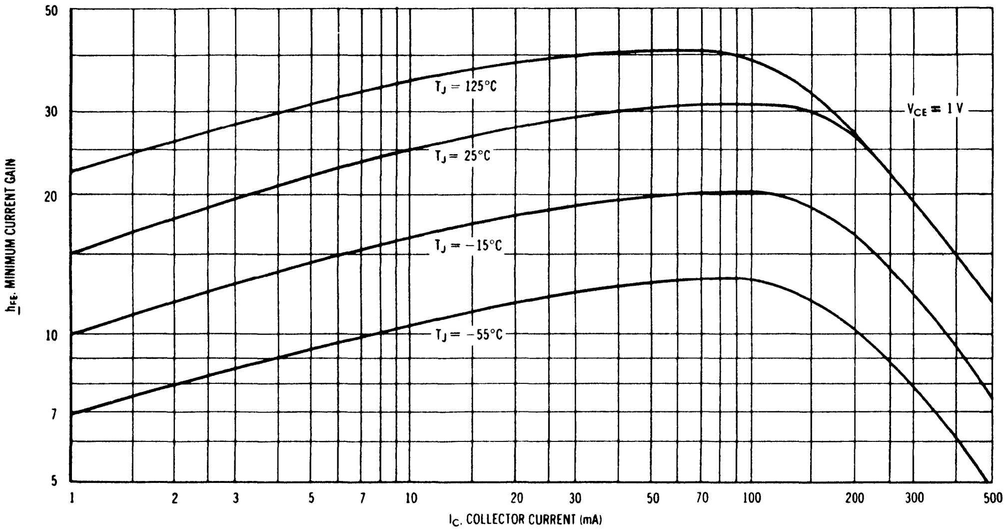


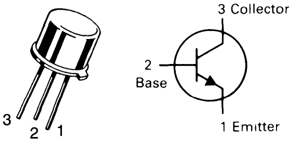
FIGURE 3 — MINIMUM CURRENT GAIN CHARACTERISTICS



2N3700 For Specifications, See 2N3019 Data.

2N3724
2N3725

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3724	2N3725	Unit
Collector-Emitter Voltage	V_{CEO}	30	50	Vdc
Collector-Base Voltage	V_{CBO}	50	80	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71		Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	2N3725		50	—	—	
	2N3724		30	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 μAdc, V_{BE} = 0)	2N3725		80	—	—	
	2N3724		50	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 10 μAdc, I_E = 0)	2N3725		80	—	—	
	2N3724		50	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				μAdc
(V_{CB} = 60 Vdc, I_E = 0)	2N3725		—	0.12	1.7	
(V_{CB} = 40 Vdc, I_E = 0)	2N3724		—	0.12	1.7	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 100°C)	2N3725		—	—	120	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 100°C)	2N3724		—	—	120	
Collector Cutoff Current		I_{CES}				μAdc
(V_{CE} = 80 Vdc, V_{EB} = 0)	2N3725		—	0.15	10	
(V_{CE} = 50 Vdc, V_{EB} = 0)	2N3724		—	0.15	10	
Base Current		I_B	—	—	10	μAdc
(V_{CE} = 50 V, V_{EB} = 0)	2N3724					
(V_{CE} = 80 V, V_{EB} = 0)	2N3725					
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			30	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			60	—	150	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			30	—	—	
(I_C = 300 mAdc, V_{CE} = 1.0 Vdc)			40	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			35	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			20	—	—	
(I_C = 800 mAdc, V_{CE} = 2.0 Vdc)			25	—	—	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)			30	—	—	
(I_C = 800 mA, V_{CE} = 2.0 V)	2N3725		20	—	—	
(I_C = 1.0 Adc, V_{CE} = 5.0 V)	2N3725		25	—	—	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$	—			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N3725		—	0.17	0.25	
	2N3724		—	0.17	0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N3725		—	0.19	0.26	
	2N3724		—	0.19	0.20	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N3725		—	0.25	0.40	
	2N3724		—	0.25	0.32	
(I_C = 500 mAdc, I_B = 50 mAdc)	2N3725		—	0.30	0.52	
	2N3724		—	0.30	0.42	
(I_C = 800 mAdc, I_B = 80 mAdc)	2N3725		—	0.43	0.80	
	2N3724		—	0.43	0.65	
(I_C = 1.0 mAdc, I_B = 100 mAdc)	2N3725		—	0.55	0.95	
	2N3724			0.55	0.75	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	—	0.76	
(I_C = 100 mAdc, I_B = 10 mAdc)			—	—	0.86	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.1	
(I_C = 500 mAdc, I_B = 50 mAdc)			0.8	—	1.1	
(I_C = 800 mAdc, I_B = 80 mAdc)			—	—	1.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	—	1.7	

SMALL SIGNAL CHARACTERISTICS

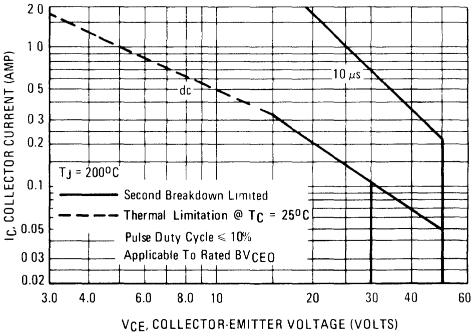
Characteristic		Symbol	Min	Typ	Max	Unit
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	300	—	—	MHz
Output Capacitance		C_{obo}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N3725		—	—	10	
	2N3724		—	—	12	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	—	55	pF

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 1.0%.
(2) $f_T = |h_{fe}| \cdot f_{test}$.

SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) (Figures 8, 10)	t_d	–	5.0	10	ns
Rise Time		t_r	–	15	30	ns
Turn-On Time		t_{on}	–	20	35	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, $I_{B1} = I_{B2}$ = 50 mAdc) (Figures 9, 10)	t_s	–	35	50	ns
Fall Time		t_f	–	20	25	ns
Turn-Off Time		t_{off}	–	50	60	ns

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



TYPICAL DC CHARACTERISTICS

FIGURE 2 – DC CURRENT GAIN

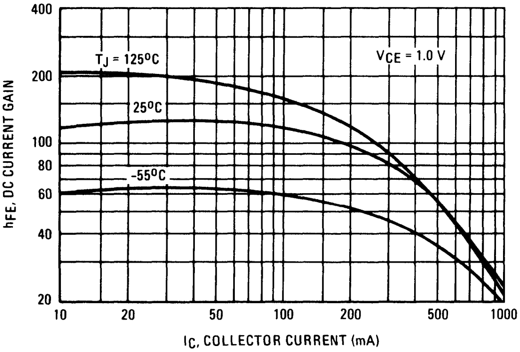


FIGURE 3 – "ON" VOLTAGES

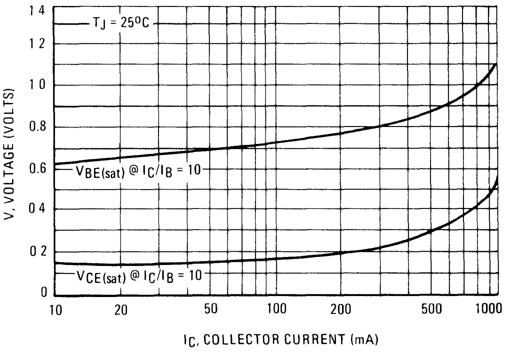


FIGURE 4 – COLLECTOR SATURATION REGION

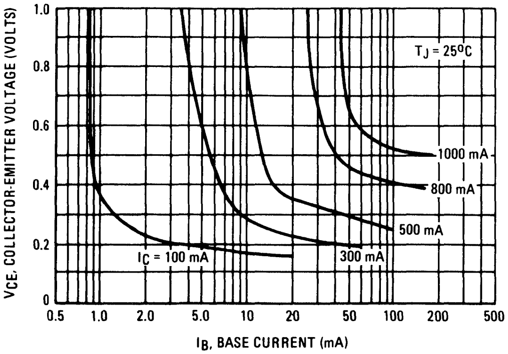
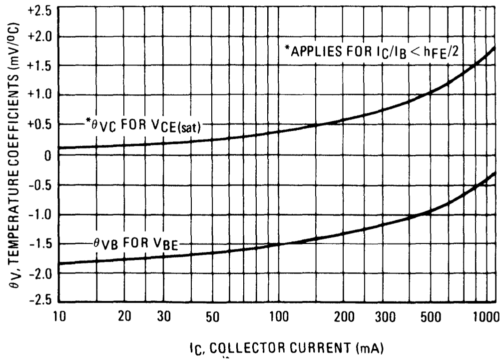


FIGURE 5 – TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 6 – CURRENT-GAIN – BANDWIDTH PRODUCT

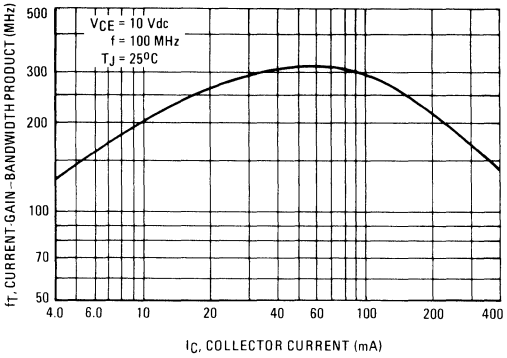


FIGURE 7 – CAPACITANCE

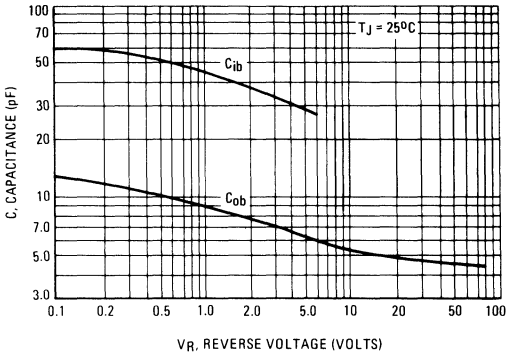


FIGURE 8 – TURN-ON TIME

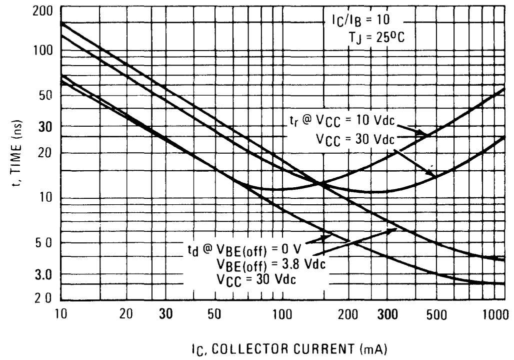


FIGURE 9 – TURN-OFF TIME

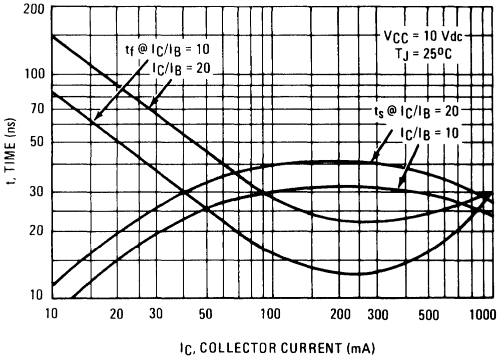


FIGURE 10 – SWITCHING TIME TEST CIRCUIT

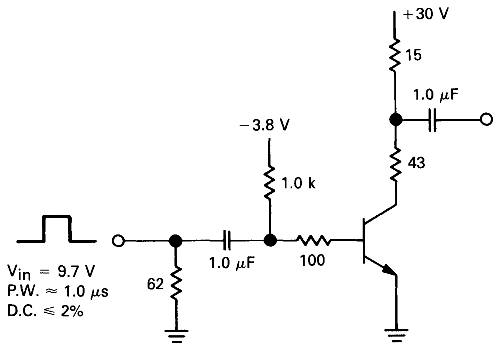
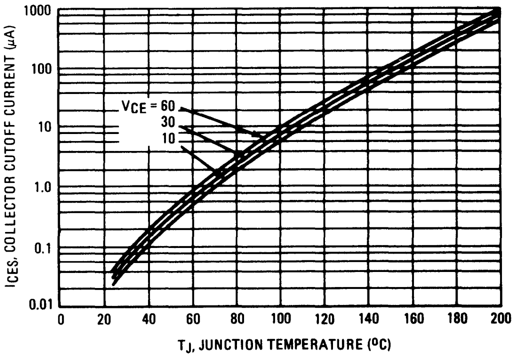
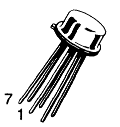


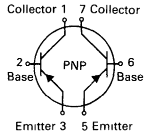
FIGURE 11 – COLLECTOR CUTOFF CURRENT



2N3726
2N3727

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MD2905,A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	45		Vdc
Collector-Base Voltage	V_{CBO}	45		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Base Current	I_B	100		mAdc
Collector Current — Continuous	I_C	300		mAdc
		One Die	Both Die	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.29	500 2.86	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.85 4.85	1.4 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Collector₁ to Collector₂ Voltage Voltage rating any lead to case	V_{C1} V_{C2}	±200 ±200		Vdc Vdc

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	45	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0) (V_{CB} = 30 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.01 mAdc, V_{CE} = 5.0 Vdc) (I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)(1)	h_{FE}	 80 120 135 115	 — — 350 —	—
Collector-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 2.5 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 2.5 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	 60 200	 — 600	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	30	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	—	11.5	kohm
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	—	1500	X 10^{-6}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	135	420	—

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

Characteristic	Symbol	Min	Max	Unit
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	—	80	μmhos
Noise Figure (I_C = 30 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 1.0 kHz, B.W. = 200 Hz)	NF	—	4.0	dB

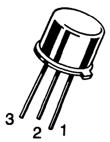
MATCHING CHARACTERISTICS

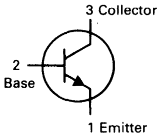
Characteristic	Symbol	Min	Max	Unit
DC Current Gain Ratio(3) (I_C = 0.1 mAdc to 1.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE1}/h_{FE2}	0.9	1.0	—
Base-Emitter Voltage Differential	$\|V_{BE1}-V_{BE2}\|$			mVdc
(I_C = 0.1 mAdc to 1.0 mAdc, V_{CE} = 5.0 Vdc) 2N3726		—	5.0	
2N3727		—	2.5	
Base-Emitter Differential Change Due to Temperature	$\Delta(V_{BE1}-V_{BE2})$			mVdc
(I_C = 0.1 mAdc to 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55°C to +25°C) 2N3726		—	1.6	
2N3727		—	0.8	
(I_C = 0.1 mAdc to 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = +25°C to +125°C) 2N3726		—	2.0	
2N3727		—	1.0	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.
(3) For purposes of this ratio, the lowest h_{FE} reading is taken as h_{FE1}.

2N3734
2N3735

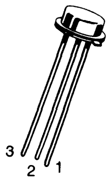
CASE 79-04, STYLE 1
TO-39 (TO-205AD)





2N3737

CASE 26-03, STYLE 1
TO-46 (TO-206AB)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3725 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N3734	2N3735 2N3737	Unit
Collector-Emitter Voltage	V_{CEO}	30	50	Vdc
Collector-Base Voltage	V_{CBO}	50	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		TO-39 2N3734 2N3735	TO-46 2N3737	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	0.5 2.86	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	4.0 22.8	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N3734	2N3735 2N3737	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.044	0.088	°C/mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.175	0.35	°C/mW

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	2N3734		30	—	
	2N3735, 2N3737		50	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	2N3734		50	—	
	2N3735, 2N3737		75	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CEX}			μAdc
(V_{CE} = 25 Vdc, V_{EB} = 2 Vdc)	2N3734		—	0.20	
(V_{CE} = 25 Vdc, V_{EB} = 2 Vdc, T_A = 100°C)			—	20	
(V_{CE} = 40 Vdc, V_{EB} = 2 Vdc)	2N3735, 2N3737		—	0.20	
(V_{CE} = 40 Vdc, V_{EB} = 2 Vdc, T_A = 100°C)			—	20	
Base Cutoff Current		I_{BL}			μAdc
(V_{CE} = 25 Vdc, V_{EB} = 2 Vdc)	2N3734		—	0.3	
(V_{CE} = 40 Vdc, V_{EB} = 2 Vdc)	2N3735, 2N3737		—	0.3	
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1 Vdc)			35	—	
(I_C = 150 mAdc, V_{CE} = 1 Vdc)			40	—	
(I_C = 500 mAdc, V_{CE} = 1 Vdc)			35	—	
(I_C = 1 Adc, V_{CE} = 1.5 Vdc)	2N3734		30	120	
	2N3735, 2N3737		20	80	
(I_C = 1.5 Adc, V_{CE} = 5 Vdc)	2N3734		30	—	
	2N3735, 2N3737		20	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)			—	0.2	
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.5	
(I_C = 1 Adc, I_B = 100 mAdc)			—	0.9	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)			—	0.8	
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.0	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.2	
(I_C = 1 Adc, I_B = 100 mAdc)			0.9	1.4	

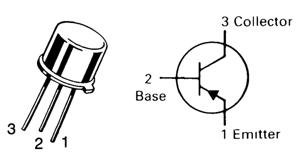
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	9.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	80	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	h_{fe}	2.5	—	—
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 30 V, $V_{BE(off)}$ = 2.0 V, I_C = 1.0 Amp, I_{B1} = 100 mA)	t_{on}	—	40	ns
Turn-Off Time (V_{CC} = 30 V, $V_{BE(off)}$ = 2.0 V, I_C = 1.0 Amp, I_{B1} = 100 mA)	t_{off}	—	60	ns
Total Control Charge (I_C = 1 Amp, I_B = 100 mA, V_{CC} = 30 V)	Q_T	—	10	NC

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

2N3743

JAN, JTX AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	300	Vdc
Collector-Base Voltage	V_{CBO}	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.7	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	300	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	300	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ Vdc, $I_E = 0$) ($V_{CB} = 200$ Vdc, $I_E = 0$, $T_A = 100°C$)	I_{CBO}	 — —	 0.3 30	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain(2) ($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc)	h_{FE}	 20 25 25 25 25	 — — — 250 —	—
Collector-Emitter Saturation Voltage(2) ($I_C = 10$ mAdc, $I_B = 1$ mAdc) ($I_C = 30$ mAdc, $I_B = 3$ mAdc)	$V_{CE(sat)}$	 — —	 5.0 8.0	Vdc
Base-Emitter Saturation Voltage(2) ($I_C = 10$ mAdc, $I_B = 1$ mAdc) ($I_C = 30$ mAdc, $I_B = 3$ mAdc)	$V_{BE(sat)}$	 — —	 1.0 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	15	pF
Input Capacitance ($V_{EB} = 1.0$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	400	pF
Input Impedance ($V_{CE} = 10$ V, $I_C = 10$ mA, f = 1 kHz)	h_{ie}	—	1.0	kohms
Voltage Feedback Ratio ($V_{CE} = 10$ V, $I_C = 10$ mA, f = 1 kHz)	h_{re}	—	4.0	$X\ 10^{-4}$
Small-Signal Current Gain ($V_{CE} = 10$ V, $I_C = 10$ mA, f = 1 kHz)	h_{fe}	30	300	—

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

Characteristic	Symbol	Min	Max	Unit
Current Gain — High Frequency (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	$\lvert h_{fe}\rvert$	1.5	—	—
Output Admittance (V_{CE} = 10 V, I_C = 10 mA, f = 1 kHz)	h_{oe}	—	200	μmhos
Real Part of Input Impedance (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 5 MHz)	$Re(h_{ie})$	—	40	ohms

(1) PW ≤ 30 μs, Duty Cycle ≤ 1.0%.
(2) PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — JUNCTION CAPACITANCE

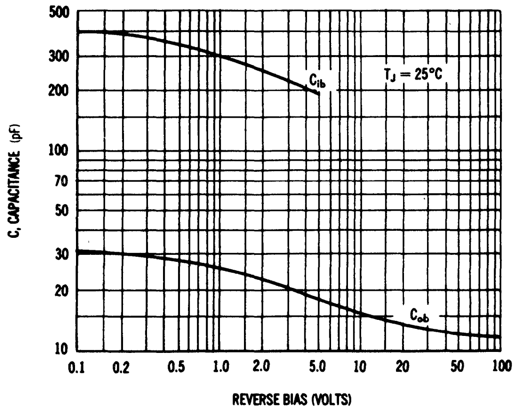


FIGURE 2 — GAIN-BANDWIDTH PRODUCT

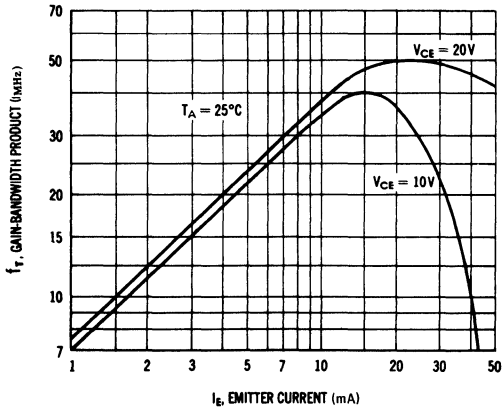
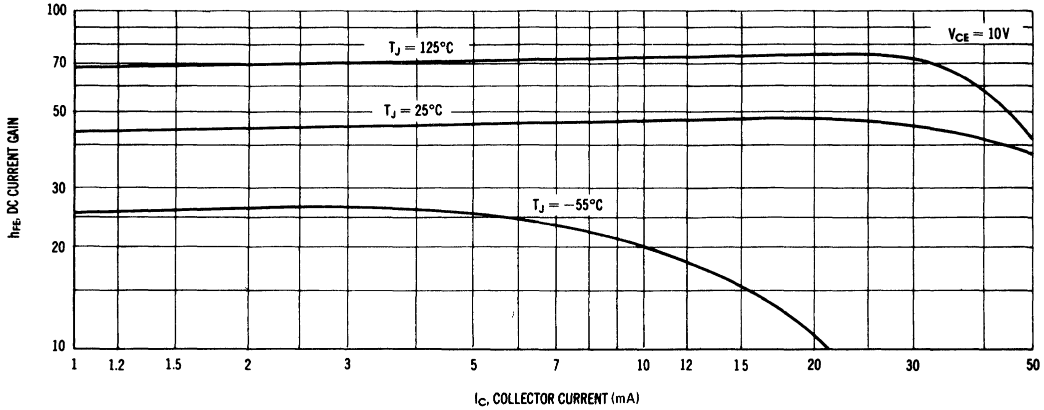


FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus JUNCTION TEMPERATURE



3

FIGURE 4 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

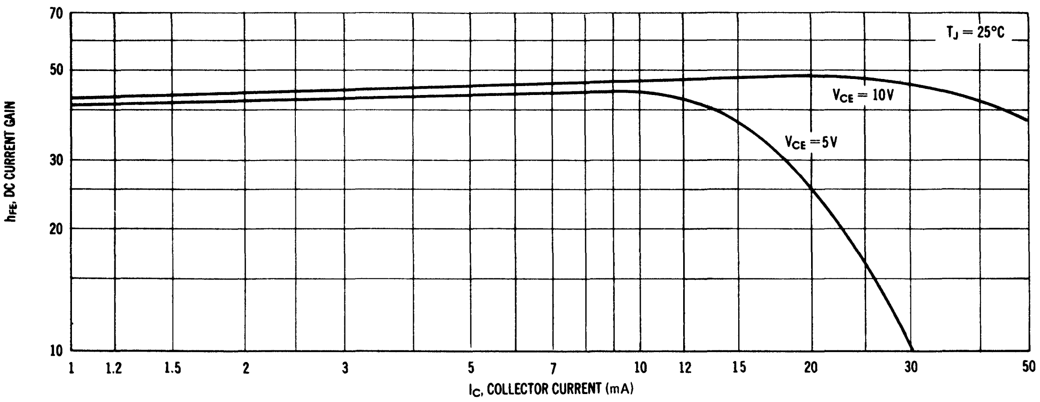


FIGURE 5 — COLLECTOR-EMITTER SATURATION VOLTAGE

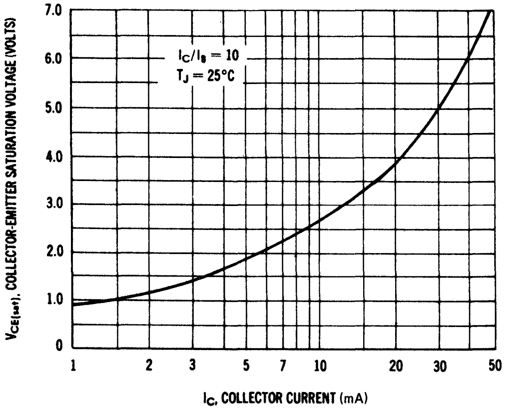
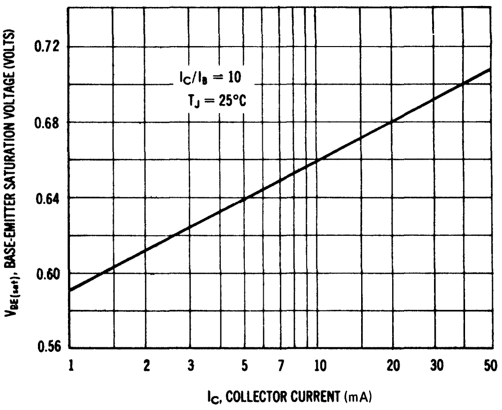


FIGURE 6 — BASE-EMITTER SATURATION VOLTAGE



SMALL SIGNAL y PARAMETERS

$T_A = 25°C$

FIGURE 7 — INPUT ADMITTANCE

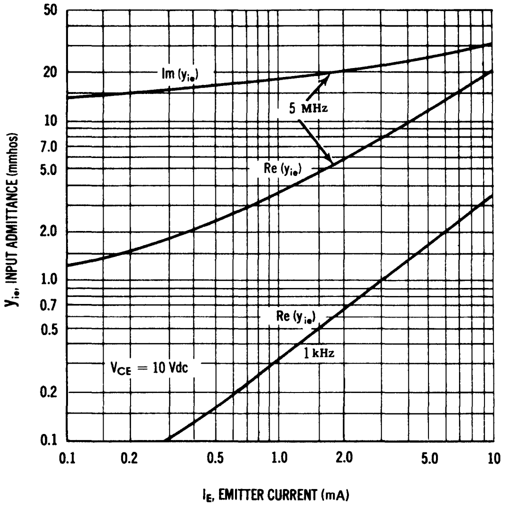


FIGURE 8 — REVERSE TRANSFER ADMITTANCE

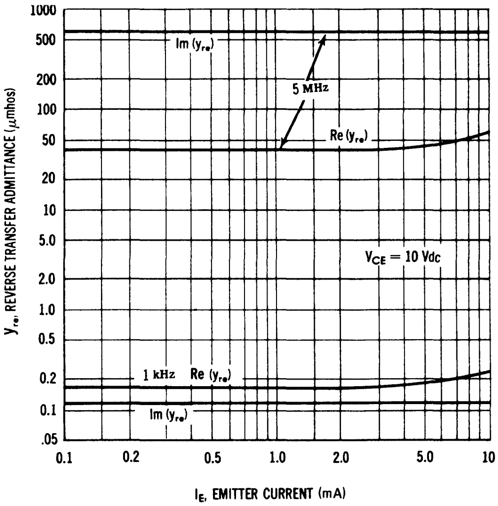


FIGURE 9 — FORWARD TRANSFER ADMITTANCE

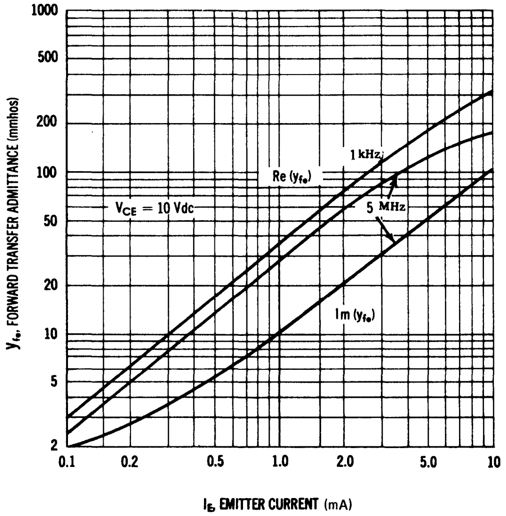
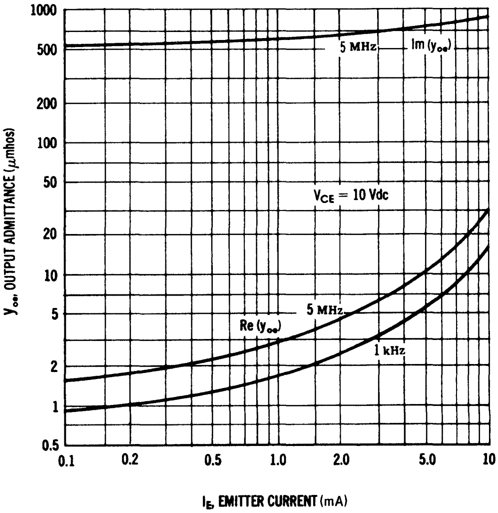
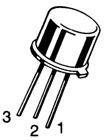


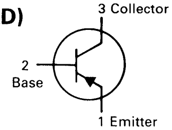
FIGURE 10 — OUTPUT ADMITTANCE



2N3762
2N3763

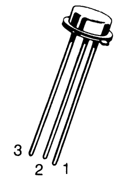
JAN, JTX, JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)





2N3764
2N3765

CASE 26-03, STYLE 1
TO-46 (TO-206AB)



SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N3762 2N3764	2N3763 2N3765	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	40	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		TO-39 **2N3762** **2N3763**	**TO-46** **2N3764** **2N3765**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	0.5 2.86	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	4.0 22.8	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Lead Temperature 1/16″ from Case for 10 Seconds	T_L	+235		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N3762 2N3763	2N3764 2N3765	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	44	88	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	350	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	2N3762, 2N3764		40	—	
	2N3763, 2N3765		60	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 10 μAdc, I_E = 0)	2N3762, 2N3764		40	—	
	2N3763, 2N3765		60	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CEX}			μAdc
(V_{CE} = 20 Vdc, V_{EB} = 2.0 Vdc)	2N3762, 2N3764		—	0.10	
(V_{CE} = 20 Vdc, V_{EB} = 2.0 Vdc, T_A = 100°C)			—	10	
(V_{CE} = 30 Vdc, V_{EB} = 2.0 Vdc)	2N3763, 2N3765		—	0.10	
(V_{CE} = 30 Vdc, V_{EB} = 2.0 Vdc, T_A = 100°C)			—	10	
Base Cutoff Current		I_{BL}			μAdc
(V_{CE} = 20 Vdc, V_{EB} = 2.0 Vdc)	2N3762, 2N3764		—	0.2	
(V_{CE} = 30 Vdc, V_{EB} = 2.0 Vdc)	2N3763, 2N3765		—	0.2	
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			35	—	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)			40	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			35	—	
(I_C = 1.0 Adc, V_{CE} = 1.5 Vdc)	2N3762, 2N3764		30	120	
	2N3763, 2N3765		20	80	
(I_C = 1.5 Adc, V_{CE} = 5.0 Vdc)	2N3762, 2N3764		30	—	
	2N3763, 2N3765		20	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	0.1	
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.22	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	0.9	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	0.8	
(I_C = 150 mAdc, I_B = 15 mAdc)			—	1.0	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.2	
(I_C = 1.0 Adc, I_B = 100 mAdc)			0.9	1.4	

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

Characteristic	Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	15	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	80	pF
Current Gain — High Frequency (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) 2N3762, 2N3764 2N3763, 2N3765	$\|h_{fe}\|$	 1.8 1.5	 — —	—
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 30 V, $V_{BE(off)}$ = 2.0 V, I_C = 1.0 Amp, I_{B1} = 100 mA)	t_d	—	8.0	ns
Rise Time (V_{CC} = 30 V, $V_{BE(off)}$ = 2.0 V, I_C = 1.0 Amp, I_{B1} = 100 mA)	t_r	—	3.5	ns
Storage Time (V_{CC} = 30 V, I_C = 1.0 Amp, I_{B1} = $-I_{B2}$ = 100 mA)	t_s	—	80	ns
Fall Time (V_{CC} = 30 V, I_C = 1.0 Amp, I_{B1} = $-I_{B2}$ = 100 mA)	t_f	—	35	ns
Total Control Charge (I_C = 1.0 Amp, I_B = 100 mA, V_{CC} = 30 V)	Q_T	—	30	pC

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

"ON" CONDITION CHARACTERISTICS

FIGURE 1 — DC CURRENT GAIN

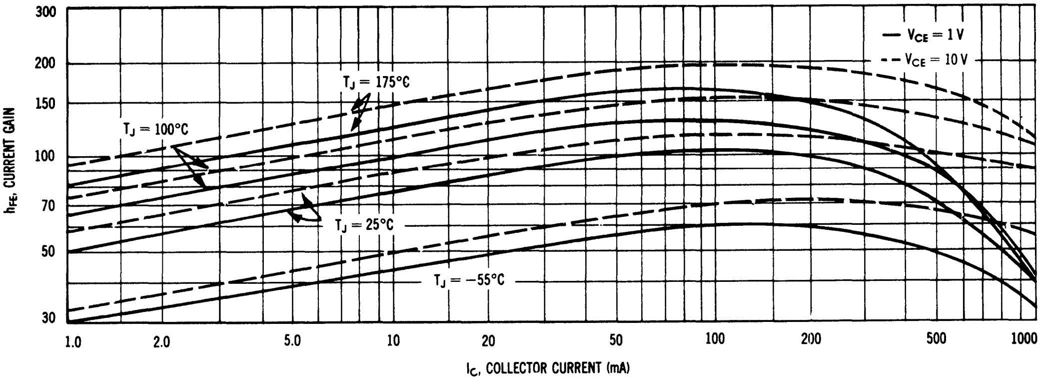
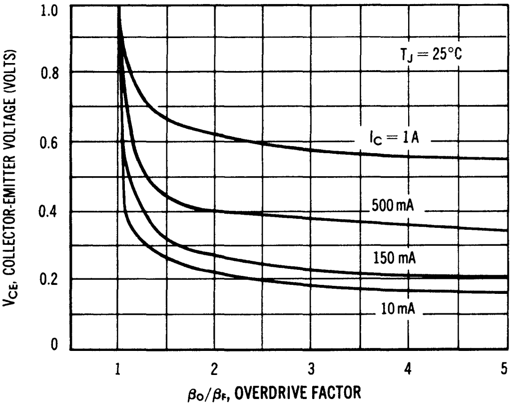


FIGURE 2 — COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector current. β_O (current gain at the edge of saturation) is the current gain of the transistor at 1 volt, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit. EXAMPLE: For type 2N3734, estimate a base current (I_{BF}) to ensure saturation at a temperature of 25°C and a collector of 500 mA.

Observe that at I_C = 500 mA an overdrive factor of at least 2.0 is required to drive the transistor well into the saturation region. From Figure 1, it is seen that h_{FE} @ 1 volt is typically 54 (guaranteed limits from the Table of Characteristics can be used for "worst-case" design).

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE}@1\,\text{Volt}}{I_C/I_{BF}} \qquad 2 = \frac{54}{500\,\text{mA}/I_{BF}} \qquad I_{BF} \approx 18.5\,\text{mA typ}$$

FIGURE 3 — "ON" VOLTAGES

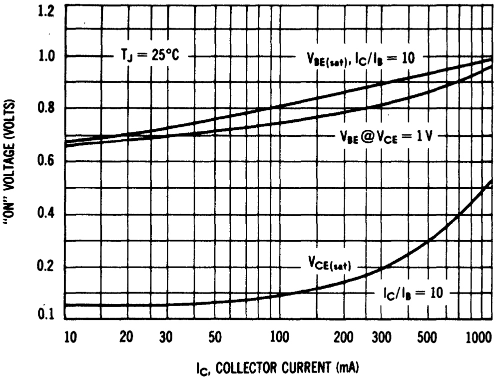


FIGURE 4 — TEMPERATURE COEFFICIENTS

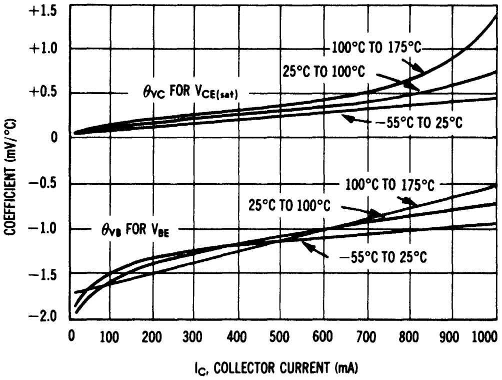
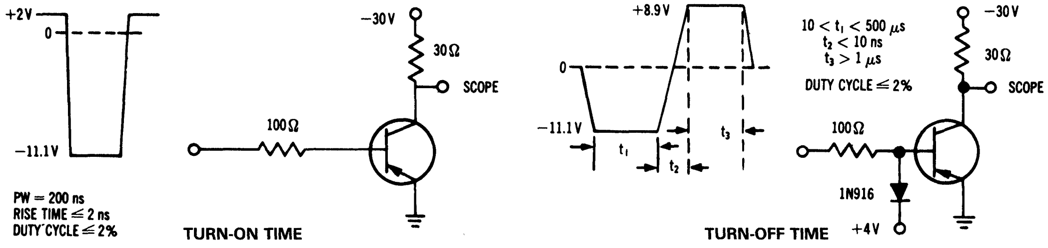


FIGURE 5 — SWITCHING TIME EQUIVALENT TEST CIRCUITS

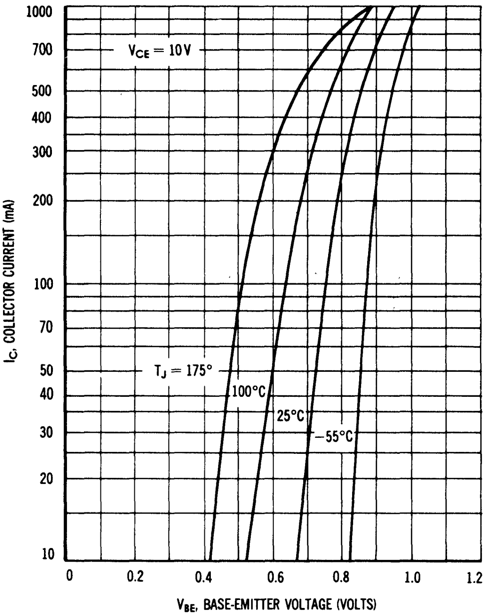


TURN-ON TIME

TURN-OFF TIME

LARGE SIGNAL CHARACTERISTICS

FIGURE 6 — TRANSCONDUCTANCE



"OFF" CONDITION CHARACTERISTICS

FIGURE 7 — TRANSCONDUCTANCE

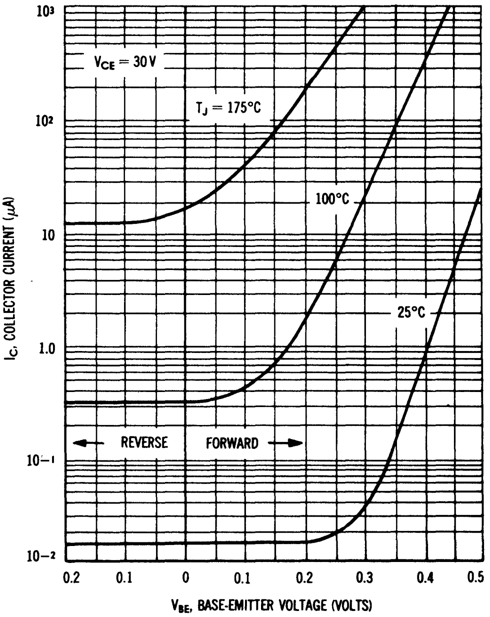


FIGURE 8 — INPUT ADMITTANCE

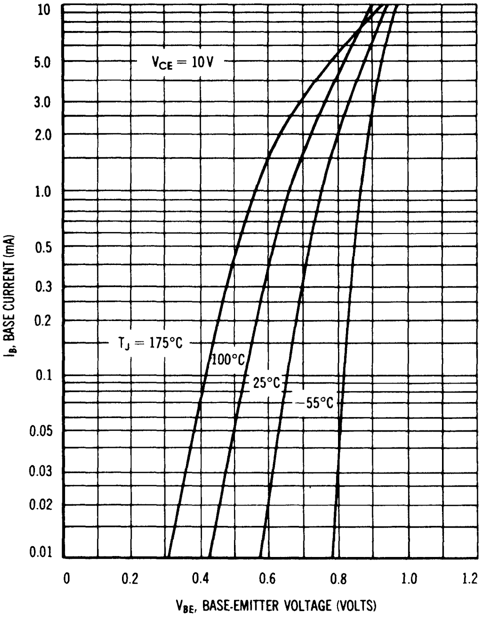
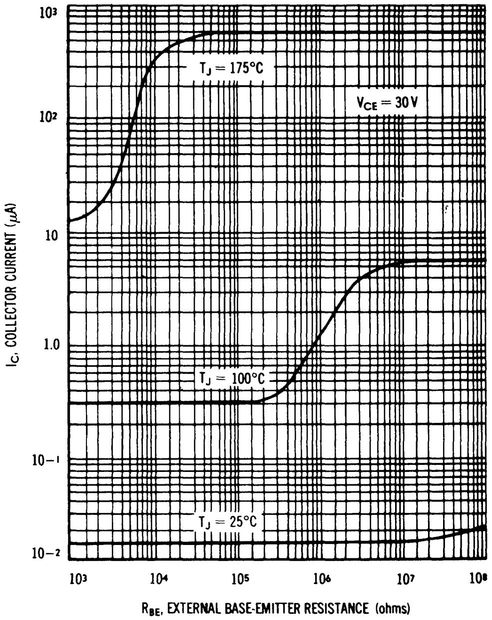


FIGURE 9 — EFFECT OF BASE-EMITTER RESISTANCE



SWITCHING CHARACTERISTICS

— T_J = 25°C
-- T_J = 150°C

FIGURE 10 — TURN-ON TIME

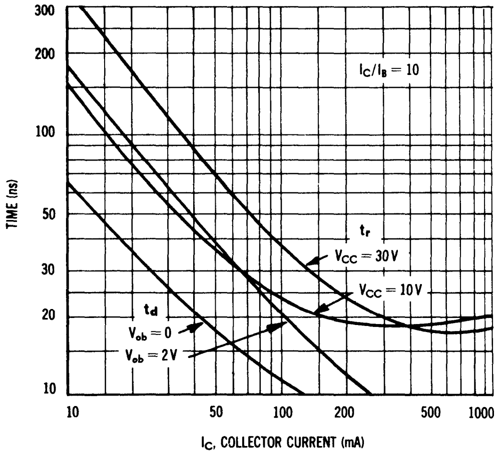


FIGURE 11 — RISE AND FALL TIME

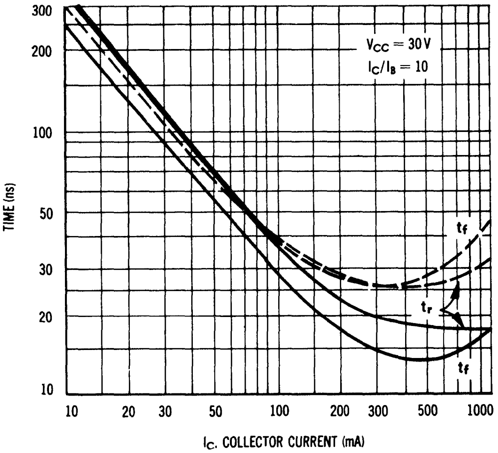


FIGURE 12 — STORAGE TIME

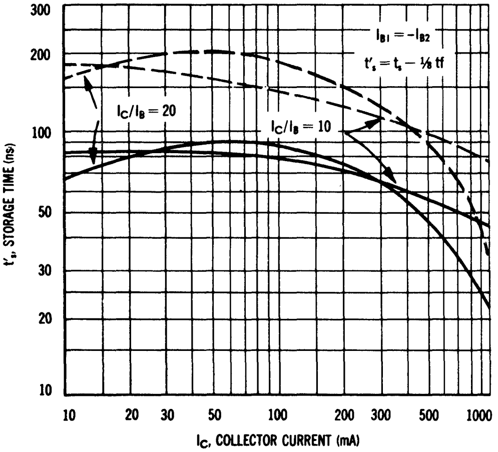


FIGURE 13 — FALL TIME

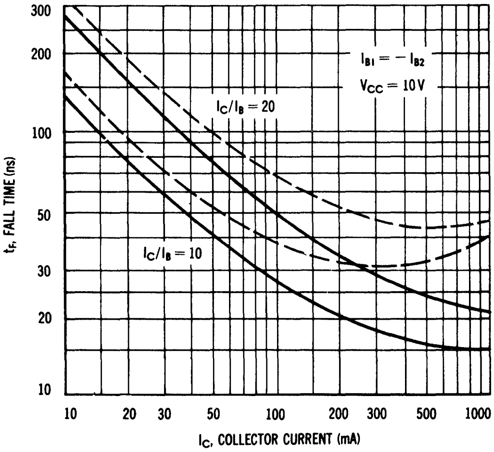


FIGURE 14 — CHARGE DATA

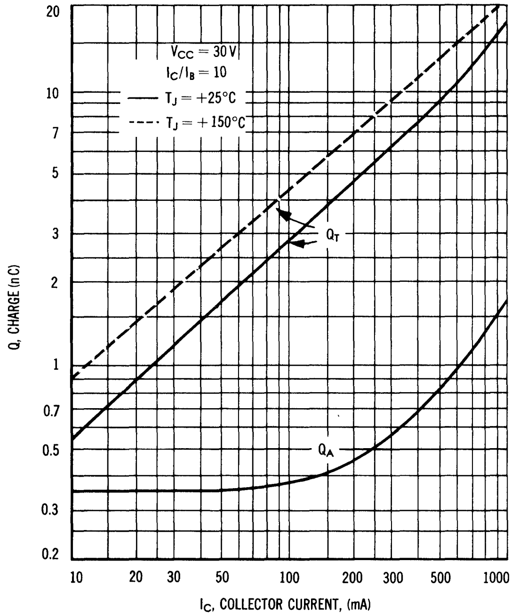


FIGURE 15 — CAPACITANCE

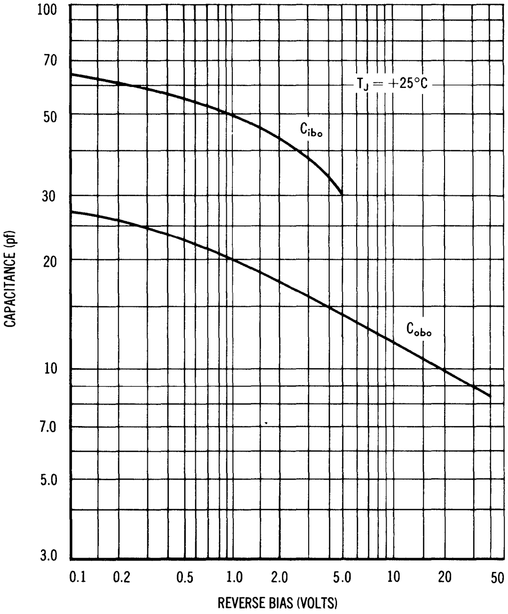
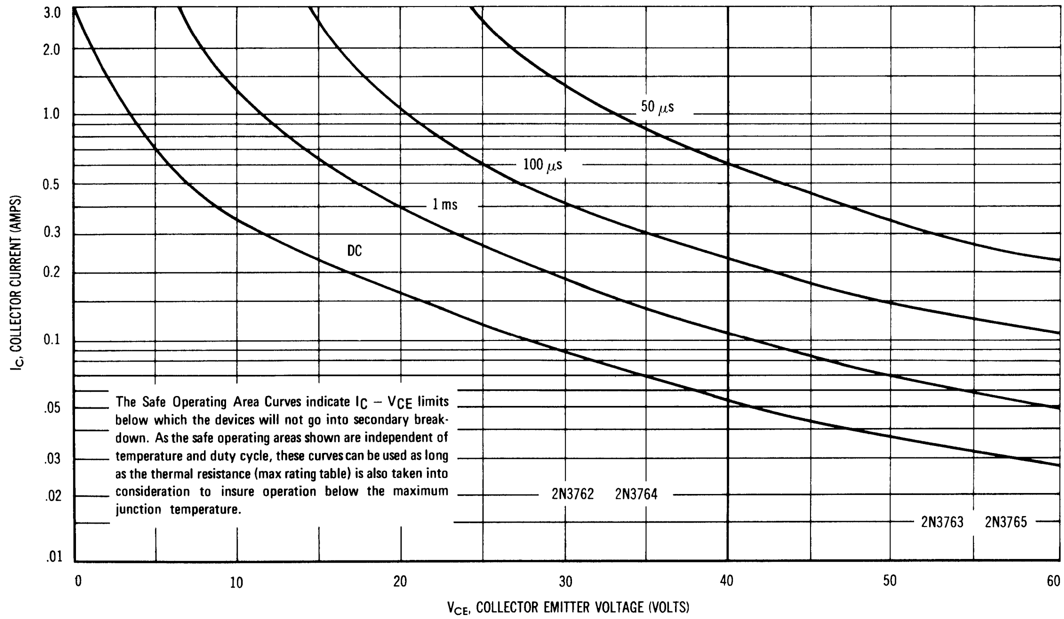


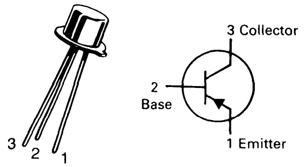
FIGURE 16 — ACTIVE REGION SAFE OPERATING AREAS



The Safe Operating Area Curves indicate $I_C - V_{CE}$ limits below which the devices will not go into secondary breakdown. As the safe operating areas shown are independent of temperature and duty cycle, these curves can be used as long as the thermal resistance (max rating table) is also taken into consideration to insure operation below the maximum junction temperature.

2N3798
2N3799

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.86	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.15	°C/mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.49	°C/mW

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)		I_{CBO}	 — —	 — —	 0.01 10	μAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
(I_C = 1.0 μAdc, V_{CE} = 5.0 Vdc)	2N3799		75	—	—	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N3798 2N3799		100 225	— —	— —	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N3798 2N3799		150 300	— —	— —	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	2N3798 2N3799		75 150	— —	— —	
(I_C = 500 μAdc, V_{CE} = 5.0 Vdc)	2N3798 2N3799		150 300	— —	450 900	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N3798 2N3799		150 300	— —	— —	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N3798 2N3799		125 250	— —	— —	
Collector-Emitter Saturation Voltage(1) (I_C = 100 μAdc, I_B = 10 μAdc) (I_C = 1.0 mAdc, I_B = 100 μAdc)		$V_{CE(sat)}$	 — —	 — —	 0.2 0.25	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 100 μAdc, I_B = 10 μAdc) (I_C = 1.0 mAdc, I_B = 100 μAdc)		$V_{BE(sat)}$	 — —	 — —	 0.7 0.8	Vdc
Base-Emitter On Voltage (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	—	0.7	Vdc

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

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 500 µAdc, V_{CE} = 5.0 Vdc, f = 30 MHz) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	 30 100	 — —	 — 500	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N3798 2N3799	h_{ie}	 3.0 10	 — —	 15 40	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	—	—	25	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N3798 2N3799	h_{fe}	 150 300	 — —	 600 900	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	5.0	—	60	µmhos
Noise Figure (I_C = 100 µAdc, V_{CE} = 10 Vdc, R_G = 3.0 k ohms), f = 100 Hz, B.W. = 20 Hz 2N3798 2N3799	NF	 — —	 4.0 2.5	 7.0 4.0	dB
Spot f = 1.0 kHz, B.W. = 200 Hz 2N3798 Noise 2N3799		 — —	 1.5 0.8	 3.0 1.5	
f = 10 kHz, B.W. = 2.0 kHz 2N3798 2N3799		— —	1.0 0.8	2.5 1.5	
Broadband Noise-Bandwidth 10 Hz to 15.7 kHz 2N3798 2N3799		— —	2.5 1.5	3.5 2.5	

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

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

3

SPOT NOISE FIGURE

(V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 1 — SOURCE RESISTANCE EFFECTS, f = 1.0 kHz

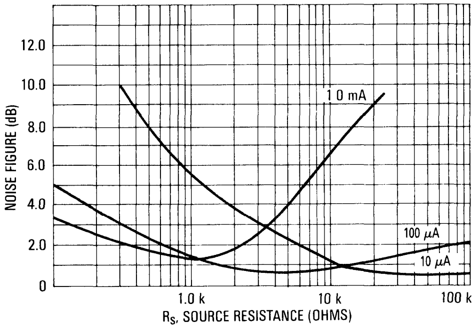


FIGURE 2 — SOURCE RESISTANCE EFFECTS, f = 10 Hz

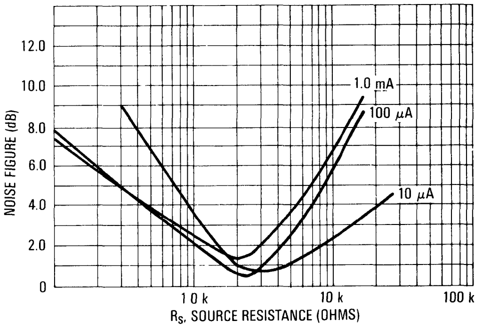


FIGURE 3 — FREQUENCY EFFECTS

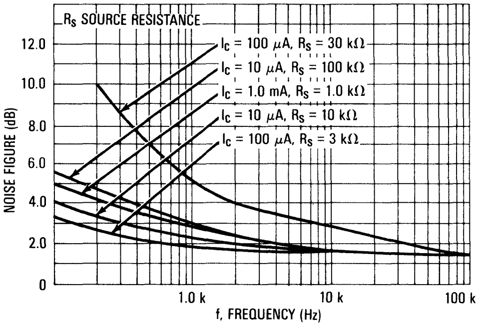


FIGURE 4a — TYPICAL CURRENT GAIN CHARACTERISTICS—2N3798

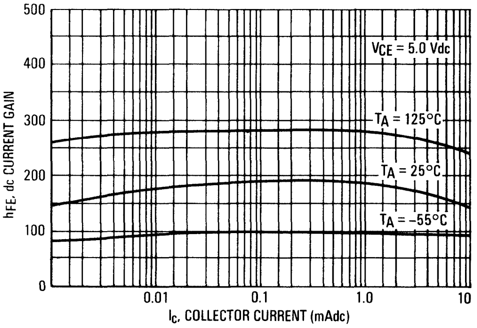
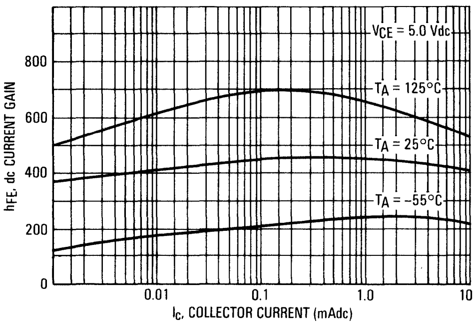
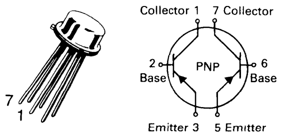


FIGURE 4b — TYPICAL CURRENT GAIN CHARACTERISTICS — 2N3799



2N3806, A
thru
2N3811, A

CASE 654-07, STYLE 1



2N3810, 2N3811 — JAN, JTX, JTXV AVAILABLE

DUAL AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	Both Die	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 500 2.86	 600 3.43	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)			—	0.01	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)			—	10	
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 1.0 μAdc, V_{CE} = 5.0 Vdc)	2N3807,9,11,A		75	—	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	2N3806,8,10,A		100	—	
	2N3807,9,11,A		225	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N3806,8,10,A		150	450	
	2N3807,9,11,A		300	900	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	2N3806,8,10,A		75	—	
	2N3807,9,11,A		150	—	
(I_C = 500 μAdc, V_{CE} = 5.0 Vdc)	2N3806,8,10,A		150	450	
	2N3807,9,11,A		300	900	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N3806,8,10,A		150	450	
	2N3807,9,11,A		300	900	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N3806,8,10,A		125	—	
	2N3807,9,11,A		250	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 100 μAdc, I_B = 1.0 μA)			—	0.2	
(I_C = 1.0 mAdc, I_B = 100 μAdc)			—	0.25	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$			Vdc
(I_C = 100 μAdc, I_B = 10 μAdc)			—	0.7	
(I_C = 1.0 mAdc, I_B = 100 μAdc)			—	0.8	

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

Characteristic		Symbol	Min	Max	Unit
Base-Emitter On Voltage (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	—	0.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 30 MHz)			30	—	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)			100	500	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	8.0	pF
Input Impedance		h_{ie}			kΩ
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3806,8,10,A		3.0	30	
	2N3807,9,11,A		10	40	
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{re}	—	25	X 10^{-4}
Small-Signal Current Gain		h_{fe}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3806,8,10,A		150	600	
	2N3807,9,11,A		300	900	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	5.0	60	μmhos
Noise Figure		NF			dB
(I_C = 100 μAdc, V_{CE} = 10 Vdc, R_G = 3.0 kohms					
f = 100 Hz, BW = 20 Hz	2N3806,8,10,A		—	7.0	
	2N3807,9,11,A		—	4.0	
Spot Noise f = 1.0 kHz, BW = 200 Hz	2N3806,8,10,A		—	3.0	
	2N3807,9,11,A		—	1.5	
f = 10 kHz, BW = 2.0 kHz)	2N3806,8,10,A		—	2.5	
	2N3807,9,11,A		—	1.5	
Broadband Noise Bandwidth	2N3806,8,10,A		—	3.5	
10 Hz to 15.7 kHz	2N3807,9,11,A		—	2.5	
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(2)		h_{FE1}/h_{FE2}			—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N3808,9		0.8	1.0	
	2N3810,11		0.9	1.0	
	2N3810A,11A		0.95	1.0	
(I_C = 100 μAdc, V_{CE} = 50 Vdc, T_A = −55 to +125°C)	2N3810A,11A		0.85	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$			mVdc
(I_C = 10 μAdc to 10 mAdc, V_{CE} = 5.0 Vdc)	2N3808,9		—	8.0	
	2N3810,A,11,A		—	5.0	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N3808,9		—	5.0	
	2N3810,11		—	3.0	
	2N3810A,11A		—	1.5	
Base-Emitter Voltage Differential Change Due to Temperature		$\Delta(V_{BE1}-V_{BE2})$			mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +25°C)	2N3808,9		—	1.6	
	2N3810,11		—	0.8	
	2N3810A,11A		—	0.4	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = +25 to +125°C)	2N3808,9		—	2.0	
	2N3810,11		—	1.0	
	2N3810A,11A		—	0.5	

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

(2) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

FIGURE 1 — DC CURRENT GAIN versus COLLECTOR CURRENT

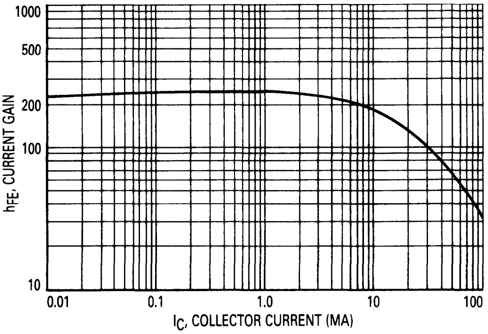


FIGURE 2 — DC CURRENT GAIN versus COLLECTOR CURRENT

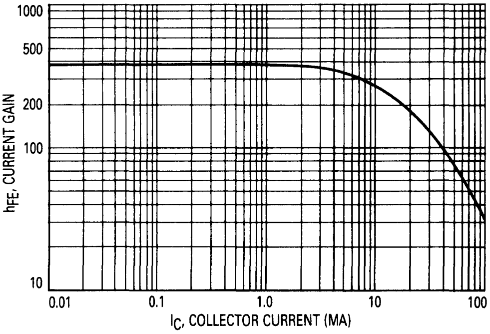


FIGURE 3 — "ON" VOLTAGES

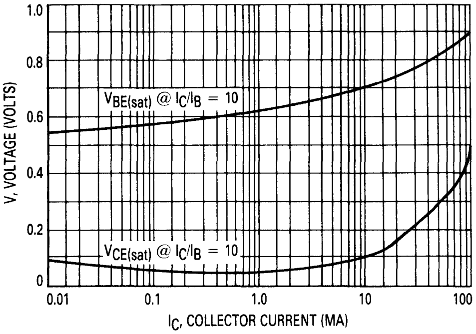
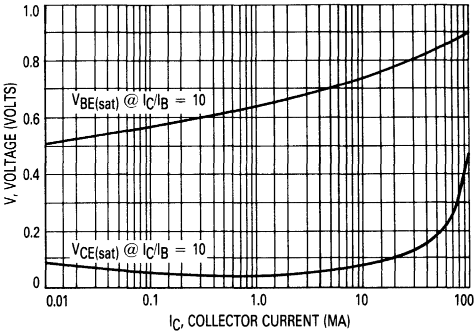
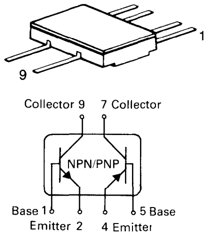


FIGURE 4 — "ON" VOLTAGES



2N3838

CASE 610A-04, STYLE 1



COMPLEMENTARY DUAL AMPLIFIER TRANSISTORS

NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector 1 to Collector 2 Voltage Voltage Rating any Lead to Case	V_{C1C2}	±120 ±120		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.25 1.67	0.35 2.34	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.7 4.67	1.4 9.34	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

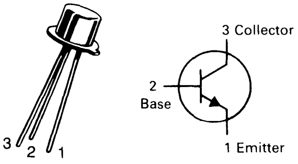
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Emitter Nonmatching Voltage ($I_{C(on)} = 600$ mAdc, $I_{B(on)} = 120$ mAdc, $I_{B(off)} = 0$)	$V_{CEO(NL)}$†	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current ($V_{CE} = 50$ Vdc, $V_{BE(off)} = 0.5$ Vdc)	I_{BEV}	—	10	nAdc
Collector Cutoff Current ($V_{CE} = 50$ Vdc, $V_{BE(off)} = 0.5$ Vdc)	I_{CEV}	—	0.01	μAdc
($V_{CE} = 50$ Vdc, $V_{BE(off)} = 0.5$ Vdc, $T_A = 150°C$)		—	10	
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	35	—	—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)		50	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1)		75	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)		100	300	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1)		50	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	0.85	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	200	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	8.0	pF
Input Impedance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ie}	1.6	9.0	kohms
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	60	300	—
Output Admittance ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{oe}	—	50	μmho
Noise Figure ($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc, $R_S = 1.0$ kohm, f = 1.0 kHz)	NF	—	8.0	dB
SWITCHING CHARACTERISTICS				
Delay Time ($V_{CC} = 10$ Vdc, $V_{BE(off)} = 0$ Vdc, $I_C = 150$ mAdc, $I_{B1} = 15$ mAdc)	t_d	—	10	ns
Rise Time	t_r	—	40	ns
Storage Time ($V_{CC} = 10$ Vdc, $I_C = 150$ mAdc, $I_{B1} = I_{B2} = 15$ mAdc)	t_s	—	250	ns
Fall Time	t_f	—	90	ns

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

† The highest value of collector supply voltage that may be safely used with a resistive load switching circuit in which the collector current is 600 mAdc.

2N3946
2N3947

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.15	°C/mW
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.49	°C/mW

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 40 Vdc, V_{OB} = 3.0 Vdc) (V_{CE} = 40 Vdc, V_{OB} = 3.0 Vdc, T_A = 150°C)	I_{CEX}	 — —	 0.010 15	μAdc
Base Cutoff Current (V_{CE} = 40 Vdc, V_{OB} = 3.0 Vdc)	I_{BL}	—	.025	μAdc
ON CHARACTERISTICS				
DC Current Gain(1)	h_{FE}			—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) 2N3946		30	—	
2N3947		60	—	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) 2N3946		45	—	
2N3947		90	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc) 2N3946		50	150	
2N3947		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc) 2N3946		20	—	
2N3947		40	—	
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	 — —	 0.2 0.3	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	 0.6 —	 0.9 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product	f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz) 2N3946		250	—	
2N3947		300	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.0	pF

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

Characteristic		Symbol	Min	Max	Unit
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3946	h_{ie}	0.5	6.0	kohms
	2N3947		2.0	12	
Voltage Feedback Ratio (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3946	h_{re}	—	10	X 10^{-4}
	2N3947		—	20	
Small Signal Current Gain (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3946	h_{fe}	50	250	—
	2N3947		100	700	
Output Admittance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)	2N3946	h_{oe}	1.0	30	μmhos
	2N3947		5.0	50	
Collector Base Time Constant (I_C = 10 mA, V_{CE} = 20 V, f = 31.8 MHz)		$r_b'C_c$	—	200	ps
Noise Figure (I_C = 100 μA, V_{CE} = 5.0 V, R_g = 1.0 kΩ, f = 10 Hz to 15.7 kHz)		NF	—	5.0	dB

SWITCHING CHARACTERISTICS

Delay Time	V_{CC} = 3.0 Vdc, V_{OB} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mA		t_d	—	35	ns
Rise Time			t_r	—	35	ns
Storage Time	V_{CC} = 3.0 V, I_C = 10 mA,	2N3946	t_s	—	300	ns
		2N3947		—	375	
Fall Time	I_{B1} = I_{B2} = 1.0 mAdc		t_f	—	75	ns

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2%.

TYPICAL SWITCHING CHARACTERISTICS

(T_A = 25°C unless otherwise noted)

FIGURE 1 — DELAY AND RISE TIME

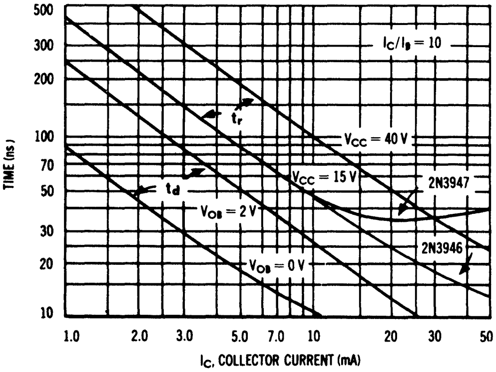


FIGURE 2 — RISE TIME

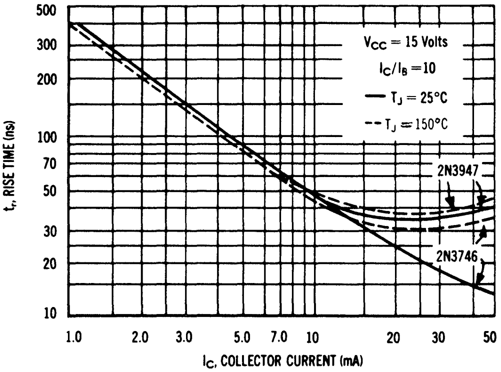


FIGURE 3 — STORAGE AND FALL TIMES

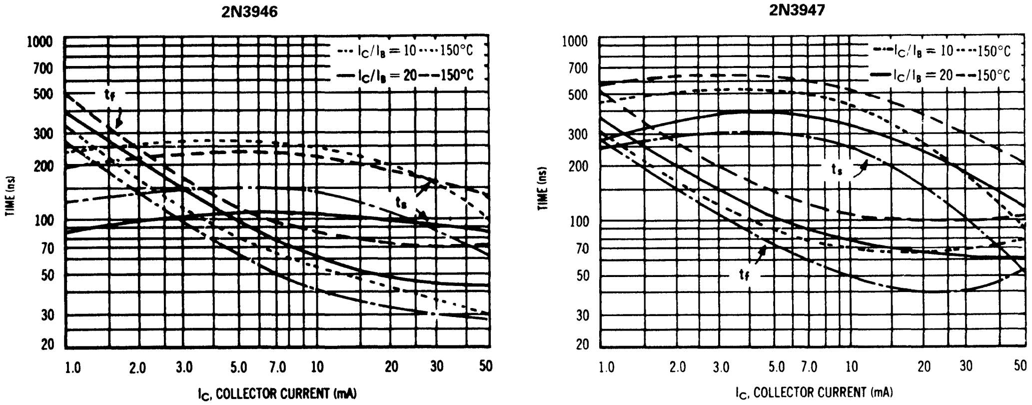


FIGURE 4 — TURN-ON TIME EQUIVALENT TEST CIRCUIT

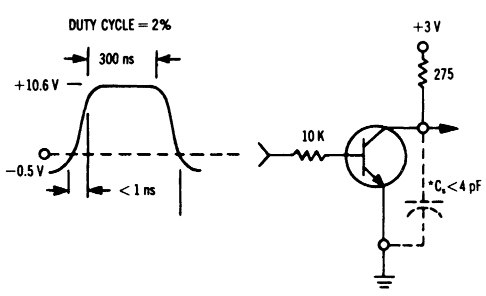
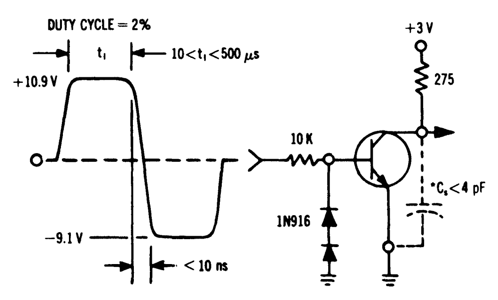


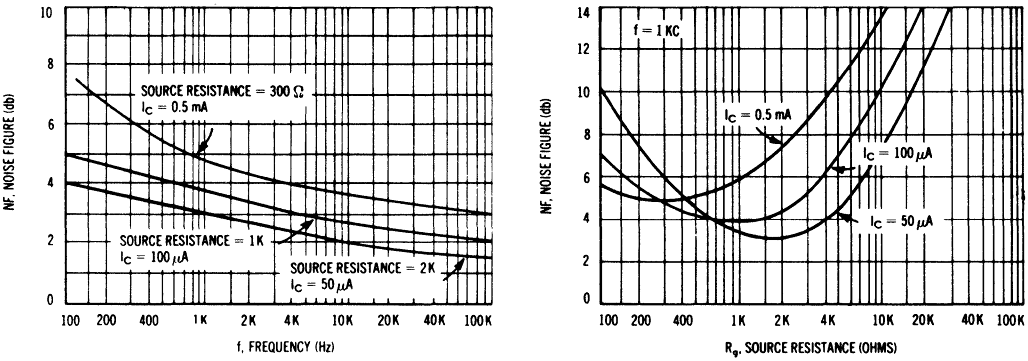
FIGURE 5 — TURN-OFF TIME EQUIVALENT TEST CIRCUIT



*TOTAL SHUNT CAPACITANCE OF TEST JIG AND CONNECTORS

AUDIO SMALL-SIGNAL CHARACTERISTICS

FIGURE 6 — NOISE FIGURE VARIATIONS
V_{CE} = 5.0 V, T_A = 25°C



h PARAMETERS
V_{CE} = 10 V, T_A = 25°C, f = 1.0 kc

FIGURE 7 — CURRENT GAIN

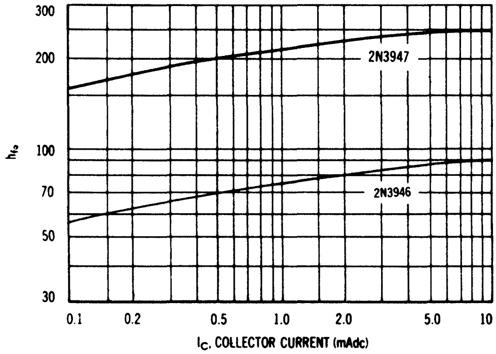


FIGURE 8 — OUTPUT CAPACITANCE

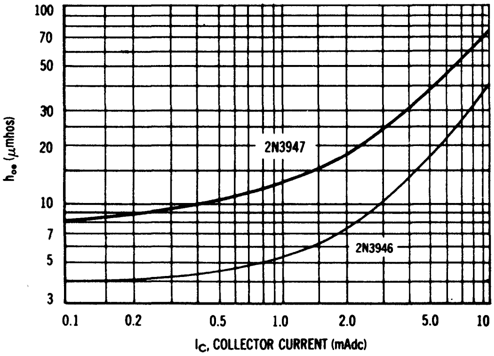


FIGURE 9 — INPUT IMPEDANCE

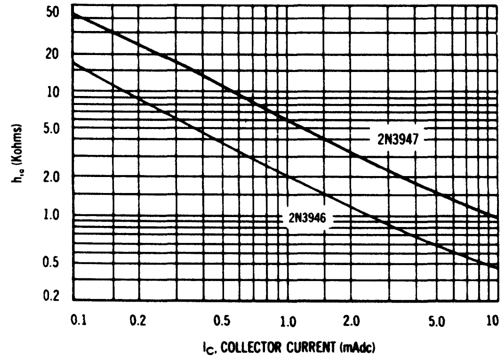


FIGURE 10 — VOLTAGE FEEDBACK RATIO

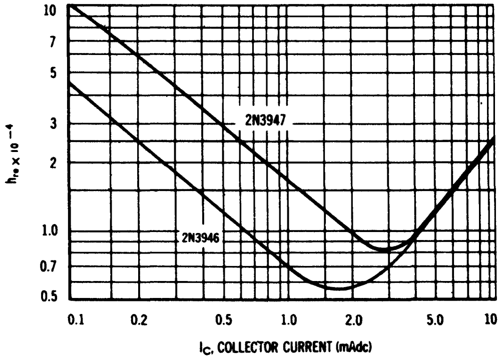
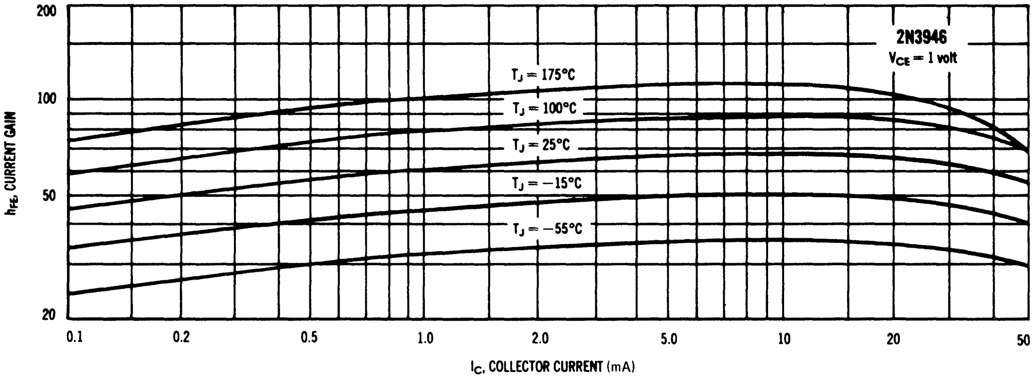


FIGURE 11 — CURRENT GAIN CHARACTERISTICS

2N3946



2N3947

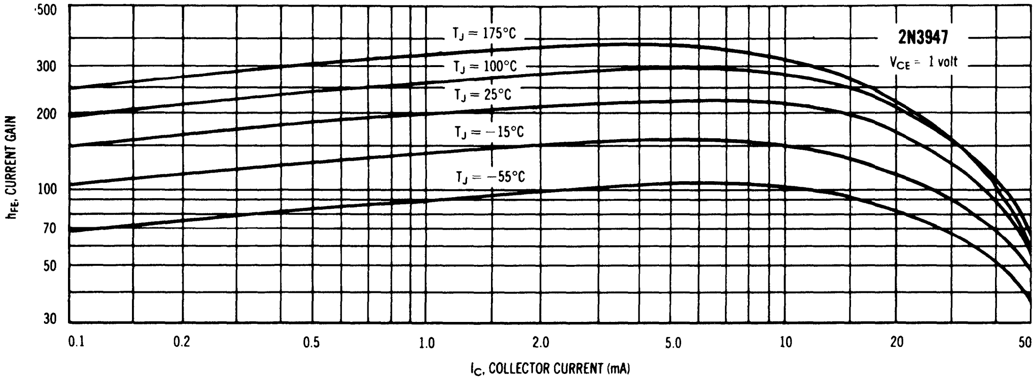


FIGURE 12 — CAPACITANCE

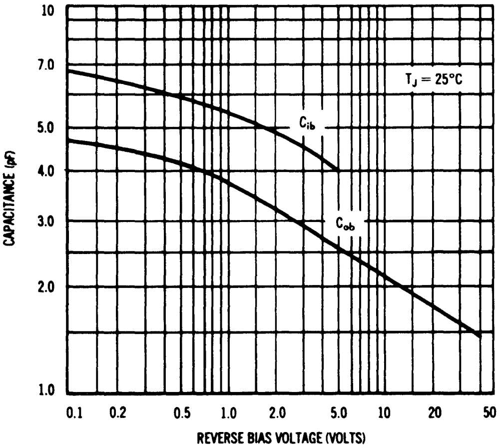


FIGURE 13 — CHARGE DATA

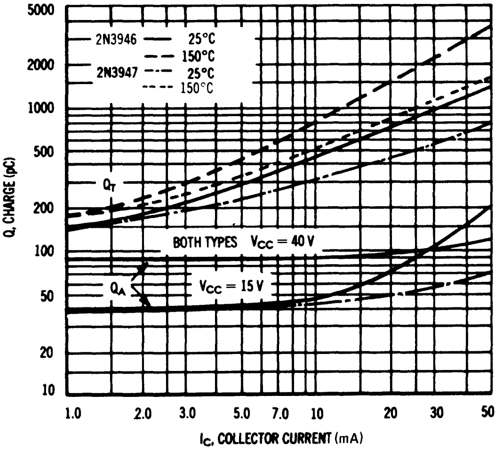
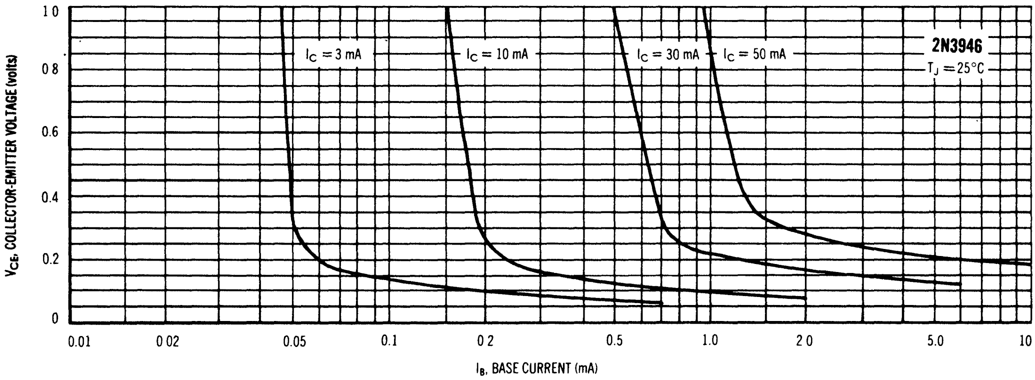


FIGURE 14 — COLLECTOR SATURATION REGION

2N3946



2N3947

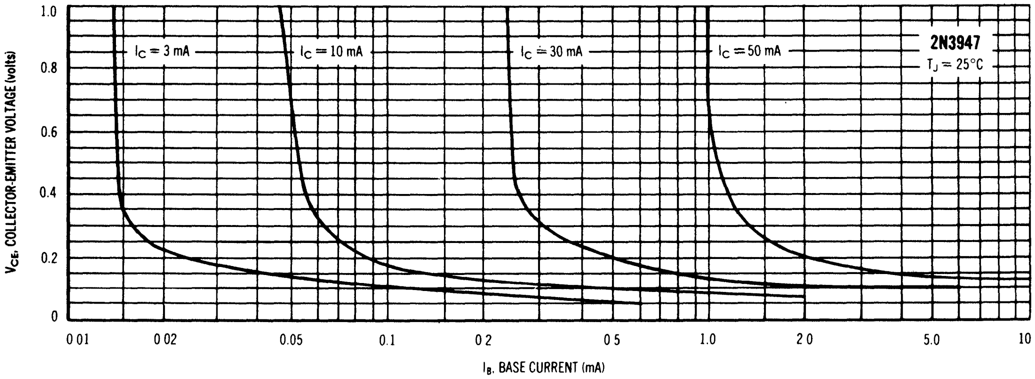


FIGURE 15 — "ON" VOLTAGES

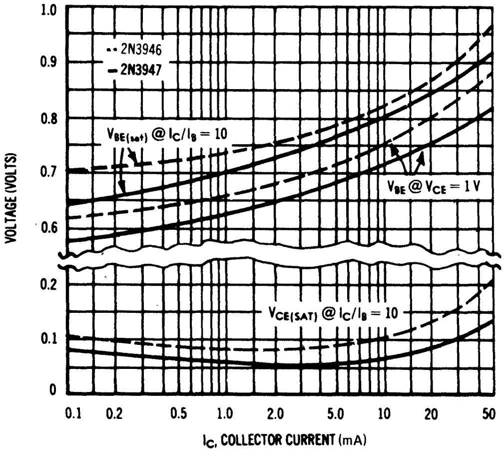
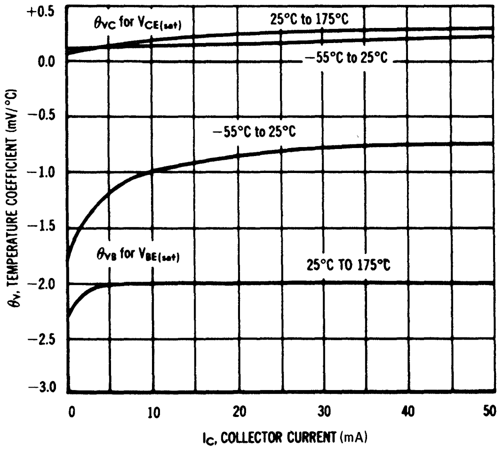
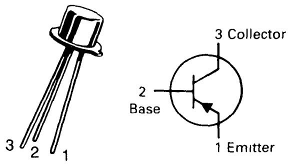


FIGURE 16 — TEMPERATURE COEFFICIENTS



2N3962
thru
2N3965

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N3798 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N3962 2N3965	2N3964	2N3963	Unit
Collector-Emitter Voltage	V_{CEO}	60	45	80	V
Collector-Base Voltage	V_{CBO}	60	45	80	V
Emitter-Base Voltage	V_{EBO}	6.0			V
Collector Current — Continuous	I_C	200			mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 0.36 2.06			 Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.2 6.85			 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
($I_C = 5.0$ mA)	2N3962, 2N3965		60	—	
	2N3963		80	—	
	2N3964		45	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$			Vdc
($I_C = 10$ μA)	2N3962, 2N3965		60	—	
	2N3963		80	—	
	2N3964		45	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 10$ μA)	2N3962, 2N3965		60	—	
	2N3963		80	—	
	2N3964		45	—	
Emitter-Base Breakdown Voltage ($I_C = 10$ μA)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
($V_{CE} = 50$ V; 2N3964 = 40 V)	2N3965, 2N3962		—	10	
($V_{CE} = 70$ V)	2N3963		—	10	
Collector Cutoff Current		I_{CES}			nAdc
($V_{CE} = 50$ V)	2N3962		—	10	
($V_{CE} = 70$ V)	2N3963		—	10	
($V_{CE} = 40$ V)	2N3964		—	10	
($V_{CE} = 50$ V)	2N3965		—	10	
Emitter Cutoff Current ($V_{EB} = 4.0$ V)		I_{EBO}	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
($I_C = 10$ μA, $V_{CE} = 5.0$ V)	2N3962, 2N3963		100	300	
	2N3964, 2N3965		250	500	
($I_C = 100$ μA, $V_{CE} = 5.0$ V)	2N3962, 2N3963		100	—	
	2N3964, 2N3965		250	—	
($I_C = 1.0$ mA, $V_{CE} = 5.0$)	2N3962, 2N3963		100	450	
	2N3964, 2N3965		250	600	
($I_C = 10$ μA, $V_{CE} = 5.0$, $T_A = -55°C$)	2N3962, 2N3963		40	—	
	2N3964, 2N3965		100	—	

(continued)

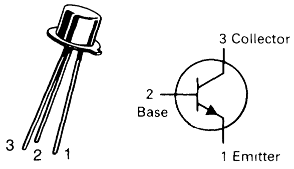
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
DC Current Gain(1) continued				
(I_C = 1.0 mA, V_{CE} = 5.0 V, T_A = 100°C) 2N3962, 2N3963		—	600	
2N3964, 2N3965		—	800	
(I_C = 1.0 μA, V_{CE} = 5.0 V) 2N3962, 2N3963		60	—	
2N3964, 2N3965		180	—	
(I_C = 10 mA, V_{CE} = 5.0 V) 2N3962, 2N3963		100	—	
2N3964, 2N3965		200	—	
(I_C = 50 mA, V_{CE} = 5.0 V) 2N3962, 2N3963		90	—	
2N3964, 2N3965		180	—	
(I_C = 50 mA, V_{CE} = 5.0 V, T_A = −55°C) 2N3962, 2N3963		45	—	
2N3964, 2N3965		90	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			
(I_C = 10 mA, I_B = 0.5 mA)		—	0.25	V
(I_C = 50 mA, I_B = 5.0 mA)(1)		—	0.4	V
Base-Emitter Saturation Voltage	$V_{BE(sat)}$			
(I_C = 10 mA, I_B = 0.5 mA)		—	0.9	V
(I_C = 50 mA, I_B = 5.0 mA)(1)		—	0.95	V
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 5.0 V, f = 1.0 MHz)	C_{obo}	—	6.0	pF
Input Capacitance (V_{EB} = 0.5 V, f = 1.0 MHz)	C_{ibo}	—	15	pF
Input Impedance	h_{ie}			kΩ
(I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz) 2N3962, 2N3963		2.5	17	
2N3964, 2N3965		6.0	20	
Voltage Feedback Ratio (I_C = 1.0 mA, V_{CE} = 5.0, f = 1.0 kHz)	h_{re}	—	10	10^{-4}
Small-Signal Current Gain	h_{fe}			
(I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz) 2N3962, 2N3963		100	550	—
2N3964, 2N3965		250	700	—
Magnitude of Forward Current Transfer Ratio, Common-Emitter	$\lvert h_{fe} \rvert$			
(I_C = 0.5 mA, V_{CE} = 5.0 V, f = 20 MHz) 2N3962, 2N3963		2.0	8.0	—
2N3964, 2N3965		2.5	8.0	—
Output Admittance	h_{oe}			μmhos
(I_C = 1.0 mA, V_{CE} = 5.0, f = 1.0 kHz) 2N3962, 2N3963		5.0	40	
2N3964, 2N3965		5.0	50	
Noise Figure	NF			dB
(I_C = 20 mA, V_{CE} = 5.0 V, BW = 15.7 kHz) 2N3962, 2N3963		—	3	
2N3964, 2N3965		—	2	
(I_C = 20 μA, V_{CE} = 5.0 V, BW = 1.5 kHz, 2N3962, 2N3963		—	3	
f = 10 kHz, R_S = 10 kΩ) 2N3964, 2N3965		—	2	
(I_C = 20 μA, V_{CE} = 5.0 V, BW = 150 Hz, 2N3962, 2N3963		—	3	
f = 1.0 kHz, R_S = 10 kΩ) 2N3964, 2N3965		—	2	
(I_C = 20 μA, V_{CE} = 5.0 V, BW = 15 Hz, 2N3962, 2N3963		—	10	
f = 100 Hz, R_S = 10 kΩ) 2N3964, 2N3965		—	4	
(I_C = 20 μA, V_{CE} = 5.0 V, BW = 2.0 Hz, 2N3964, 2N3965 f = 10 Hz, R_S = 10 kΩ)		—	8	

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2%.

2N4013
2N4014

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4013	2N4014	Unit
Collector-Emitter Voltage	V_{CEO}	30	50	Vdc
Collector-Base Voltage	V_{CBO}	50	80	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous — Peak	I_C	1.0 2.0		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.5 28.6		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.4 6.8		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$				Vdc
(I_C = 10 mAdc, I_B = 0)	2N4014		50	—	—	
	2N4013		30	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 μAdc, V_{BE} = 0)	2N4014		80	—	—	
	2N4013		50	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 10 μAdc, I_E = 0)	2N4014		80	—	—	
	2N4013		50	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				μAdc
(V_{CB} = 60 Vdc, I_E = 0)	2N4014		—	0.12	1.7	
(V_{CB} = 40 Vdc, I_E = 0)	2N4013		—	0.12	1.7	
(V_{CB} = 60 Vdc, I_E = 0, T_A = 100°C)	2N4014		—	—	120	
(V_{CB} = 40 Vdc, I_E = 0, T_A = 100°C)	2N4013		—	—	120	
Collector Cutoff Current		I_{CES}				μAdc
(V_{CE} = 80 Vdc, V_{EB} = 0)	2N4014		—	0.15	10	
(V_{CE} = 50 Vdc, V_{EB} = 0)	2N4013		—	0.15	10	
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			30	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			60	—	150	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			30	—	—	
(I_C = 300 mAdc, V_{CE} = 1.0 Vdc)			40	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			35	—	—	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)			20	—	—	
(I_C = 800 mAdc, V_{CE} = 2.0 Vdc)	2N4014		20			
	2N4013		25	—	—	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	2N4014		25			
	2N4013		30	—	—	

(continued)

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

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N4014		—	0.17	0.25	
	2N4013		—	0.17	0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)	2N4014		—	0.19	0.26	
	2N4013		—	0.19	0.20	
(I_C = 300 mAdc, I_B = 30 mAdc)	2N4014		—	0.25	0.40	
	2N4013		—	0.25	0.32	
(I_C = 500 mAdc, I_B = 50 mAdc)	2N4014		—	0.30	0.52	
	2N4013		—	0.30	0.42	
(I_C = 800 mAdc, I_B = 80 mAdc)	2N4014		—	0.43	0.80	
	2N4013		—	0.43	0.65	
(I_C = 1.0 Adc, I_B = 100 mAdc)	2N4014		—	0.55	0.95	
	2N4013		—	0.55	0.75	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	—	0.76	
(I_C = 100 mAdc, I_B = 10 mAdc)			—	—	0.86	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.1	
(I_C = 500 mAdc, I_B = 50 mAdc)			0.8	—	1.1	
(I_C = 800 mAdc, I_B = 80 mAdc)			—	—	1.5	
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	—	1.7	

SMALL-SIGNAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	300	—	—	MHz
Output Capacitance		C_{obo}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	2N4014		—	—	10	
	2N4013		—	—	12	
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	—	55	pF

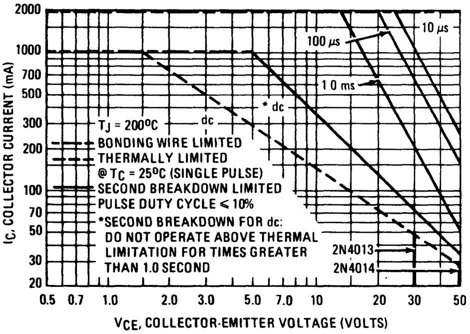
SWITCHING CHARACTERISTICS

Characteristic	Conditions		Symbol	Min	Typ	Max	Unit
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) (Figures 8, 10)		t_d	—	5.0	10	ns
Rise Time			t_r	—	15	30	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc) (Figures 9, 10)	2N4014 2N4013	t_s	—	30	50	ns
Fall Time			t_f	—	20 25	25 30	ns
Turn-On Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 3.8 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc) (Figures 8, 10)		t_{on}	—	20	35	ns
Turn-Off Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc) (Figures 9, 10)	2N4014 2N4013	t_{off}	—	50	60	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 1.0%.

(2) $f_T = |h_{fe}| \cdot f_{test}$.

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



TYPICAL DC CHARACTERISTICS

FIGURE 2 – DC CURRENT GAIN

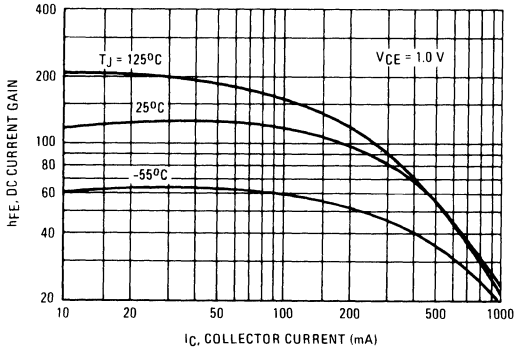


FIGURE 3 – "ON" VOLTAGES

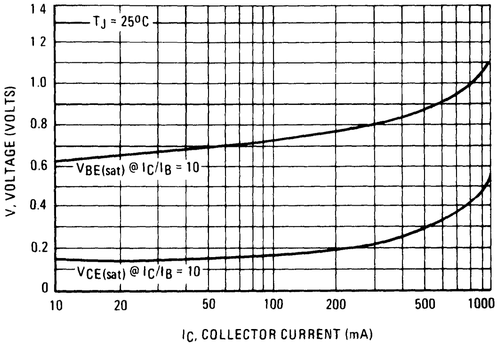


FIGURE 4 – COLLECTOR SATURATION REGION

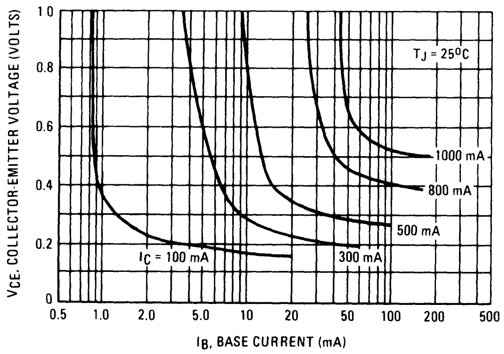
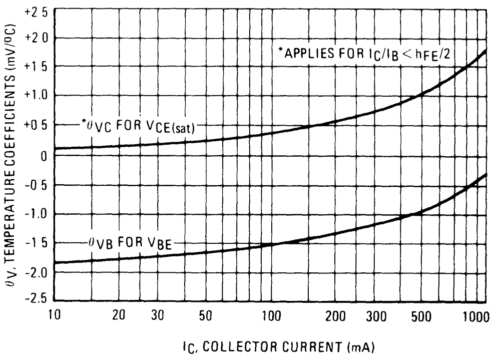


FIGURE 5 – TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 6 – CURRENT-GAIN – BANDWIDTH PRODUCT

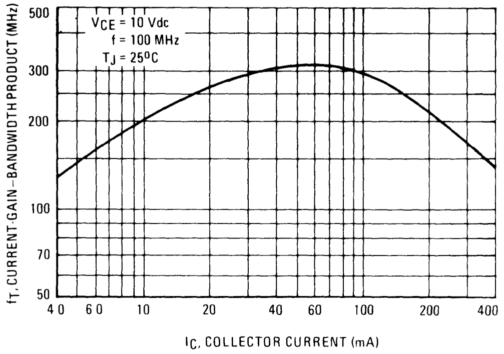


FIGURE 7 – CAPACITANCE

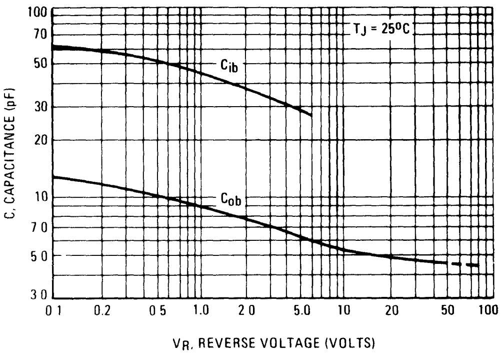


FIGURE 8 — TURN-ON TIME

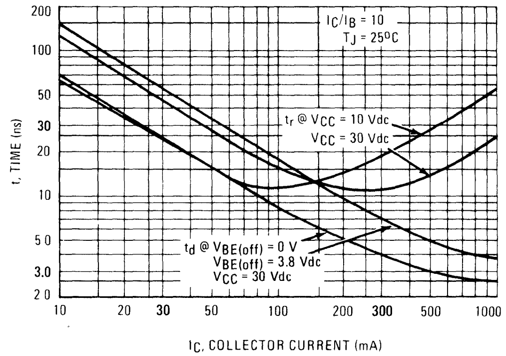


FIGURE 9 — TURN-OFF TIME

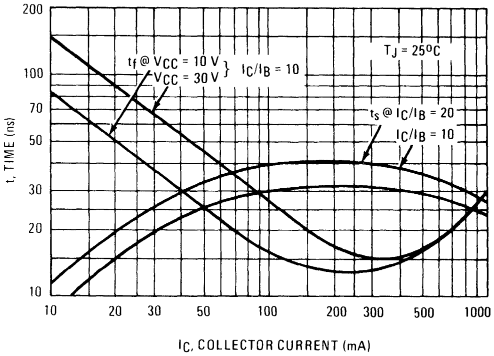
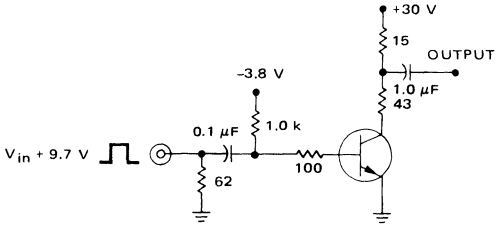
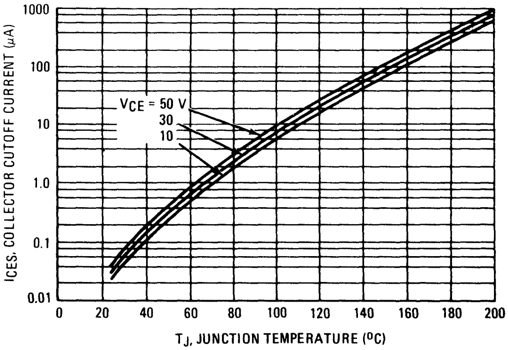


FIGURE 10 — SWITCHING TIME TEST CIRCUIT



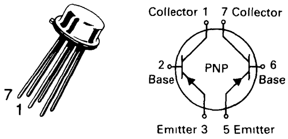
$t_r \leq 1.0$ ns
PW ≥ 200 ns
Duty Cycle ≤ 2.0%
Generator Source Impedance = 50 Ω
Pulse Generator EH1421 Timing Unit and 1121 Pulse Driver
Oscilloscope Tektronix 661 Sampling Scope

FIGURE 11 — COLLECTOR CUTOFF CURRENT



2N4015
2N4016

CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector 1 to Collector 2 Voltage Voltage Rating and Lead to Case	V_{C1C2}	±200 ±200		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Base Current	I_B	100		mAdc
Collector Current — Continuous	I_C	300		mAdc
		One Die	Both Die	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	400 2.29	500 2.86	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	0.85 4.85	1.4 8.0	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

Refer to MD2905,A for graphs.

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

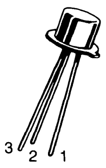
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current	I_{CBO}			
(V_{CB} = 50 Vdc, I_E = 0)		—	10	nAdc
(V_{CB} = 50 Vdc, I_E = 0, T_A = +150°C)		—	10	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 0.01 mAdc, V_{CE} = 5.0 Vdc)		80	—	
(I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)		120	—	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		135	350	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)(1)		115	—	
Collector-Emitter Saturation Voltage(1) (I_C = 50 mAdc, I_B = 2.5 mAdc)	$V_{CE(sat)}$	—	0.25	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 50 mAdc, V_{CE} = 2.5 Vdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2)	f_T			MHz
(I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		200	600	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		60	—	
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	25	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	—	11.5	kohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	—	15	$X\ 10^{-4}$
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	135	420	—

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

Characteristic		Symbol	Min	Max	Unit
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	—	80	μmhos
Noise Figure (I_C = 0.03 mAdc, V_{CE} = 5.0 Vdc, R_S = 10 kohms, f = 1.0 kHz, BW = 200 Hz)		NF	—	4.0	dB
MATCHING CHARACTERISTICS					
DC Current Gain Ratio (I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc)		h_{FE1}/h_{FE2}	0.9	1.0	—
Base-Emitter Voltage Differential (I_C = 0.1 to 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N4015	$\lvert V_{BE1}-V_{BE2}\rvert$	—	5.0	mVdc
	2N4016		—	2.5	
Base-Emitter Voltage Differential Gradient (I_C = 0.1 to 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +25°C)	2N4015	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	—	1.6	mVdc
	2N4016		—	0.8	
(I_C = 0.1 to 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = +25°C to +125°C)	2N4015		—	2.0	
	2N4016		—	1.0	

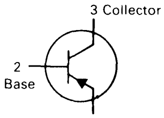
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

2N4026 thru 2N4029



CASE 22-03, STYLE 1
TO-18 (TO-206AA)

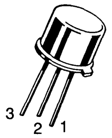
2N4030 thru 2N4033



CASE 79-04, STYLE 1
TO-39 (TO-205AD)
AVAILABLE IN
JAN, JTX, JTXV

GENERAL PURPOSE TRANSISTORS

PNP SILICON



Refer to 2N4404 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N4026/28 2N4030/32	2N4027/29 2N4031/33	Unit
Collector-Emitter Voltage(1)	V_{CEO}	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	5.0	Vdc
		2N4026-2N4029	2N4030-2N4033	
Collector Current — Continuous	I_C	1.0	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	.5 2.85	1.25 7.15	W mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.0 11.4	7.0 40	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Lead or Terminal Temperature(2)	T_L	+300		°C

(1) Applicable 0 to 10 mA

(2) Measured at a distance not less than 1/16″ from seated surface (or case) for 60 Sec.

THERMAL CHARACTERISTICS

Characteristic	Symbol	TO-18	TO-39	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	20	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	280	140	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			V
(I_C = 10 mA)	2N4026,28,30,32		60	—	
	2N4027,29,31,33		80	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			V
(I_C = 10 μA)	2N4026,28,30,32		60	—	
	2N4027,29,31,33		80	—	
Emitter-Base Breakdown Voltage (I_E = 10 μA)		$V_{(BR)EBO}$	5.0	—	V
Collector Cutoff Current		I_{CBO}			nA
(V_{CB} = 50 V)	2N4026,28,30,32		—	50	
(V_{CB} = 60 V)	2N4027,29,31,33		—	50	
(V_{CB} = 50 V, T_A = 150°C)	2N4026,28,30,32		—	50	μA
(V_{CB} = 60 V, T_A = 150°C)	2N4027,29,31,33		—	50	
Emitter Cutoff Current (V_{EB} = 5.0 V)		I_{EBO}	—	10	μA
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 100 mA, V_{CE} = 5.0 V, @ −55°C)	2N4026,27,30,31		15	—	
	2N4028,29,32,33		40	—	
(I_C = 100 μA, V_{CE} = 5.0 V)	2N4026,27,30,31		30	—	
	2N4028,29,32,33		75	—	
(I_C = 100 mA, V_{CE} = 5.0 V)	2N4026,27,30,31		40	120	
	2N4028,29,32,33		100	300	
(I_C = 500 mA, V_{CE} = 5.0 V)	2N4026,27,30,31		25	—	
	2N4028,29,32,33		70	—	
(I_C = 1.0 A, V_{CE} = 5.0 V)	2N4026,30		15	—	
	2N4027,31		10	—	
	2N4028,32		40	—	
	2N4029,33		25	—	

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

Characteristic	Symbol	Min	Max	Unit
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)		—	0.15	
(I_C = 500 mA, I_B = 50 mA)		—	0.50	
(I_C = 1.0 A, I_B = 100 mA) 2N4026,28,30,32		—	1.0	
Base-Emitter Saturation Voltage (I_C = 150 mA, I_B = 15 mA)	$V_{BE(sat)}$	—	0.9	V
Base-Emitter On Voltage	$V_{BE(on)}$			V
(I_C = 1.0 A, V_{CE} = 1.0 V) 2N4026,28,30,32		—	1.2	
(I_C = 500 mA, V_{CE} = 0.5 V)		—	1.1	

SMALL-SIGNAL CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Output Capacitance (V_{CE} = 10 V, f = 1.0 MHz)	C_{obo}	—	20	pF
Input Capacitance (V_{EB} = 0.5 V, f = 1.0 MHz)	C_{ibo}	—	110	pF
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10 V, f = 100 MHz)	h_{fe}	1.0	4.0	—

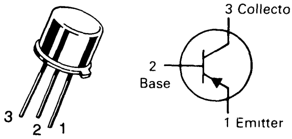
SWITCHING CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Storage Time (I_C = 500 mA, I_{B1} = I_{B2} = 50 mA)	t_s	—	350	ns
Turn-On Time (I_C = 500 mA, I_{B1} = 50 mA)	t_{on}	—	100	ns
Fall Time (I_C = 500 mA, I_{B1} = I_{B2} = 50 mA)	t_f	—	50	ns

(3) Pulse Width = 300 μs, Duty Cycle 1.0%.

2N4036
2N4037

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4036	2N4037	Unit
Collector-Emitter Voltage	V_{ECO}	65	40 (sus)(1)	Vdc
Collector-Base Voltage	V_{CBO}	90	60	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	7.0	Vdc
Base Current	I_B	0.5		Adc
Collector Current — Continuous	I_C	1.0		Adc
Continuous Power Dissipation at or Below $T_C = 25°C$ Linear Derating Factor	P_D	 5.0 28.6	 5.0 28.6	 Watts mW/°C
Continuous Power Dissipation at or Below $T_A = 25°C$ Linear Derating Factor	P_D	 1.0 5.72	 1.0 5.72	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Lead Temperature 1/16″ from Case for 10 Seconds	T_L	230		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	2N4036	2N4037	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	35	°C/W

(1) Must not be tested on a curve tracer.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 100$ mAdc, $I_B = 0$)	2N4036 2N4037	$V_{CEO(sus)}$	65 40	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc)	2N4037	$V_{(BR)CBO}$	60	—	Vdc
Collector Cutoff Current ($V_{CE} = 85$ V, $V_{BE} = 1.5$ V) ($V_{CE} = 30$ V, $V_{BE} = 1.5$ V, $T_C = 150°C$)	2N4036 2N4037	I_{CEX}	— —	0.1 100	mAdc
Collector Cutoff Current ($V_{CB} = 90$ V, $I_E = 0$) ($V_{CB} = 60$ V, $I_E = 0$)	2N4036 2N4037	I_{CBO}	— —	1.0 0.25	μAdc
Emitter Cutoff Current ($V_{BE} = 7.0$ Vdc, $I_C = 0$) ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	2N4036 2N4037	I_{EBO}	— —	10 1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 150$ mAdc, $V_{CE} = 2.0$ V) ($I_C = 0.1$ mAdc, $V_{CE} = 10$ V) ($I_C = 1.0$ mAdc, $V_{CE} = 10$ V)	2N4036 2N4036 2N4037	h_{FE}	20 20 15	200 — —	—
($I_C = 150$ mAdc, $V_{CE} = 10$ V)	2N4036 2N4037		40 50	140 250	
($I_C = 500$ mAdc, $V_{CE} = 10$ V)	2N4036		20	—	
Collector-Emitter Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	2N4036 2N4037	$V_{CE(sat)}$	— —	0.65 1.4	V
Base-Emitter Saturation Voltage ($I_C = 150$ mA, $I_B = 15$ mA)	2N4036	$V_{BE(sat)}$	—	1.4	V
Base-Emitter On Voltage ($I_C = 150$ mA, $V_{CE} = 10$ V)	2N4037	$V_{BE(on)}$	—	1.5	V
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 10$ V, f = 1.0 MHz)	2N4037	C_{cb}	—	30	pF
Current Gain — High Frequency ($I_C = 50$ mA, $V_{CE} = 10$ V, f = 20 MHz)	2N4036 2N4037	$\|h_{fe}\|$	3.0 3.0	— 10	—
SWITCHING CHARACTERISTICS					
Rise Time ($I_{B1} = 15$ mA)	2N4036	t_r	—	70	ns
Storage Time ($I_{B2} = 15$ mA)	2N4036	t_s	—	600	ns
Fall Time ($I_{B2} = 15$ mA)	2N4036	t_f	—	100	ns
Turn-On Time ($I_{B1} = I_{B2}$)	2N4036	t_{on}	—	110	ns
Turn-Off Time ($I_{B1} = I_{B2}$)	2N4036	t_{off}	—	700	ns

FIGURE 1 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

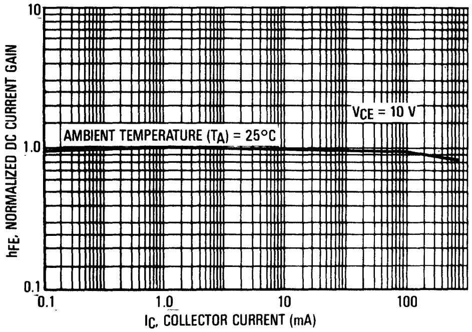


FIGURE 2 — DISSIPATION DERATING CURVE

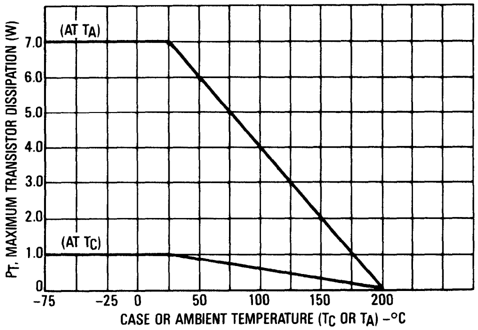


FIGURE 3 — TYPICAL COLLECTOR-CUTOFF CURRENT versus JUNCTION TEMPERATURE

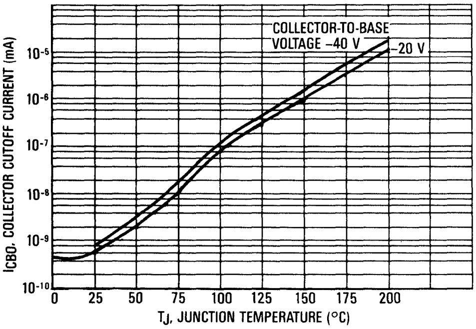


FIGURE 4 — TYPICAL SATURATION-VOLTAGE CHARACTERISTICS

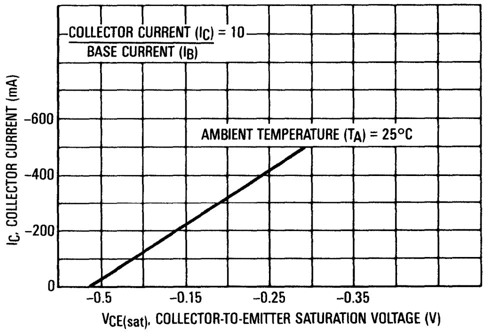


FIGURE 5 — TYPICAL SMALL-SIGNAL BETA CHARACTERISTICS

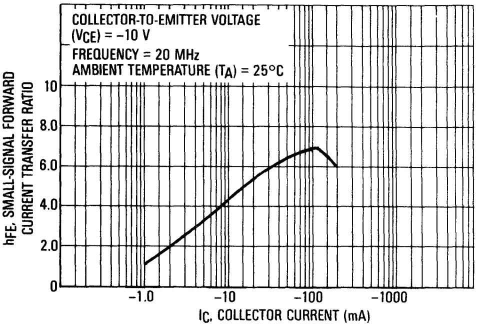
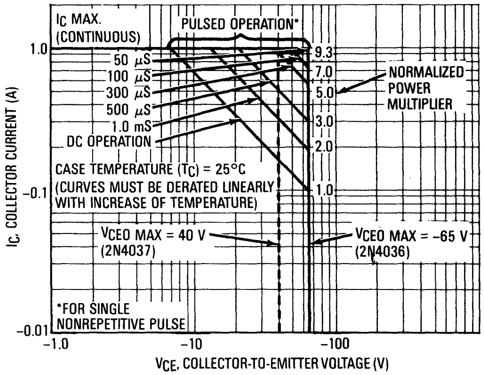
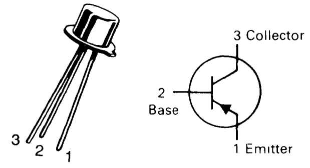


FIGURE 6 — MAXIMUM SAFE OPERATING AREAS (SOA)



2N4208
2N4209

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTORS

PNP SILICON

Refer to MM4257 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N4208	2N4209	Unit
Collector-Emitter Voltage	V_{CEO}	12	15	Vdc
Collector-Base Voltage	V_{CBO}	12	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.9		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 3.0 mAdc, I_B = 0)	2N4208 2N4209	$V_{(BR)CEO}$	12 15	— —	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc, V_{BE} = 0)	2N4208 2N4209	$V_{(BR)CES}$	12 15	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	2N4208 2N4209	$V_{(BR)CBO}$	12 15	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.5	5.9	—	Vdc
Collector Cutoff Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 8.0 Vdc, V_{BE} = 0) (V_{CE} = 6.0 Vdc, V_{BE} = 0, T_A = 125°C) (V_{CE} = 8.0 Vdc, V_{BE} = 0, T_A = 125°C)	2N4208 2N4209 2N4208 2N4209	I_{CES}	— — — —	— — — —	10 10 5.0 5.0	nAdc μAdc
Base Current (V_{CE} = 6.0 Vdc, V_{BE} = 0) (V_{CE} = 8.0 Vdc, V_{BE} = 0)	2N4208 2N4209	I_B	— —	— —	1.0 1.0	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 1.0 mAdc, V_{CE} = 0.5 Vdc)	2N4208 2N4209		15 35	— —	— —	
(I_C = 10 mAdc, V_{CE} = 0.3 Vdc)	2N4208 2N4209		30 50	— —	120 120	
(I_C = 10 mAdc, V_{CE} = 0.3 Vdc, T_A = −55°C)	2N4208 2N4209		12 20	— —	— —	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)(1)	2N4208 2N4209		30 40	— —	— —	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 1.0 mAdc, I_B = 0.1 mAdc)	2N4208 2N4209		— —	— —	0.13 0.15	
(I_C = 10 mAdc, I_B = 1.0 mAdc)	2N4208 2N4209		— —	— —	0.15 0.18	
(I_C = 50 mAdc, I_B = 5.0 mAdc)(1)	2N4208 2N4209		— —	— —	0.5 0.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 1.0 mAdc, I_B = 0.1 mAdc)			—	0.7	0.8	
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.75	0.86	0.90	
(I_C = 50 mAdc, I_B = 5.0 mAdc)(1)			—	1.1	1.5	

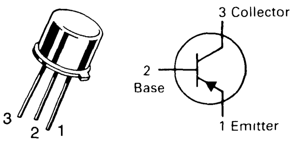
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) 2N4208	f_T	700	1000	—	MHz
2N4209		850	1100	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	2.0	3.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	2.0	3.5	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 1.5 Vdc, V_{BE} = 0, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	10	15	ns
Delay Time	t_d	—	5.0	10	ns
Rise Time	t_r	—	5.0	15	ns
Turn-Off Time (V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc) 2N4208	t_{off}	—	12	15	ns
2N4209		—	16	20	
Storage Time 2N4208	t_s	—	12	15	ns
2N4209		—	17	20	
Fall Time 2N4208	t_f	—	6.0	10	ns
2N4209			8.0	10	
Storage Time (I_C ≈ 10 mAdc, I_{B1} ≈ 10 mAdc, I_{B2} ≈ 10 mAdc) 2N4208	t_s	—	—	15	ns
2N4209		—	—	20	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

2N4234
thru
2N4236

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4234	2N4235	2N4236	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	Vdc
Collector-Base Voltage	V_{CBO}	40	60	80	Vdc
Emitter-Base Voltage	V_{EBO}	7.0			Vdc
Base Current	I_B	0.2			Vdc
Collector Current — Continuous	I_C	1.0 3.0*			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.7			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	6.0 34			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	29	°C/W

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

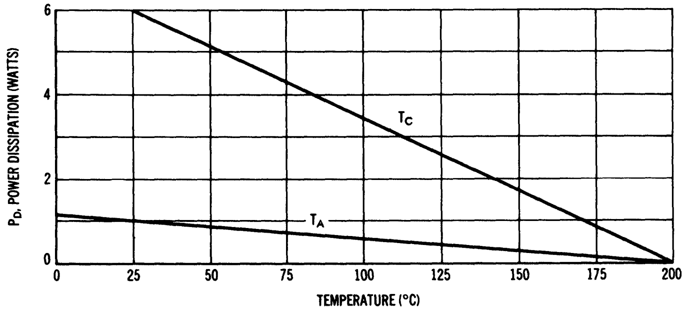
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1) (I_C = 100 mAdc, I_B = 0)	2N4234 2N4235 2N4236	$V_{CEO(sus)}$	40 60 80	— — —	Vdc
Collector Cutoff Current		I_{CEO}			mAdc
(V_{CE} = 30 Vdc, I_B = 0)	2N4234		—	1.0	
(V_{CE} = 40 Vdc, I_B = 0)	2N4235		—	1.0	
(V_{CE} = 60 Vdc, I_B = 0)	2N4236		—	1.0	
Collector Cutoff Current		I_{CEX}			mAdc
(V_{CE} = 40 Vdc, V_{BE} = 1.5 Vdc)	2N4234		—	0.1	
(V_{CE} = 60 Vdc, V_{BE} = 1.5 Vdc)	2N4235		—	0.1	
(V_{CE} = 80 Vdc, V_{BE} = 1.5 Vdc)	2N4236		—	0.1	
(V_{CE} = 30 Vdc, V_{BE} = 1.5 Vdc, T_C = 150°C)	2N4234		—	1.0	
(V_{CE} = 40 Vdc, V_{BE} = 1.5 Vdc, T_C = 150°C)	2N4235		—	1.0	
(V_{CE} = 60 Vdc, V_{BE} = 1.5 Vdc, T_C = 150°C)	2N4236		—	1.0	
Collector Cutoff Current		I_{CBO}			mAdc
(V_{CB} = 40 Vdc, I_E = 0)	2N4234		—	0.1	
(V_{CB} = 60 Vdc, I_E = 0)	2N4235		—	0.1	
(V_{CB} = 80 Vdc, I_E = 0)	2N4236		—	0.1	
Emitter Cutoff Current (V_{BE} = 7 Vdc, I_C = 0)		I_{EBO}	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)			40	—	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			30	150	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			20	—	
(I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)			10	—	
Collector-Emitter Saturation Voltage(1) (I_C = 1.0 Adc, I_B = 125 mAdc)		$V_{CE(sat)}$	—	0.6	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 1.0 Adc, I_B = 100 mAdc)		$V_{BE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage (I_C = 250 mAdc, V_{CE} = 1.0 Vdc)		V_{BE}	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 1.0 MHz)		f_T	3.0	—	MHz

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

Characteristic	Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	100	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	25	—	—

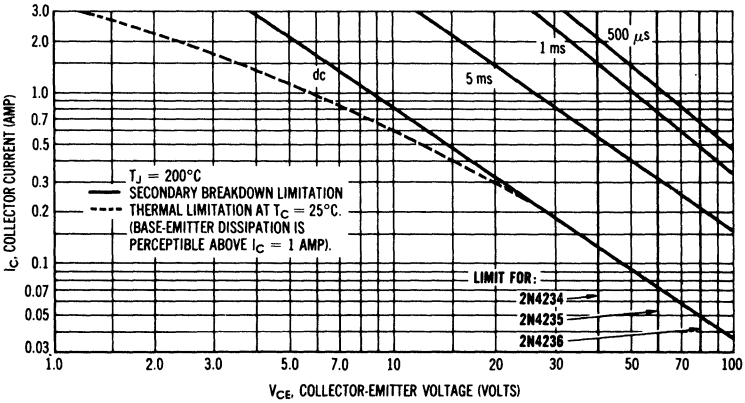
(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Indicates Data in addition to JEDEC Requirements.

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



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

FIGURE 2 — ACTIVE-REGION SAFE OPERATING AREAS



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

LARGE SIGNAL CHARACTERISTICS

FIGURE 3 — TRANSCONDUCTANCE

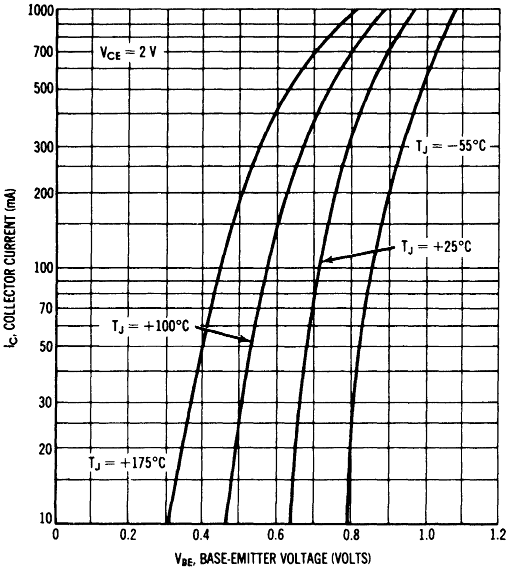
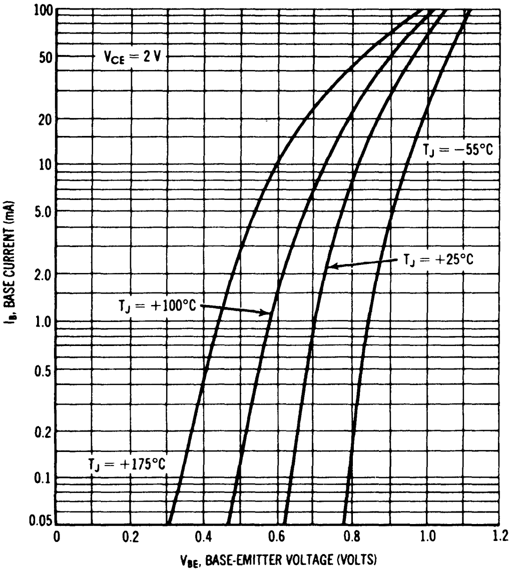


FIGURE 4 — INPUT ADMITTANCE



"OFF" REGION CHARACTERISTICS

FIGURE 5 — TRANSCONDUCTANCE

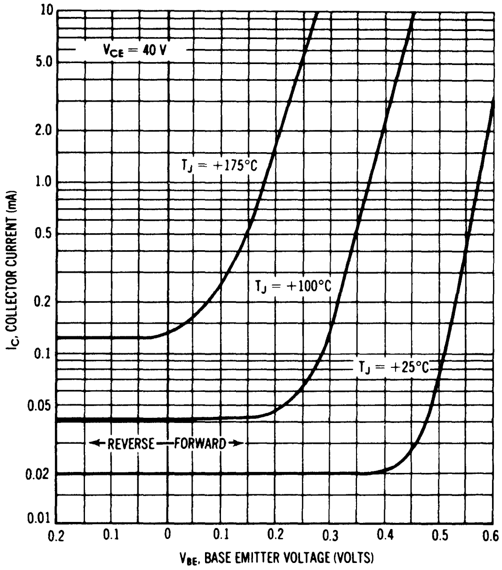


FIGURE 6 — EFFECTS OF BASE-EMITTER RESISTANCE

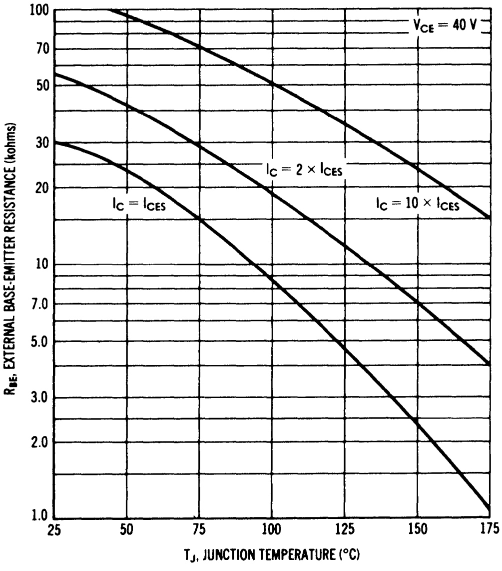
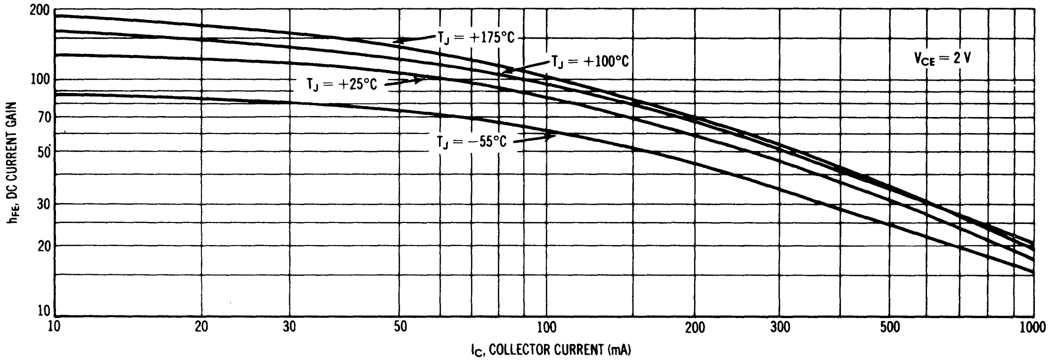


FIGURE 7 — CURRENT GAIN



SATURATION REGION CHARACTERISTICS

FIGURE 8 — COLLECTOR SATURATION REGION

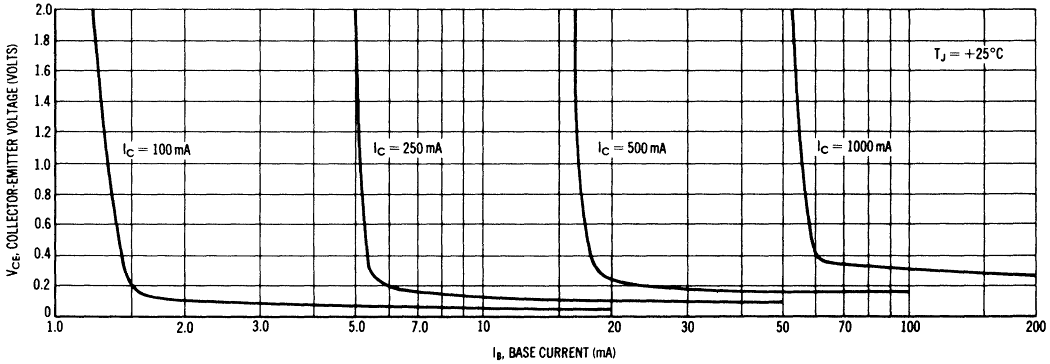


FIGURE 9 — "ON" VOLTAGES

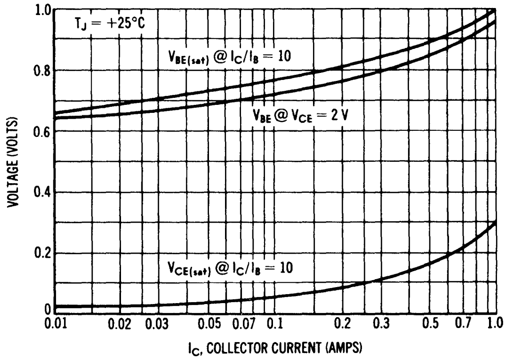
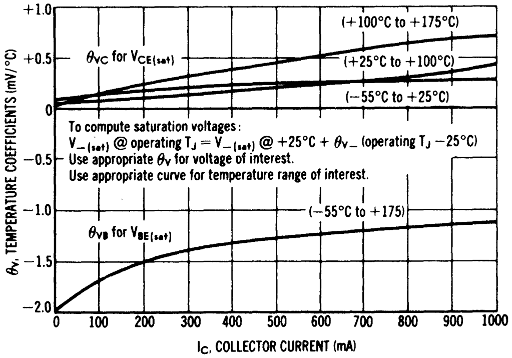


FIGURE 10 — TEMPERATURE COEFFICIENTS



To compute saturation voltages:
$V_{-(sat)}$ @ operating $T_J = V_{-(sat)}$ @ $+25°C + \theta_{V-}$ (operating $T_J - 25°C$)
Use appropriate θ_V for voltage of interest.
Use appropriate curve for temperature range of interest.

DYNAMIC CHARACTERISTICS

FIGURE 11 — TURN-ON TIME

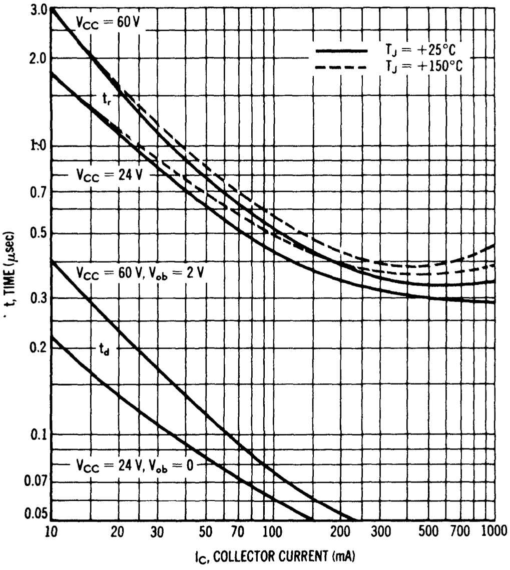


FIGURE 12 — STORAGE TIME

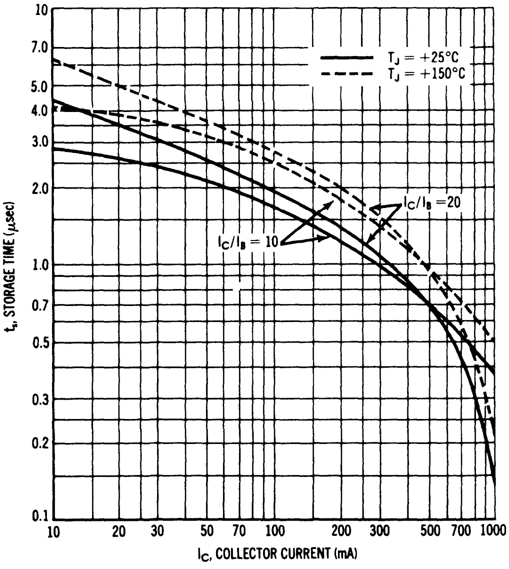


FIGURE 13 — CAPACITANCE

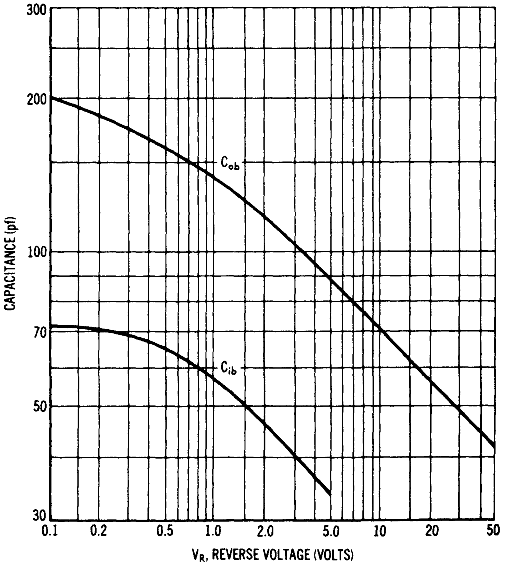
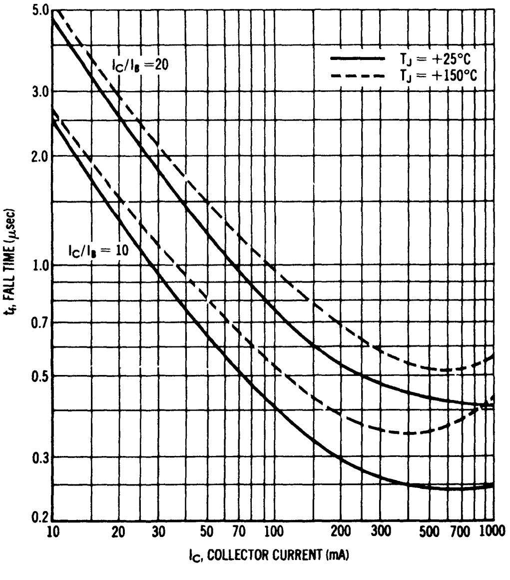
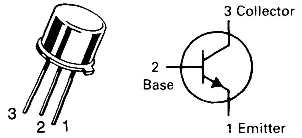


FIGURE 14 — FALL TIME



2N4237
thru
2N4239

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4237	2N4238	2N4239	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	Vdc
Collector-Base Voltage	V_{CBO}	50	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Base Current	I_B	500			mA
Collector Current — Continuous	I_C	1.0 3.0*			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.3			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	6.0 34			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

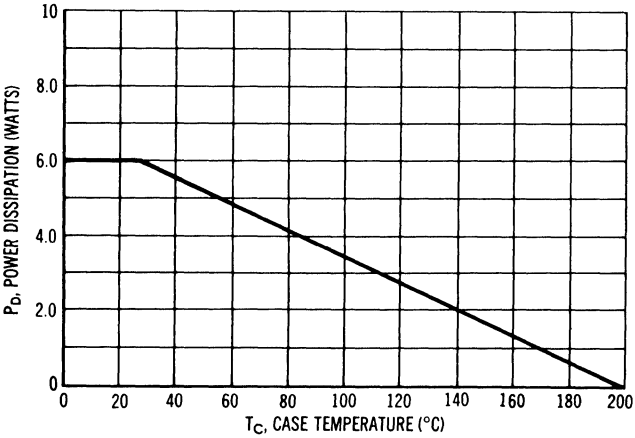
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	29	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(1)		$V_{CEO(sus)}$			Vdc
(I_C = 100 mAdc, I_B = 0)	2N4237		40	—	
	2N4238		60	—	
	2N4239		80	—	
Collector Cutoff Current		I_{CEX}			mAdc
(V_{CE} = 50 Vdc, V_{EB} = 1.5 Vdc)	2N4237		—	0.1	
(V_{CE} = 80 Vdc, V_{EB} = 1.5 Vdc)	2N4238		—	0.1	
(V_{CE} = 100 Vdc, V_{EB} = 1.5 Vdc)	2N4239		—	0.1	
(V_{CE} = 30 Vdc, V_{EB} = 1.5 Vdc, T_C = 150°C)	2N4237		—	1.0	
(V_{CE} = 50 Vdc, V_{EB} = 1.5 Vdc, T_C = 150°C)	2N4238		—	1.0	
(V_{CE} = 70 Vdc, V_{EB} = 1.5 Vdc, T_C = 150°C)	2N4239		—	1.0	
Collector Cutoff Current		I_{CBO}			mAdc
(V_{CB} = Rated V_{CBO}, I_E = 0)			—	0.1	
(V_{CE} = Rated V_{CEO}, I_B = 0)			—	.07	
Emitter Cutoff Current (V_{EB} = 6.0 Vdc, I_C = 0)		I_{EBO}	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)			30	—	
(I_C = 250 mAdc, V_{CE} = 1.0 Vdc)			30	150	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			30	—	
(I_C = 1.0 Adc, V_{CE} = 1.0 Vdc)			15	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$			Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.3	
(I_C = 1.0 Adc, I_B = 0.1 Adc)			—	0.6	
Base-Emitter Saturation Voltage(1) (I_C = 1.0 Adc, I_B = 0.1 Adc)		$V_{BE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage(1) (I_C = 250 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_C = 0, f = 0.1 MHz)		C_{obo}	—	100	pF
Small Signal Current Gain (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{fe}	30	—	—
Current Gain — High Frequency (V_{CE} = 10 V, I_C = 100 mA, f = 1 MHz)		$\lvert h_{fe} \rvert$	1.0	—	—

(1) Pulse Test: Pulse Width $\leq$ 300 μs, Duty Cycle 2.0%.

FIGURE 1 — POWER-TEMPERATURE DERATING CURVE



Safe Area Curves are indicated by Figure 5. All limits are applicable and must be observed.

SWITCHING CHARACTERISTICS

FIGURE 2 — SWITCHING TIME EQUIVALENT CIRCUIT

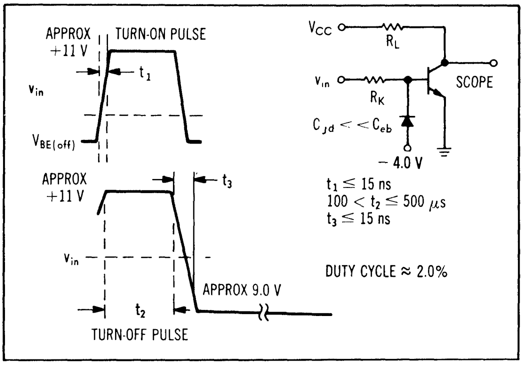


FIGURE 3 — TURN-ON TIME

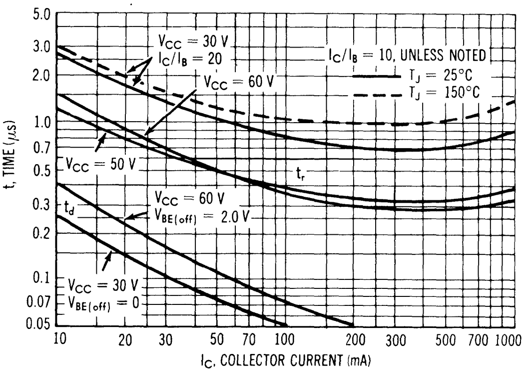


FIGURE 4 — THERMAL RESPONSE

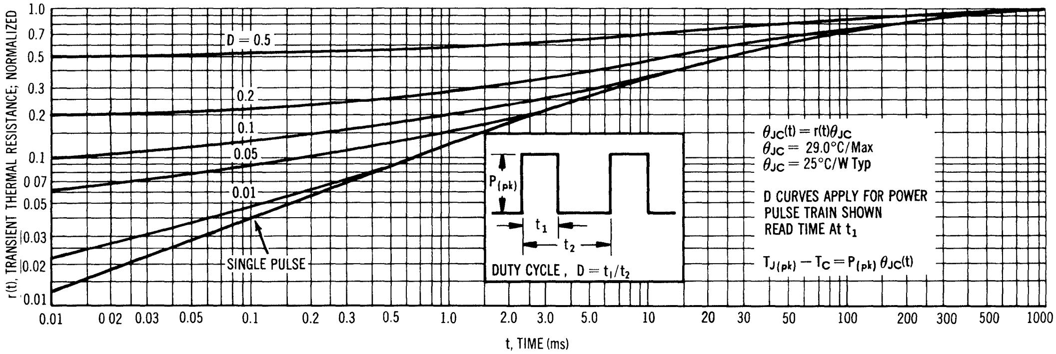
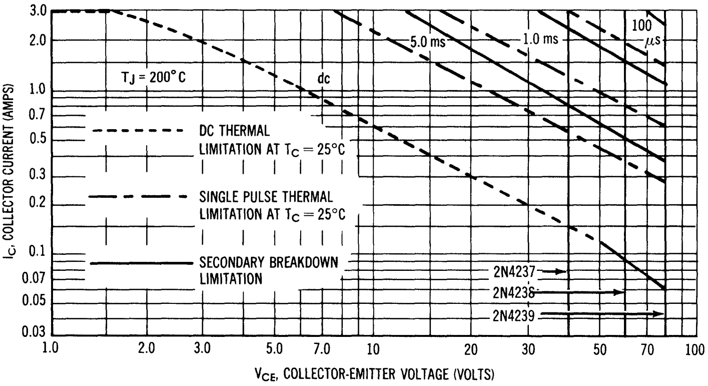


FIGURE 5 — ACTIVE-REGION SAFE OPERATING AREAS



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

For this particular transistor family, the thermal curves are the limiting design values, except for a small portion of the dc curve. The pulse secondary breakdown curves are shown for information only.

FIGURE 6 — STORAGE TIME

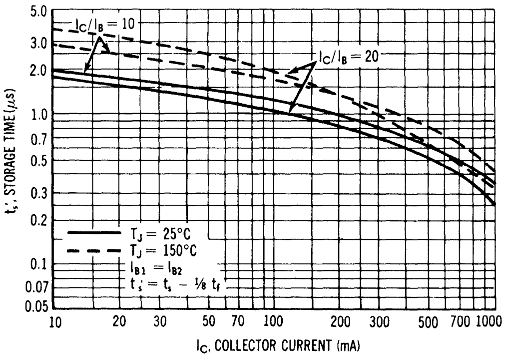
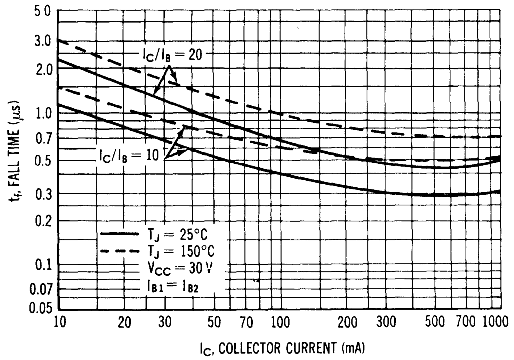


FIGURE 7 — FALL TIME



TYPICAL DC CHARACTERISTICS

FIGURE 8 — CURRENT GAIN

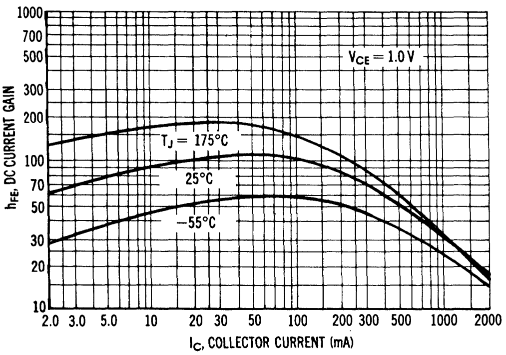


FIGURE 9 — COLLECTOR SATURATION REGION

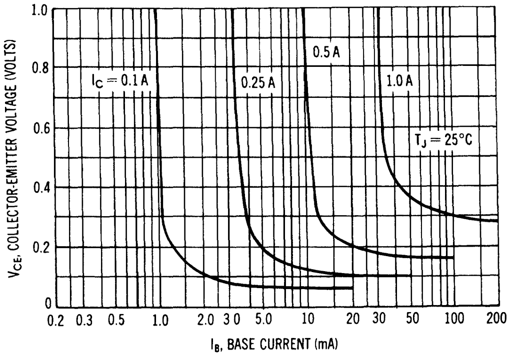


FIGURE 10 — EFFECTS OF BASE-EMITTER RESISTANCE

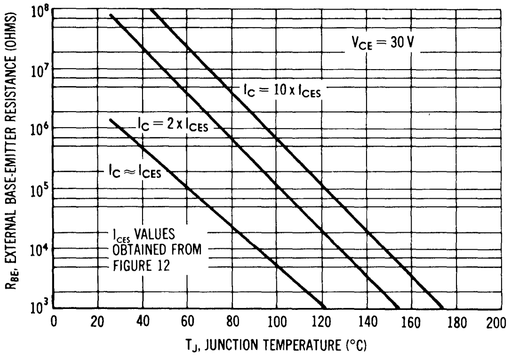


FIGURE 11 — "ON" VOLTAGE

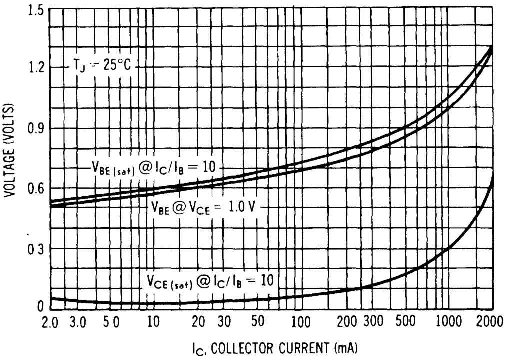


FIGURE 12 — COLLECTOR CUTOFF REGION

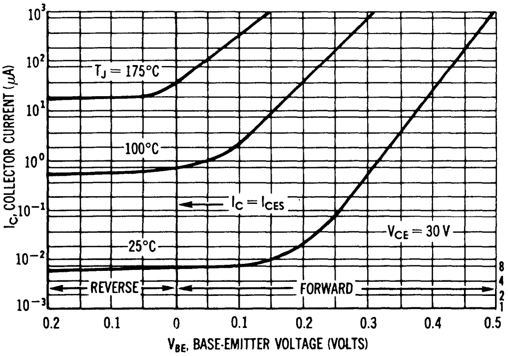
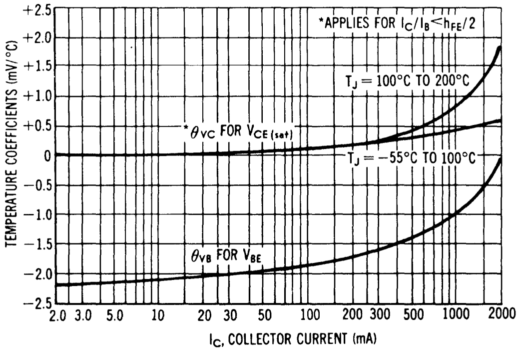
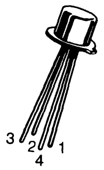


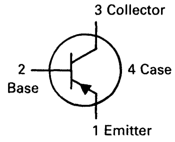
FIGURE 13 — TEMPERATURE COEFFICIENTS



2N4260
2N4261

2N4261 JAN, JTX AVAILABLE
CASE 20-03, STYLE 10
TO-72 (TO-206AF)





SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

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

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10$ mAdc, $I_E = 0$)		$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	4.5	—	Vdc
Collector Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE(off)} = 2.0$ Vdc) ($V_{CE} = 10$ Vdc, $V_{BE(off)} = 2.0$ Vdc, $T_A = 150°C$) ($V_{CE} = 10$ Vdc, $V_{EB(on)} = 0.4$ Vdc)		I_{CEX}	 — — —	 0.005 5.0 0.05	μAdc
Base Cutoff Current ($V_{CE} = 10$ Vdc, $V_{BE(off)} = 2.0$ Vdc)		I_{BL}	—	0.005	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 2.0$ Vdc)		h_{FE}	 25 30 20	 — 150 —	—
Collector-Emitter Saturation Voltage ($I_C = 1.0$ mAdc, $I_B = 0.1$ mAdc) ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{CE(sat)}$	 — —	 0.15 0.35	Vdc
Base-Emitter On Voltage ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	 — —	 0.8 1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 4.0$ Vdc, f = 100 MHz) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	 2N4260 2N4261 2N4260 2N4261	f_T	 1200 1500 1600 2000	 — — — —	MHz
Output Capacitance ($V_{CB} = 4.0$ Vdc, $I_E = 0$, f = 100 kHz)		C_{obo}	—	2.5	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)		C_{ibo}	—	2.5	pF
Current Gain — High Frequency ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	2N4260 2N4261	$\lvert h_{fe} \rvert$	16 20	— —	—

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

Characteristic		Symbol	Min	Max	Unit
Collector Base Time Constant		$r_b'C_C$			ps
(I_C = 5.0 mAdc, V_{CE} = 4.0 Vdc, f = 31.8 MHz)	2N4260		—	35	
	2N4261		—	60	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 31.8 MHz)	2N4260		—	30	
	2N4261		—	50	

		Typical Performance (v_{out} = 1.0 V)		
SWITCHING CHARACTERISTICS		@ 10 mA	@ 30 mA	
Rise Time	t_r	0.5	0.9	ns
Fall Time	t_f	1.0	1.2	ns
Turn-On Time	$t_{on(delay)}$	1.0	1.2	ns
Turn-Off Delay Time	$t_{off(delay)}$	1.0	1.2	ns

TYPICAL CHARACTERISTICS

FIGURE 1 — DC CURRENT GAIN

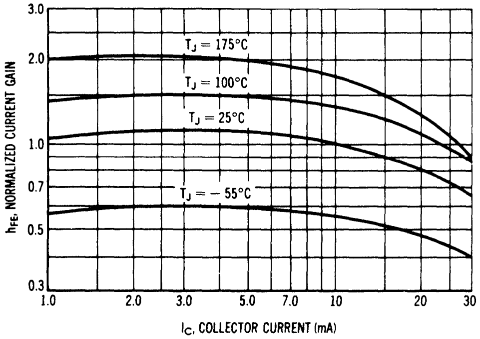
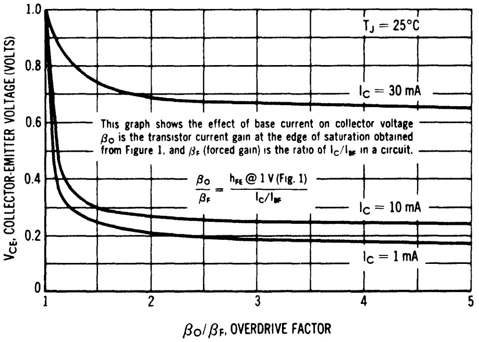


FIGURE 2 — COLLECTOR SATURATION REGION



This graph shows the effect of base current on collector voltage β_O is the transistor current gain at the edge of saturation obtained from Figure 1, and β_F (forced gain) is the ratio of I_C/I_{BF} in a circuit.

$$\frac{\beta_O}{\beta_F} = \frac{h_{FE} @ 1 \text{ V (Fig. 1)}}{I_C/I_{BF}}$$

FIGURE 3 — "ON" VOLTAGES

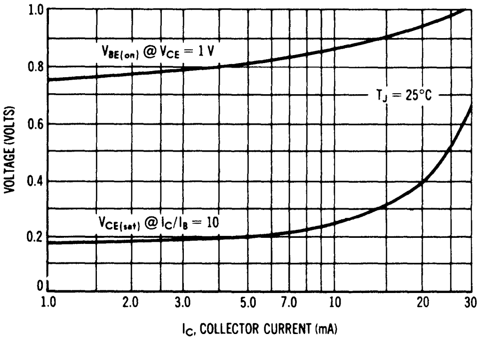


FIGURE 4 — TEMPERATURE COEFFICIENTS

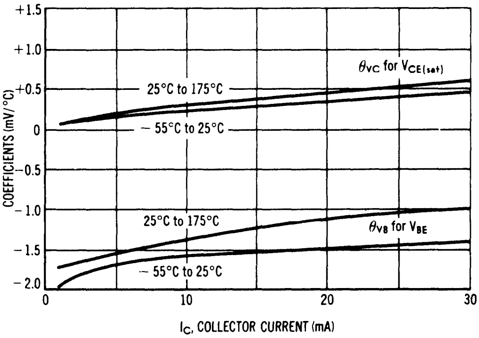


FIGURE 5 — CURRENT-GAIN — BANDWIDTH PRODUCT

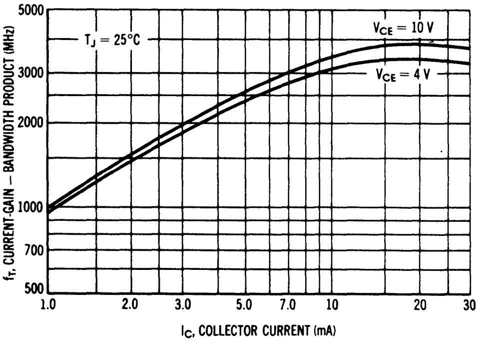


FIGURE 6 — COLLECTOR-BASE CONSTANT

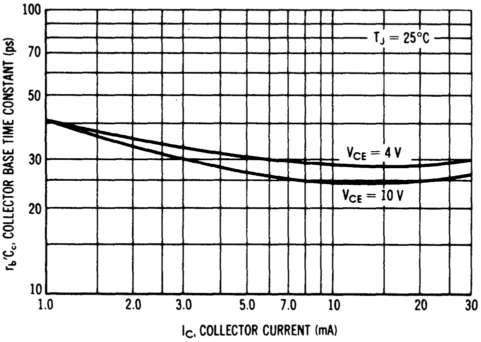
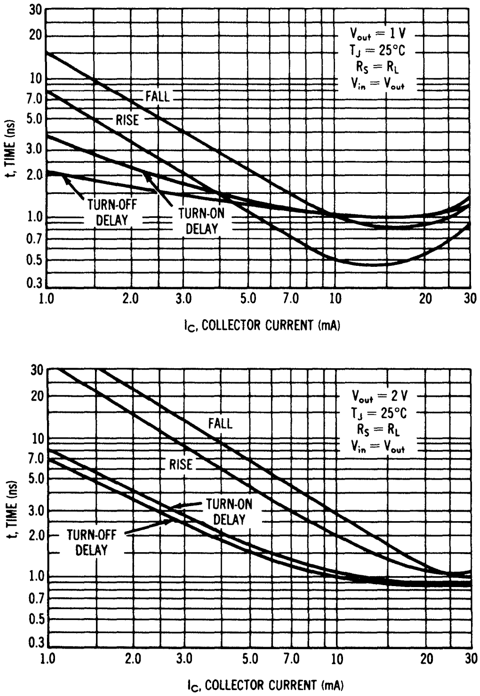
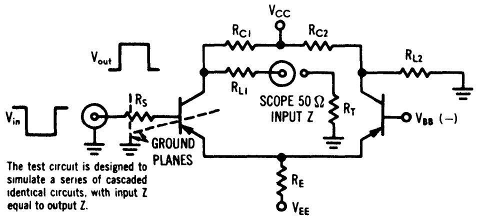


FIGURE 7 — SWITCHING TIMES





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

	$V_{in} = V_{out} = 2$ V $V_{BB} = 1$ V $R_{C1} = R_{C2}$							$V_{in} = V_{out} = 1$ V $V_{BB} = 0.5$ V $R_{C1} = R_{C2}$						
I_C mA	R_S ohms	R_C ohms	R_{L1} ohms	R_{L2} ohms	R_E ohms	V_{EE} volts	V_{CC} volts	R_S ohms	R_C ohms	R_{L1} ohms	R_{L2} ohms	R_E ohms	V_{EE} volts	V_{CC} volts
1	2 k	6 k	3 k	3 k	10 k	10	16	1 k	6 k	1.2 k	1.2 k	24 k	24	32
5	360	3.56 k	400	450	2 k	10	47	175	1 k	200	250	3 k	15	27
10	160	1 k	200	250	3 k	30	26.3	75	300	100	150	3 k	30	17
20	62	300	100	150	1 k	20	16	25	150	25	75	1 k	20	11
30	28	157	66	116	1 k	30	13	8	77	0	50	1 k	30	9

FIGURE 8 — CAPACITANCE

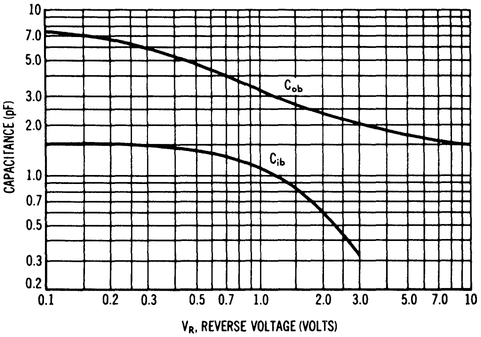
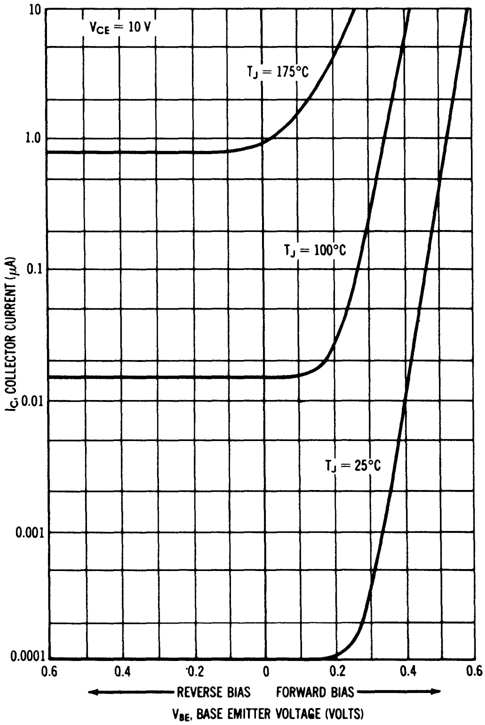
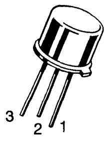


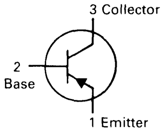
FIGURE 9 — CUT-OFF CHARACTERISTICS



2N4404
2N4405

CASE 79-04, STYLE 1
TO-39 (TO-205AD)





GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.25 7.15	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	8.75 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)		$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$)		I_{CBO}	—	25	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	25	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 5.0$ Vdc)	2N4404		30	—	
	2N4405		75	—	
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	2N4404		40	—	
	2N4405		100	—	
($I_C = 150$ mAdc, $V_{CE} = 5.0$ Vdc)(1)	2N4404		40	120	
	2N4405		100	300	
($I_C = 500$ mAdc, $V_{CE} = 5.0$ Vdc)(1)	2N4404		30	—	
	2N4405		50	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			—	0.15	
($I_C = 150$ mAdc, $I_B = 15$ mAdc)(1)			—	0.2	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)(1)			—	0.5	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			—	0.8	
($I_C = 500$ mAdc, $I_B = 50$ mAdc)(1)			0.85	1.2	
Base-Emitter On Voltage ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	200	600	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	10	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)		C_{eb}	—	75	pF

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

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	25	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_s	—	175	ns
Fall Time		t_f	—	35	ns

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

SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 1 — TURN-ON

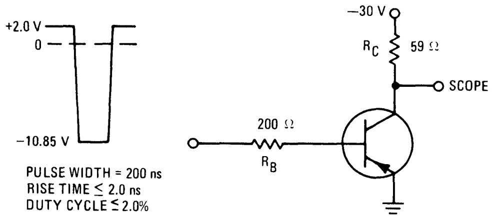
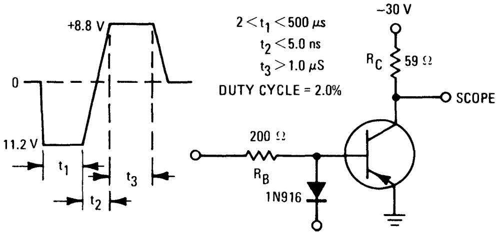


FIGURE 2 — TURN-OFF



To obtain data for curves, voltage levels are approximately as shown, R_B and R_C are varied.

TRANSIENT CHARACTERISTICS

25°C 100°C

FIGURE 3 — CAPACITANCES

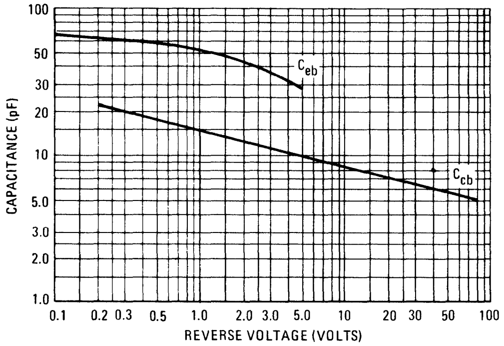


FIGURE 4 — CHARGE DATA

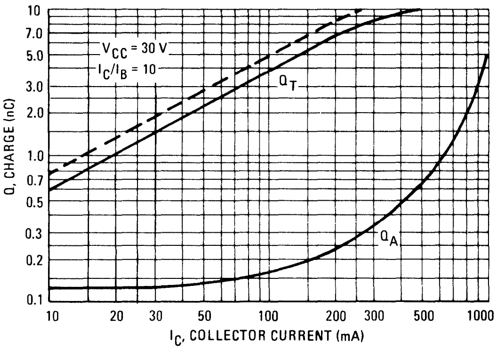


FIGURE 5 — DELAY TIME

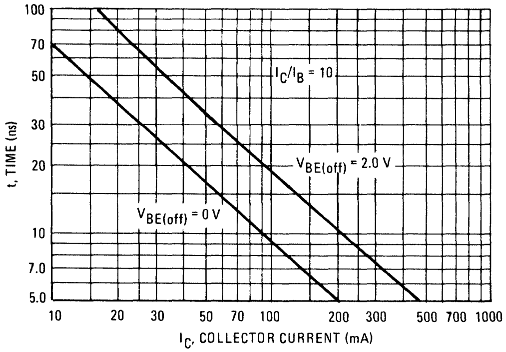


FIGURE 6 — RISE TIME

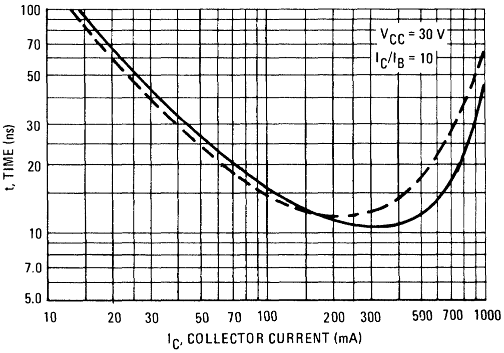


FIGURE 7 — STORAGE TIME

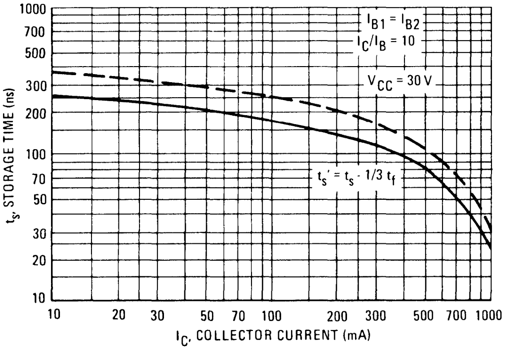
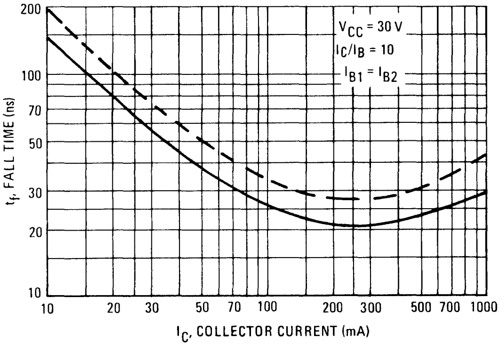


FIGURE 8 — FALL TIME



SMALL-SIGNAL CHARACTERISTICS

NOISE FIGURE

$V_{CE} = 10$ Vdc, $T_A = 25°C$

FIGURE 9 — FREQUENCY EFFECTS

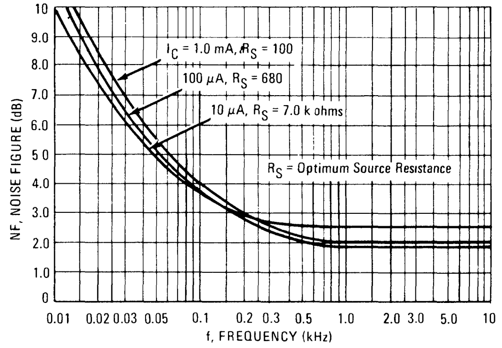
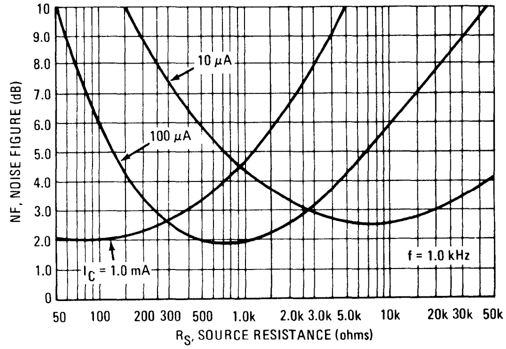


FIGURE 10 — SOURCE RESISTANCE EFFECTS



h PARAMETERS

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

This group of graphs illustrates the relationship of the "h" parameters for this series of transistors. To obtain these curves, 4 units were selected and identified by number – the same units were used to develop curves on each graph.

FIGURE 11 — CURRENT GAIN

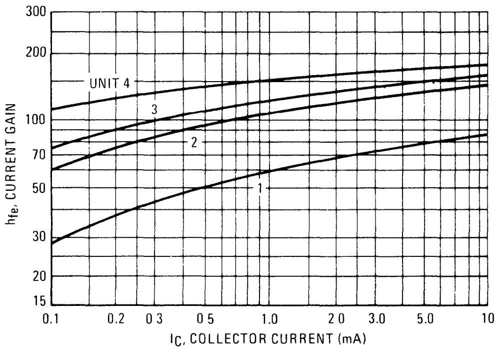


FIGURE 12 — INPUT IMPEDANCE

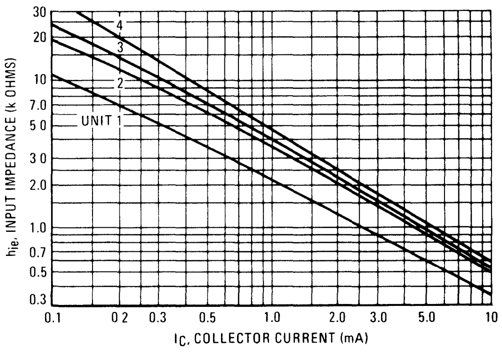


FIGURE 13 — VOLTAGE FEEDBACK RATIO

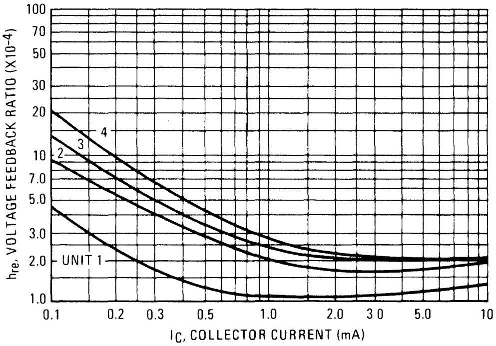
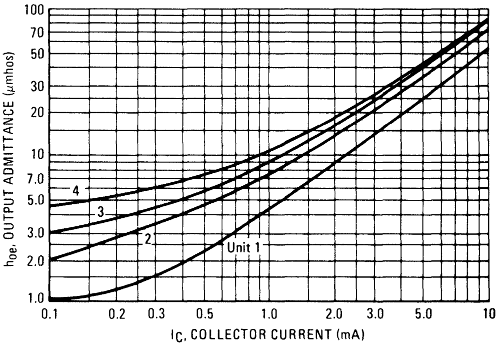


FIGURE 14 — OUTPUT ADMITTANCE



STATIC CHARACTERISTICS

FIGURE 15 — DC CURRENT GAIN

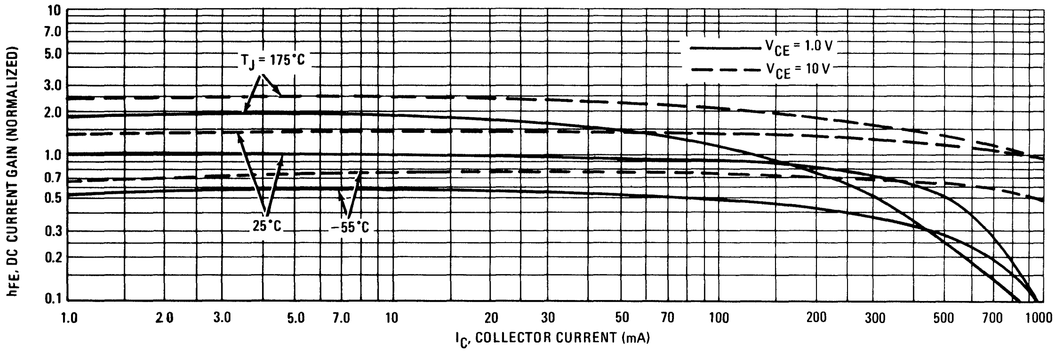


FIGURE 16 — COLLECTOR SATURATION REGION

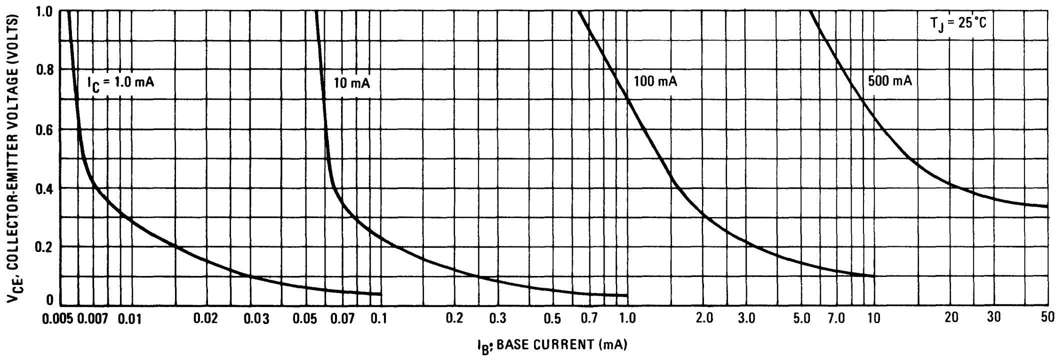


FIGURE 17 — "ON" VOLTAGES

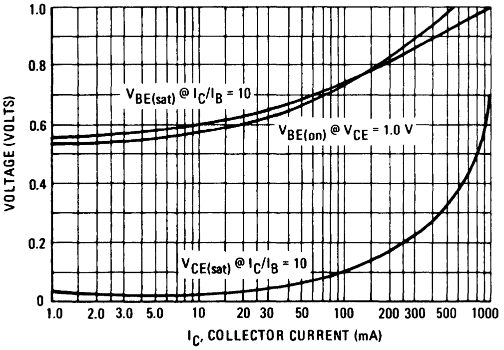
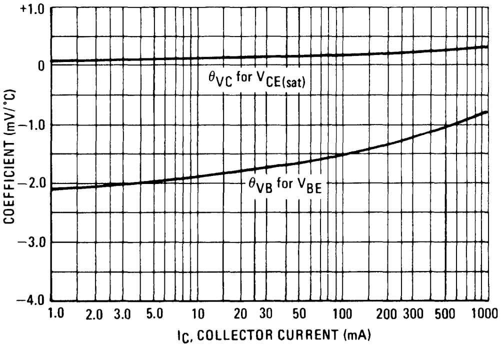
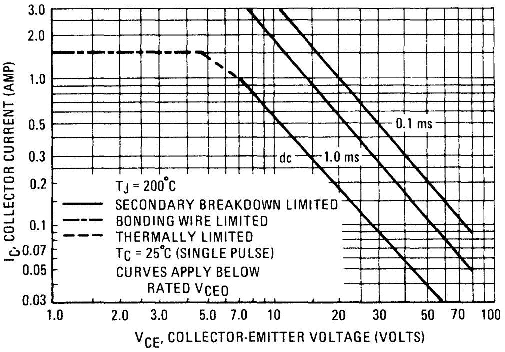


FIGURE 18 — TEMPERATURE COEFFICIENTS



RATINGS AND THERMAL DATA

FIGURE 19 — SAFE OPERATING AREA

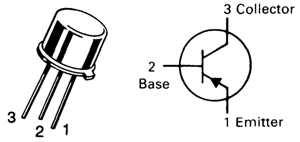


The safe operating area curves indicate I_C-V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 19 is based upon $T_{J(pk)} = 200°C$; T_C is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)} \leqq 200°C$. $T_{J(pk)}$ may be calculated from the data in Figure 20. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

2N4406
2N4407

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	80	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	2.0	Amps
Total Device Dissipation @ $T_A = 25°C$* Derate above 25°C	P_D	1.25 7.15	Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$* Derate above 25°C	P_D	8.75 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	80	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 60$ Vdc, $I_E = 0$)		I_{CBO}	—	25	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	25	nAdc
ON CHARACTERISTICS					
DC Current Gain(1)		h_{FE}			—
($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc)	2N4406 2N4407		30 80	— —	
($I_C = 150$ mAdc, $V_{CE} = 5.0$ Vdc)	2N4406 2N4407		30 80	— —	
($I_C = 500$ mAdc, $V_{CE} = 5.0$ Vdc)	2N4406 2N4407		30 80	120 240	
($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc)	2N4406 2N4407		20 30	— —	
($I_C = 1.5$ Adc, $V_{CE} = 5.0$ Vdc)	2N4406, 2N4407		10	—	
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc) ($I_C = 1.5$ Adc, $I_B = 150$ mAdc)		$V_{CE(sat)}$	 — — — —	 0.2 0.4 0.7 1.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 1.0$ Adc, $I_B = 100$ mAdc) ($I_C = 1.5$ Adc, $I_B = 150$ mAdc)		$V_{BE(sat)}$	 — 0.9 —	 0.9 1.3 1.5	Vdc
Base-Emitter On Voltage ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	150	750	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	15	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)		C_{eb}	—	160	pF

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Indicates Data in addition to JEDEC Requirements.

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

Characteristics		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc)	t_d	—	15	ns
Rise Time		t_r	—	60	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc)	t_s	—	175	ns
Fall Time		t_f	—	50	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Indicates Data in addition to JEDEC Requirements.

STATIC CHARACTERISTICS

FIGURE 1 — DC CURRENT GAIN

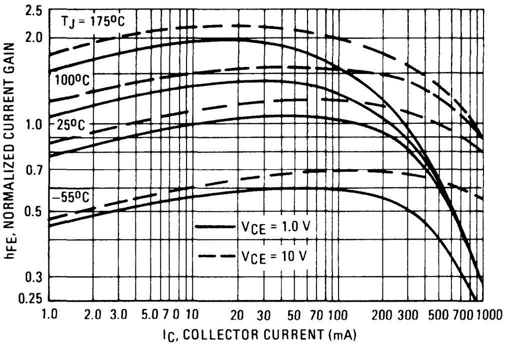


FIGURE 2 — COLLECTOR SATURATION REGION

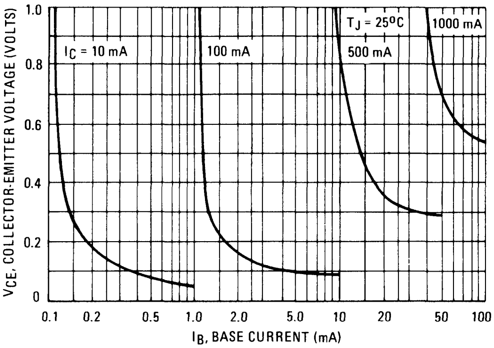


FIGURE 3 — "ON" VOLTAGES

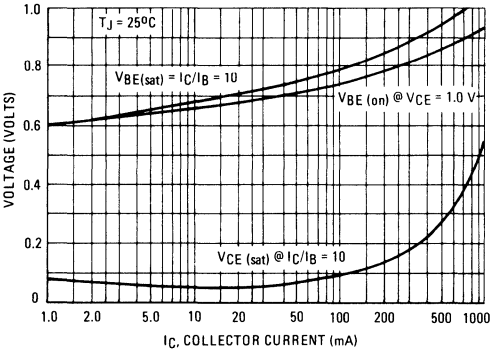


FIGURE 4 — TEMPERATURE COEFFICIENTS

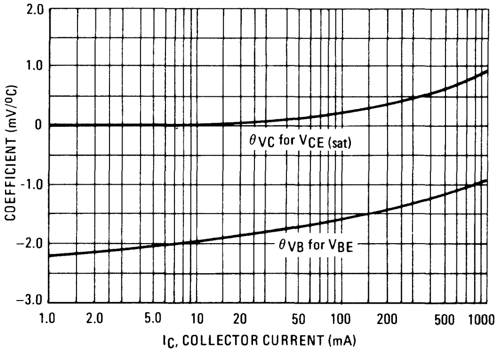
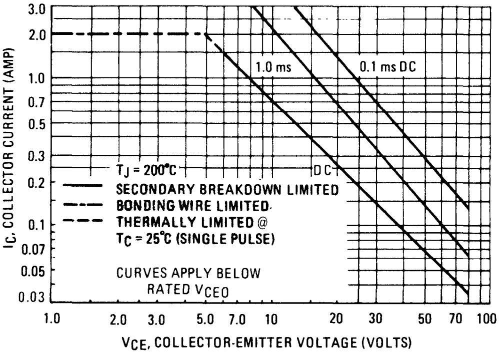


FIGURE 5 — SAFE OPERATING AREA



The safe operating area curves indicate I_C–V_{CE} limits of the transistor that must be observed for reliable operation. Collector load lines for specific circuits must fall below the limits indicated by the applicable curve.

The data of Figure 5 is based upon $T_{J(pk)}$ = 200°C; T_C is variable depending upon conditions. Pulse curves are valid for duty cycles to 10% provided $T_{J(pk)}$ ≤ 200°C. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

TRANSIENT CHARACTERISTICS

25°C 100°C

FIGURE 6 — CAPACITANCES

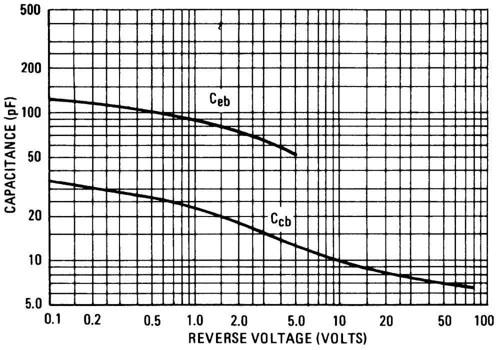


FIGURE 7 — CHARGE DATA

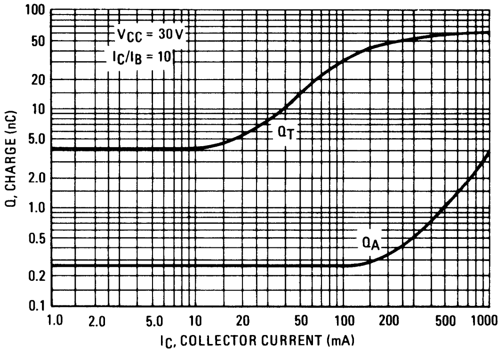


FIGURE 8 — TURN-ON TIME

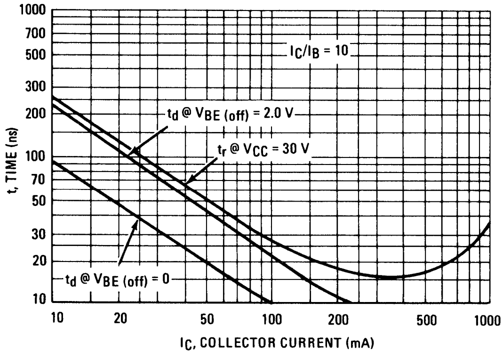
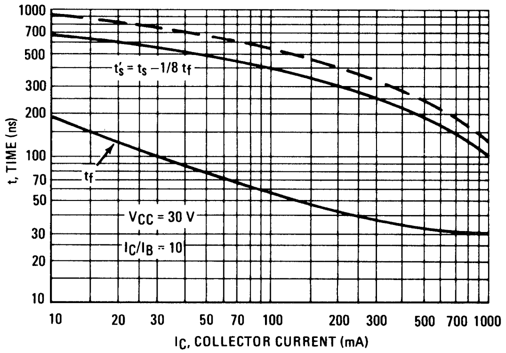


FIGURE 9 — TURN-OFF TIME



SWITCHING TIME EQUIVALENT TEST CIRCUITS

FIGURE 10 — TURN-ON TIME

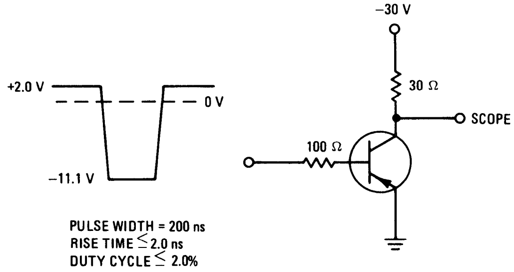
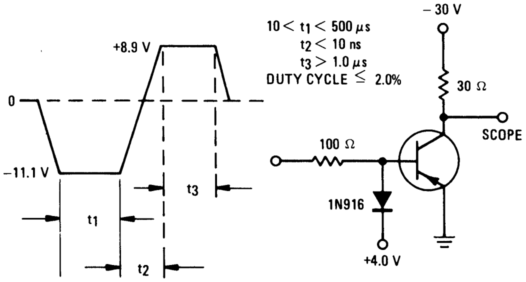


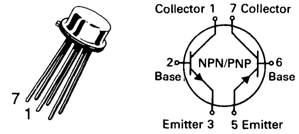
FIGURE 11 — TURN-OFF TIME



2N4453 For Specifications, See 2N869A Data.

2N4854
2N4855

2N4854 — JAN, JTX, JTXV AVAILABLE
CASE 654-07, STYLE 5



COMPLEMENTARY DUAL AMPLIFIER TRANSISTORS

NPN/PNP SILICON

Refer to MD6001 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector 1 to Collector 2 Voltage Voltage Rating any Lead to Case	V_{C1C2}	±200 ±200		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2.0	600 4.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.0 6.67	2.0 13.33	Watts
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$, $T_A = 150°C$)		I_{CBO}	—	10	μAdc
Emitter Cutoff Current ($V_{EB} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	10	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc)	2N4854		35	—	
	2N4855		20	—	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	2N4854		50	—	
	2N4855		25	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N4854		75	—	
	2N4855		35	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N4854		100	300	
	2N4855		40	120	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1)	2N4854		50	—	
	2N4855		20	—	
($I_C = 300$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N4854		35	—	
	2N4855		20	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{BE(sat)}$	0.75	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)		f_T	200	—	MHz

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

Characteristic	Symbol	Min	Max	Unit
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	8.0	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N4854	h_{ie}	1.5	9.0	kohms
2N4855		0.75	4.5	
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N4854	h_{fe}	60	300	—
2N4855		30	150	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) 2N4854	h_{oe}	—	50	μmhos
2N4855		—	25	
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kohm, f = 1.0 kHz)	NF	—	8.0	dB

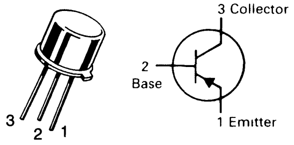
SWITCHING CHARACTERISTICS

Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	20	ns
Rise Time		t_r	—	40	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	280	ns
Fall Time		t_f	—	70	ns

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

2N4890

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

PNP SILICON

Refer to 2N4033 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.7	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

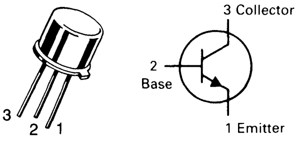
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 100 μAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, R_{BE} = 10 ohms)	$V_{(BR)CER}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	I_{CEX}	—	—	0.25	μAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	I_{BL}	—	—	0.25	μAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 150 mAdc, V_{CE} = 2.5 Vdc)		25	130	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)		50	140	250	
*(I_C = 500 mA, V_{CE} = 5 Vdc(1)		15	—	—	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.12	1.4	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	0.82	1.7	Vdc
Base-Emitter On Voltage (I_C = 150 mAdc, V_{CE} = 2.5 Vdc)	$V_{BE(on)}$	—	0.74	1.7	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)	f_T	100	280	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	9.0	15	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	60	80	pF
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.8 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_d	—	15	50	ns
Rise Time	t_r	20	20	50	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_s	—	110	200	ns
Fall Time	t_f	—	20	70	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

*Indicates Data in Addition to JEDEC Requirements.

2N4926
2N4927

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N4926	2N4927	Unit
Collector-Emitter Voltage	V_{CEO}	200	250	Vdc
Collector-Base Voltage	V_{CBO}	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	7.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

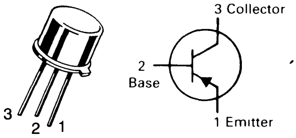
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) ($I_C = 10$ mAdc, $I_B = 0$)	 2N4926 2N4927	$V_{(BR)CEO}$	 200 250	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_C = 0$)	 2N4926 2N4927	$V_{(BR)CBO}$	 200 250	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)		$V_{(BR)EBO}$	7.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 100$ Vdc, $I_E = 0$) ($V_{CB} = 100$ Vdc, $I_E = 0$, $T_A = 100°C$) ($V_{CB} = 150$ Vdc, $I_E = 0$) ($V_{CB} = 150$ Vdc, $I_E = 0$, $T_A = 100°C$)	 2N4926 2N4927 	I_{CBO}	 — — — —	 0.1 10 0.1 10	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS (1)					
DC Current Gain	($I_C = 3.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc)	h_{FE}	10 15 20 20	— — 200 —	—
Collector-Emitter Saturation Voltage	($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)	$V_{CE(sat)}$	— —	1.0 2.0	Vdc
Base-Emitter Saturation Voltage	($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 3.0$ mAdc)	$V_{BE(sat)}$	— —	1.2 1.5	Vdc
Base-Emitter On Voltage	($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	$V_{BE(on)}$	—	1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product	($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 20 MHz)	f_T	30	300	MHz
Collector-Base Capacitance	($V_{CB} = 20$ Vdc, $I_E = 0$, f = 140 kHz)	C_{cb}	—	6.0	pF
Input Impedance	($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{ie}	75	2000	ohm
Voltage Feedback Ratio	($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{re}	0.1	2.0	$X\ 10^{-4}$
Small-Signal Current Gain	($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{fe}	25	250	—
Output Admittance	($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)	h_{oe}	—	50	μmhos
Real Part of Input Impedance	($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 5.0 MHz)	$Re(h_{ie})$	4.0	200	ohms

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

2N4928
thru
2N4931

2N4930 and 2N4931 JAN, JTX & JTXV AVAILABLE
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N3494 for graphs for 2N4928.*

MAXIMUM RATINGS

Rating	Symbol	2N4928	2N4929	2N4930	2N4931	Unit
Collector-Emitter Voltage	V_{CEO}	100	150	200	250	Vdc
Collector-Base Voltage	V_{CBO}	100	150	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	4.0	4.0	4.0	Vdc
Collector Current — Continuous	I_C	100	500	500	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 3.4	1.0 5.71	1.0 5.71	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.0 17.2	5.0 28.6	5.0 28.6	5.0 28.6	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200				°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	2N4928 2N4929 2N4930 2N4931	$V_{(BR)CEO}$	100 150 200 250	— — — —	Vdc
Collector-Base Breakdown Voltage (I_E = 0, I_C = 100 μAdc)	2N4928 2N4929 2N4930 2N4931	$V_{(BR)CBO}$	100 150 200 250	— — — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 75 Vdc, I_E = 0) (V_{CB} = 150 Vdc, I_E = 0)	2N4928 2N4929 2N4930, 2N4931	I_{CBO}	— — —	0.5 0.5 1.0	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0) (V_{BE} = 3.0 Vdc, I_C = 0)	2N4928, 2N4929 2N4930, 2N4931	I_{EBO}	— —	0.5 1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	All Types	h_{FE}	20	—	—
(I_C = 10 mAdc, V_{CE} = 10 Vdc)(1)	2N4928, 2N4929 2N4930, 2N4931		25 20	200 200	
(I_C = 50 mAdc, V_{CE} = 10 Vdc)(1) (I_C = 30 mAdc, V_{CE} = 10 Vdc)(1)	2N4928, 2N4929 2N4930, 2N4931		20 20	— —	
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	2N4928, 2N4929 2N4930, 2N4931	$V_{CE(sat)}$	— —	0.5 5.0	Vdc
Base-Emitter On Voltage (I_C = 10 mAdc, V_{CE} = 10 Vdc)		$V_{BE(on)}$	—	1.0	Vdc

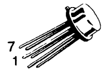
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product		f_T			MHz
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N4928, 2N4929		100	1,000	
(I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	2N4930, 2N4931		20	200	
Collector-Base Capacitance		C_{cb}			pF
(V_{CB} = 20 Vdc, I_E = 0, f = 140 kHz)	2N4928		—	6.0	
(V_{CB} = 20 Vdc, I_E = 0, f = 140 kHz)	2N4929		—	10	
(V_{CB} = 20 Vdc, I_E = 0, f = 140 kHz)	2N4930, 2N4931		—	20	
Emitter-Base Capacitance		C_{eb}			pF
(V_{BE} = 2.0 Vdc, I_C = 0, f = 140 kHz)	2N4928		—	40	
(V_{BE} = 1.0 Vdc, I_C = 0, f = 140 kHz)	2N4929		—	80	
(V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	2N4930, 2N4931		—	400	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
Refer to 2N3634 for graphs for 2N4929.
Refer to 2N3743 for graphs for 2N4930 and 2N4931.

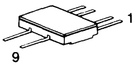
2N4937 thru 2N4939

CASE 654-07
STYLE 1



2N4941

CASE 610A-04
STYLE 1



DUAL AMPLIFIER TRANSISTORS

PNP SILICON

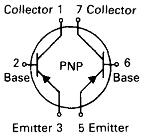
Refer to MD3250,A for graphs.

MAXIMUM RATINGS

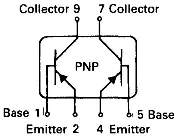
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector 1 to Collector 2 Voltage Voltage Rating and Lead to Case	V_{C1C2}	±200 ±200		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Base Current	I_B	10		mAdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	Both Die	
Total Device Dissipation	P_D			
@ T_A = 25°C — Ceramic		250	350	
Metal Can		500	600	
Derate above 25°C — Ceramic		1.5	2.0	mW
Metal Can		2.9	3.4	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
Derate above 25°C		1.2	2.0	Watts
Metal Can		6.85	11.42	mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

PIN CONNECTION DIAGRAMS

CASE 654-07
STYLE 1



CASE 610A-04
STYLE 1



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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	20	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	20	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		40	200	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		50	250	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		50	250	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 Mhz)	f_T	300	900	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz) Emitter Guarded	C_{cb}	—	5.0	pF
Input Impedance (I_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz) Collector Guarded	C_{eb}	—	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	1.0	10	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	—	10	X 10^{-4}
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	50	—	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	5.0	50	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 3.0 kΩ, f = 10 Hz to 15.7 kHz)	NF	—	4.0	dB

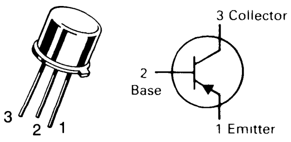
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(1)		h_{FE1}/h_{FE2}			—
(I_C = 100 μAdc to 1.0 mAdc, V_{CE} = 10 Vdc)	2N4937, 2N4941		0.9	1.0	
	2N4938		0.8	1.0	
(I_C = 100 μAdc to 1.0 mAdc, V_{CE} = 10 Vdc,					
T_A = −55°C to 125°C)	2N4937, 2N4941		0.85	1.0	
	2N4938		0.7	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$			mVdc
(I_C = 100 μAdc to 1.0 mAdc, V_{CE} = 10 Vdc)	2N4937, 2N4941		—	3.0	
	2N4938		—	5.0	
Base-Emitter Voltage Differential Gradient		$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$			mVdc
(I_C = 100 μAdc to 1.0 mAdc, V_{CE} = 10 Vdc,				1.0	
T_A = 25°C to +125°C)	2N4937, 2N4941		—	2.0	
	2N4938		—		
(I_C = 100 μAdc to 1.0 mAdc, V_{CE} = 10 Vdc,				0.8	
T_A = −55°C to 25°C)	2N4937, 2N4941		—	1.6	
	2N4938		—		

(1) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

2N5022
2N5023

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N3467 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N5022	2N5023	Unit
Collector-Emitter Voltage	V_{CEO}	50	30	V
Collector-Emitter Voltage	V_{CES}	50	30	V
Collector-Base Voltage	V_{CBO}	50	30	V
Emitter-Base Voltage	V_{EBO}	5		V
Collector Current — Continuous (Pulse Width = 300 μs, DC = 1%)	I_C	1.0*		A
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.72		Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	4.0 22.8		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
Maximum Lead Temperature (Soldering, 60 sec max)	T_L	+300		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	43.8	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

*Indicates Data in Addition to JEDEC Requirements.

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 μAdc)	2N5022	$V_{(BR)CES}$	50	—	V
	2N5023		30	—	
Collector-Emitter Sustaining Voltage (I_C = 10 mAdc)	2N5022	$V_{(BR)CEO(sus)}$*	50	—	V
	2N5023		30	—	
Collector-Base Breakdown Voltage (I_C = 100 μAdc)	2N5022	$V_{(BR)CBO}$	50	—	V
	2N5023		30	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc)	All	$V_{(BR)EBO}$	5.0	—	V
Collector Cutoff Current (V_{CE} = 30 Vdc)	2N5022	I_{CES}	—	100	nA
(V_{CE} = 20 Vdc) (T_A = 100°Cdc)	2N5023		—	15	μA
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 100 mA, V_{CE} = 1.0 Vdc)	2N5022	h_{FE}	15	—	—
	2N5023		30	—	
(I_C = 500 mA, V_{CE} = 1.0 Vdc)	2N5022		25	100	
	2N5023		40	100	
(I_C = 1.0 A, V_{CE} = 5.0 Vdc)	2N5022		25	—	
	2N5023		40	—	
(I_C = 500 ma, V_{CE} = 1.0 V, T_A = −55°C)	2N5022		10	—	
	2N5023		20	—	
Collector-Emitter Saturation Voltage(1) (I_C = 100 mAdc, I_B = 10 mAdc)	2N5022	$V_{CE(sat)}$	—	0.20	
	2N5023		—	0.17	V
(I_C = 500 mAdc, I_B = 50 mAdc)	2N5022		—	0.40	
	2N5023		—	0.35	V
(I_C = 1.0 Adc, I_B = 100 mAdc)	2N5022		—	0.80	
	2N5023		—	0.70	V

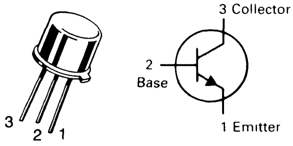
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			
(I_C = 100 mAdc, I_B = 10 mAdc)			—	1.0	V
(I_C = 500 mAdc, I_B = 50 mAdc)			0.8	1.4	V
(I_C = 1.0 Adc, I_B = 100 mAdc)			—	1.75	V
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{BE} = 0.5 V, f = 100 kHz)		C_{cb}	—	25	pF
Emitter-Base Capacitance (V_{BE} = 0.5 V, f = 100 kHz)		C_{eb}	—	100	pF
Small-Signal Current Gain		h_{fe}			—
(I_C = 50 mA, V_{CE} = 10 V, f = 100 MHz)	2N5022		1.7	—	
	2N5023		2.0	—	
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CE} = −30 V, I_C ≈ 500 mA, I_B ≈ 50 mA)		t_{on}	—	40	ns
Turn-Off Time (V_{CE} = 30 V, I_C ≈ 500 mA, I_{B1} = I_{B2} ≈ 50 mA)		t_{off}	—	90	ns

(1) Pulse Width = 300 μs, Duty Cycle = 1.0%.

2N5058
2N5059

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3724 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N5058	2N5059	Unit
Collector-Emitter Voltage	V_{CEO}	300	250	Vdc
Collector-Base Voltage	V_{CBO}	300	250	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	6.0	Vdc
Collector Current — Continuous	I_C	150		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 6.67		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 33.3		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	30	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$ (1)	150	°C/W

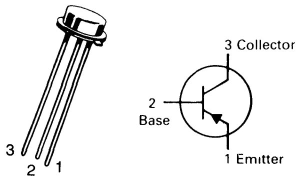
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (2) ($I_C = 30$ mAdc, $I_B = 0$)	2N5058 2N5059	$V_{(BR)CEO}$	300 250	— —	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	2N5058 2N5059	$V_{(BR)CBO}$	300 250	— —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	2N5058 2N5059	$V_{(BR)EBO}$	7.0 6.0	— —	Vdc
Collector Cutoff Current ($V_{CB} = 100$ Vdc, $I_E = 0$) ($V_{CB} = 100$ Vdc, $I_E = 0$, $T_A = +125°C$)		I_{CBO}	— —	0.05 20	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)		I_{EBO}	—	10	nAdc
ON CHARACTERISTICS (2)					
DC Current Gain ($I_C = 5.0$ mAdc, $V_{CE} = 25$ Vdc)	2N5058 2N5059	h_{FE}	10 10	— —	—
($I_C = 30$ mAdc, $V_{CE} = 25$ Vdc)	2N5058 2N5059		35 30	150 150	
($I_C = 30$ mAdc, $V_{CE} = 25$ Vdc, $T_A = -55°C$)	2N5058		10	—	
($I_C = 100$ mAdc, $V_{CE} = 25$ Vdc)	2N5058 2N5059		35 30	— —	
Collector-Emitter Saturation Voltage ($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)		$V_{CE(sat)}$	—	1.0	Vdc
Base-Emitter Saturation Voltage ($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)		$V_{BE(sat)}$	—	0.85	Vdc
Base-Emitter On Voltage ($I_C = 30$ mAdc, $V_{CE} = 25$ Vdc)		$V_{BE(on)}$	—	0.82	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (3) ($I_C = 10$ mAdc, $V_{CE} = 25$ Vdc, f = 20 MHz)		f_T	30	160	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	10	pF
Emitter-Base Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)		C_{eb}	—	75	pF

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) f_T is defined as the frequency at which the $|h_{fe}|$ extrapolates to unity.

2N5230

CASE 26-03, STYLE 1
TO-46 (TO-206AB)



LOW POWER CHOPPER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Collector Voltage	V_{ECO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	30	Vdc
Collector Current — Continuous	I_C	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.5 2.86	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.0 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Emitter-Collector Breakdown Voltage ($I_E = 10\ \mu Adc$, $I_B = 0$)	$V_{(BR)ECO}$	20	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	30	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ Vdc, $I_E = 0$)	I_{CBO}	—	1.0	nAdc
Emitter Cutoff Current ($V_{EB} = 25$ Vdc, $I_C = 0$)	I_{EBO}	—	1.0	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
($I_C = 100\ \mu Adc$, $V_{CE} = 1.0$ Vdc)		50	—	
($I_C = 200\ \mu Adc$, $V_{CE} = 0.5$ Vdc) (Inverted Connection)		15	—	
Offset Voltage	$V_{EC(ofs)}$			mVdc
($I_B = 100\ \mu Adc$, $I_E = 0$)		—	0.5	
($I_B = 1.0$ mAdc, $I_E = 0$)		—	1.0	
SMALL-SIGNAL CHARACTERISTICS				
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 140 kHz)	C_{cb}	—	5.0	pF
Emitter-Base Capacitance ($V_{EB} = 10$ Vdc, $I_C = 0$, f = 140 kHz)	C_{eb}	—	4.0	pF
Small-Signal Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 5.0$ Vdc, f = 4.0 MHz)	h_{fe}	2.0	—	—
"ON" Series Resistance ($I_B = 1.0$ mAdc, $I_E = 0$, $I_e = 100\ \mu A$ RMS, f = 1.0 kHz)	$r_{ec(on)}$	2.0	8.0	Ohms

TYPICAL CHARACTERISTICS

FIGURE 1 – EMITTER-COLLECTOR VOLTAGE versus BASE CURRENT

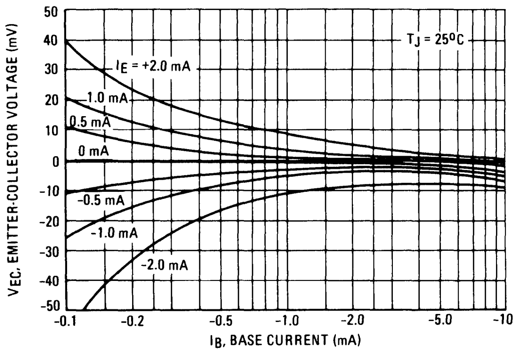


FIGURE 2 – EMITTER-COLLECTOR VOLTAGE versus JUNCTION TEMPERATURE

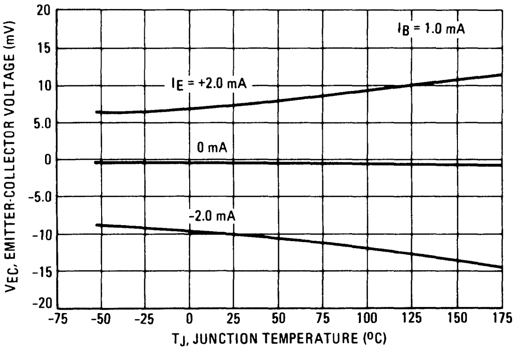


FIGURE 3 – EMITTER-COLLECTOR "ON" RESISTANCE versus BASE CURRENT

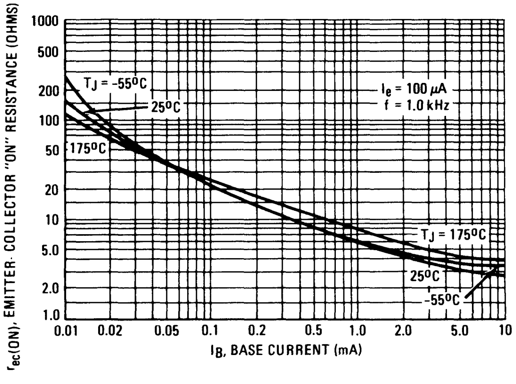


FIGURE 4 – EMITTER-COLLECTOR "ON" RESISTANCE TEMPERATURE COEFFICIENT versus BASE CURRENT

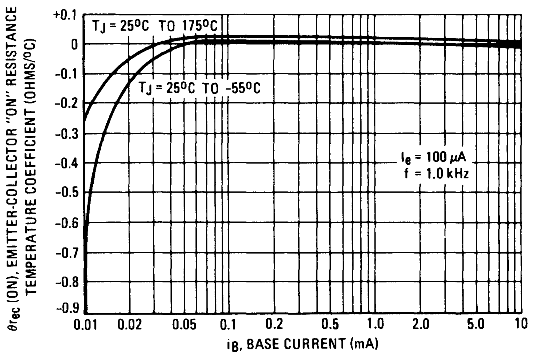


FIGURE 5 – CURRENT GAIN versus COLLECTOR CURRENT

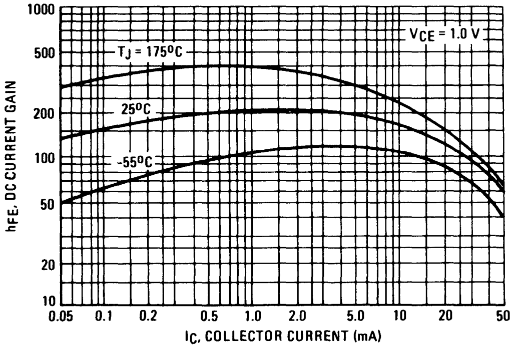


FIGURE 6 – CURRENT GAIN (Inverted Connection) versus EMITTER CURRENT

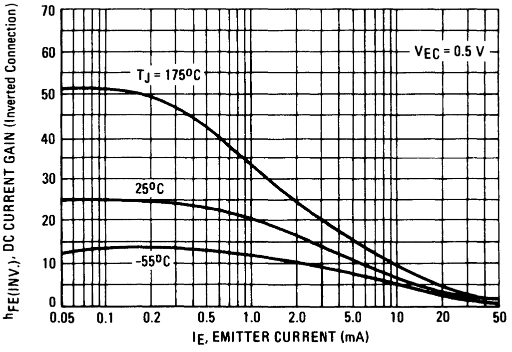


FIGURE 7 – COLLECTOR CUTOFF CURRENT versus JUNCTION TEMPERATURE

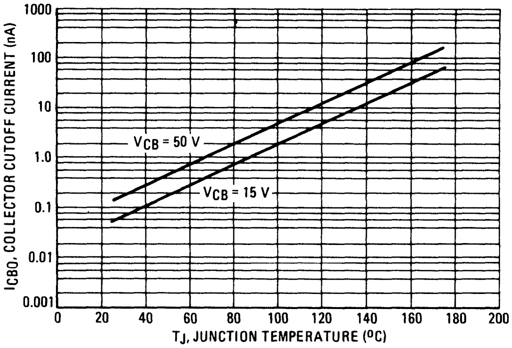


FIGURE 8 – EMITTER CUTOFF CURRENT versus JUNCTION TEMPERATURE

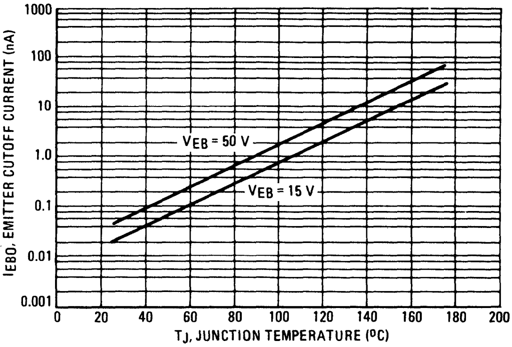


FIGURE 9 – COLLECTOR-EMITTER SATURATION VOLTAGE versus COLLECTOR CURRENT

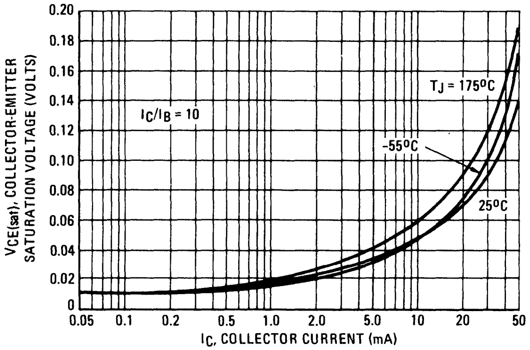
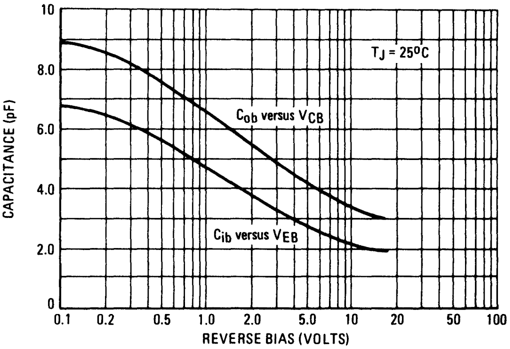
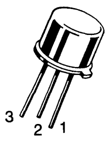


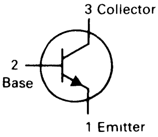
FIGURE 10 – JUNCTION CAPACITANCE versus REVERSE BIAS VOLTAGE



2N5320
2N5321

CASE 79-04, STYLE 1
TO-39 (TO-205AD)





SWITCHING TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N5320	2N5321	Unit
Collector-Emitter Voltage	V_{CEO}	75	50	Vdc
Collector-Base Voltage	V_{CBO}	100	75	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	5.0	Vdc
Base Current	I_B	1.0		Adc
Collector Current — Continuous	I_C	2.0		Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	10 0.057		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
($I_C = 100$ mAdc, $I_B = 0$)	2N5320		75	—	
	2N5321		50	—	
Collector Cutoff Current		I_{CEX}			mAdc
($V_{CE} = 100$ Vdc, $V_{BE} = 1.5$ Vdc)	2N5320		—	0.1	
($V_{CE} = 70$ Vdc, $V_{BE} = 1.5$ Vdc, $T_C = 150°C$)			—	5.0	
($V_{CE} = 75$ Vdc, $V_{BE} = 1.5$ Vdc)	2N5321		—	0.1	
($V_{CE} = 45$ Vdc, $V_{BE} = 1.5$ Vdc, $T_C = 150°C$)			—	5.0	
Emitter Cutoff Current		I_{EBO}			mAdc
($V_{BE} = 7.0$ Vdc, $I_C = 0$)	2N5320		—	0.1	
($V_{BE} = 5.0$ Vdc, $I_C = 0$)	2N5321			0.1	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 500$ mAdc, $V_{CE} = 4.0$ Vdc)	2N5320		30	130	
	2N5321		40	250	
($I_C = 1.0$ Adc, $V_{CE} = 2.0$ Vdc)	2N5320		10	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 500$ mAdc, $I_B = 50$ mAdc)	2N5320		—	0.5	
	2N5321		—	0.8	
Base-Emitter On Voltage		$V_{BE(on)}$			Vdc
($I_C = 500$ mAdc, $V_{CE} = 4.0$ Vdc)	2N5320		—	1.1	
	2N5321			1.4	
SMALL-SIGNAL CHARACTERISTICS					
Small-Signal Current Gain ($I_C = 50$ mAdc, $V_{CE} = 4.0$ Vdc, f = 10 MHz)		h_{fe}	5	—	—
SWITCHING CHARACTERISTICS					
Turn-On Time ($V_{CC} = 30$ Vdc, $I_C = 500$ mAdc, $I_{B1} = 50$ mAdc)		t_{on}	—	80	ns
Turn-Off Time ($V_{CC} = 30$ Vdc, $I_C = 500$ mAdc, $I_{B1} = I_{B2} = 50$ mAdc)		t_{off}	—	800	ns

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

FIGURE 1 — TYPICAL INPUT CHARACTERISTICS

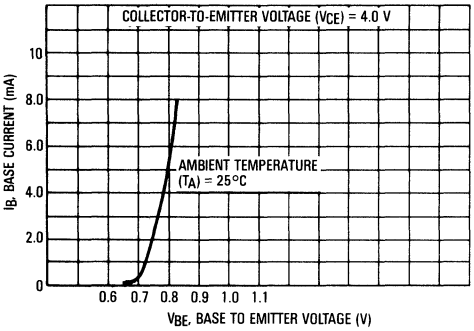


FIGURE 2 — TYPICAL TRANSFER CHARACTERISTICS

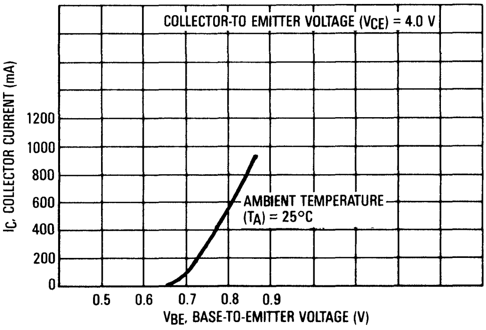


FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

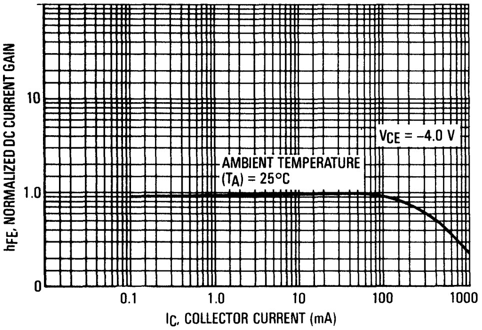
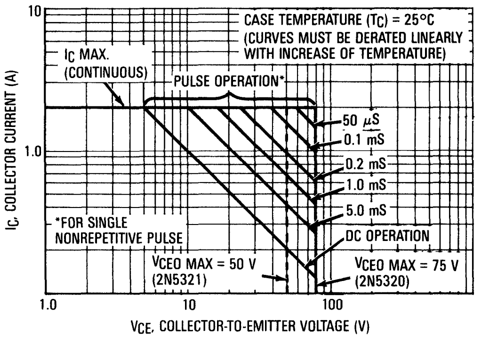
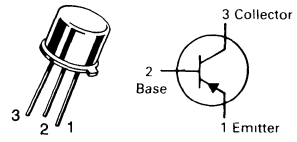


FIGURE 4 — MAXIMUM SAFE OPERATING AREAS (SOA)



2N5322
2N5323

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	2N5322	2N5323	Unit
Collector-Emitter Voltage	V_{CEO}	75	50	Vdc
Collector-Base Voltage	V_{CBO}	100	75	Vdc
Emitter-Base Voltage	V_{EBO}	7.0	5.0	Vdc
Base Current	I_B	1.0		Adc
Collector Current — Continuous	I_C	2.0		Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 0.057		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 100 mAdc, I_B = 0)	2N5322		75	—	
	2N5323		50	—	
Collector Cutoff Current		I_{CEX}			mAdc
(V_{CE} = 100 Vdc, V_{BE} = 1.5 Vdc)	2N5322		—	0.1	
(V_{CE} = 70 Vdc, V_{BE} = 1.5 Vdc, T_C = 150°C)			—	5.0	
(V_{CE} = 75 Vdc, V_{BE} = 1.5 Vdc)	2N5323		—	0.1	
(V_{CE} = 45 Vdc, V_{BE} = 1.5 Vdc, T_C = 150°C)			—	5.0	
Emitter Cutoff Current		I_{EBO}			mAdc
(V_{BE} = 7.0 Vdc, I_C = 0)	2N5322		—	0.1	
(V_{BE} = 5.0 Vdc, I_C = 0)	2N5323		—	0.1	
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
(I_C = 500 mAdc, V_{CE} = 4.0 Vdc)	2N5322		30	130	
	2N5323		40	250	
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)	2N5322		10	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)	2N5322			0.7	
	2N5323		—	1.2	
Base-Emitter On Voltage		$V_{BE(on)}$			Vdc
(I_C = 500 mAdc, V_{CE} = 4.0 Vdc)	2N5322			1.1	
	2N5323		—	1.4	
SMALL-SIGNAL CHARACTERISTICS					
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 4.0 Vdc, f = 10 MHz)		h_{fe}	5	—	—
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc)		t_{on}	—	100	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)		t_{off}	—	1000	ns

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

FIGURE 1 — TYPICAL INPUT CHARACTERISTICS

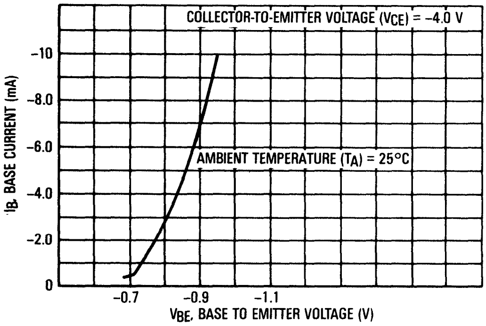


FIGURE 2 — TYPICAL TRANSFER CHARACTERISTICS

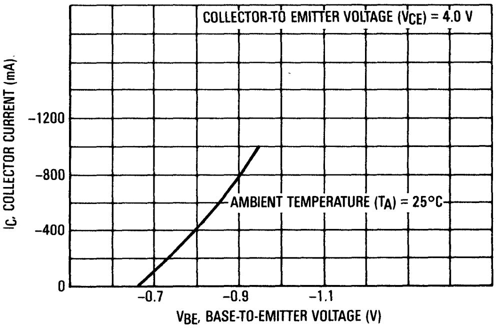


FIGURE 3 — CURRENT GAIN CHARACTERISTICS versus COLLECTOR-EMITTER VOLTAGE

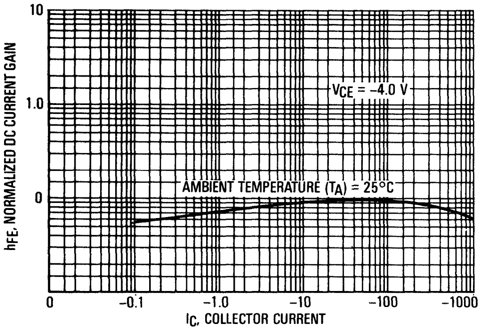
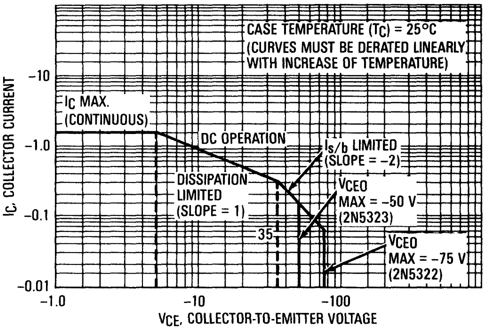


FIGURE 4 — MAXIMUM SAFE OPERATING AREAS (SOA)

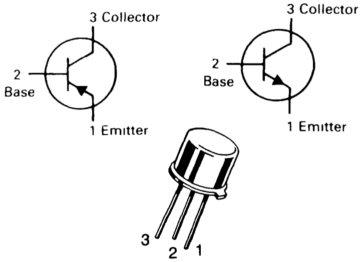


2N5415, 2N5416 For Specifications, See 2N3439 Data.

2N5581/82 For Specifications, See 2N2218,A Data.

2N5679 2N5680 2N5681 2N5682

PNP SILICON **NPN SILICON**



CASE 79-04, STYLE 1
TO-39 (TO-205AD)

GENERAL PURPOSE TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	2N5679 2N5681	2N5680 2N5682	Unit
Collector-Emitter Voltage	V_{CEO}	100	120	Vdc
Collector-Base Voltage	V_{CBO}	100	120	Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Base Current	I_B	0.5		Adc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.7		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 57		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

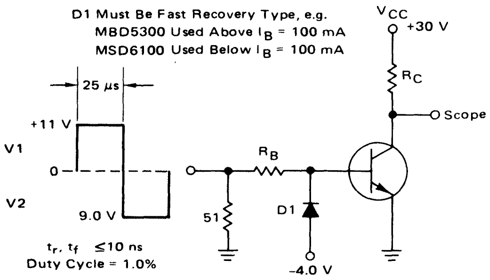
THERMAL CHARACTERISTICS

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

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage		$V_{CEO(sus)}$			Vdc
(I_C = 10 mAdc, I_B = 0)	2N5679, 2N5681		100	—	
	2N5680, 2N5682		120	—	
Collector Cutoff Current		I_{CEO}			µAdc
(V_{CE} = 70 Vdc, I_B = 0)			—	10	
(V_{CE} = 80 Vdc, I_B = 0)			—	10	
Collector Cutoff Current		I_{CEX}			
(V_{CE} = 100 Vdc, V_{EB} = 1.5 Vdc)	2N5679, 2N5681		—	1.0	µAdc
(V_{CE} = 120 Vdc, V_{EB} = 1.5 Vdc)	2N5680, 2N5682		—	1.0	
					mAdc
(V_{CE} = 100 Vdc, V_{EB} = 1.5 Vdc, T_C = 150°C)	2N5679, 2N5681		—	1.0	
(V_{CE} = 120 Vdc, V_{EB} = 1.5 Vdc, T_C = 150°C)	2N5680, 2N5682		—	1.0	
Collector Cutoff Current		I_{CBO}			µAdc
(V_{CB} = 100 Vdc, I_E = 0)	2N5679, 2N5681		—	1.0	
(V_{CB} = 120 Vdc, I_E = 0)	2N5680, 2N5682		—	1.0	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	1.0	µAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 250 mAdc, V_{CE} = 2.0 Vdc)			40	150	
(I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)			5.0	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 250 mAdc, I_B = 25 mAdc)			—	0.6	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.0	
(I_C = 1.0 Adc, I_B = 200 mAdc)			—	2.0	
Base-Emitter Saturation Voltage (I_C = 250 mAdc, V_{CE} = 2.0 Vdc)		$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 10 MHz)		f_T	30	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	—	50	pF
Small-Signal Current Gain (I_C = 0.2 Adc, V_{CE} = 1.5 Vdc, f = 1.0 kHz)		h_{fe}	40	—	—

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



R_B and R_C Varied to Obtain Desired Current Levels

For t_d and t_r, D1 is disconnected and V2 = 0
For PNP test circuit, reverse diode and voltage polarities.

PNP
2N5679, 2N5680

NPN
2N5681, 2N5682

FIGURE 2 — TURN-ON TIME

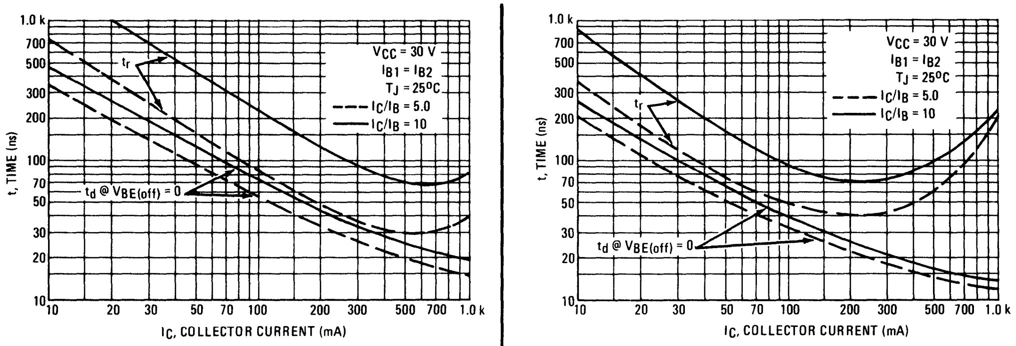


FIGURE 3 — TURN-OFF TIME

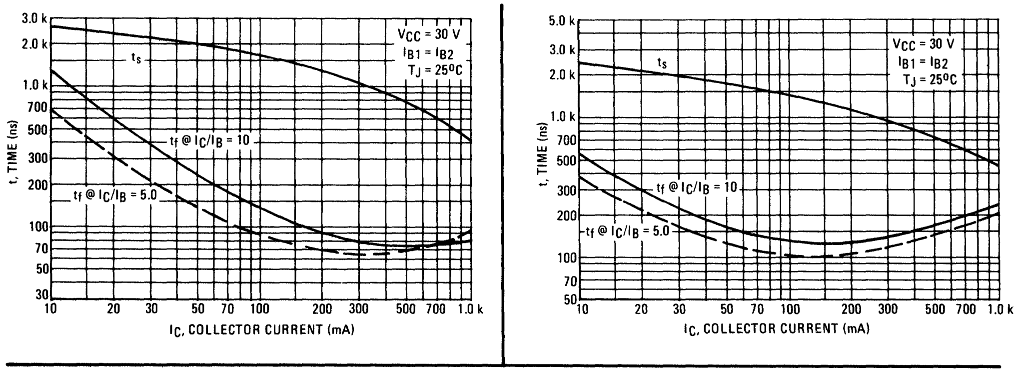


FIGURE 4 — CURRENT-GAIN — BANDWIDTH PRODUCT

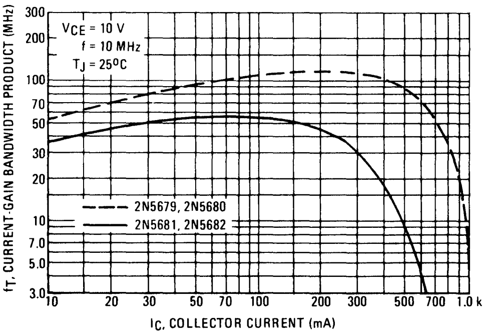


FIGURE 5 — CAPACITANCE

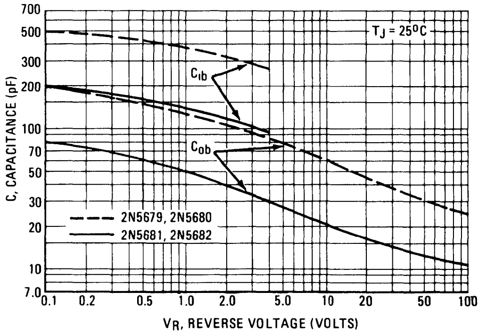


FIGURE 6 — THERMAL RESISTANCE

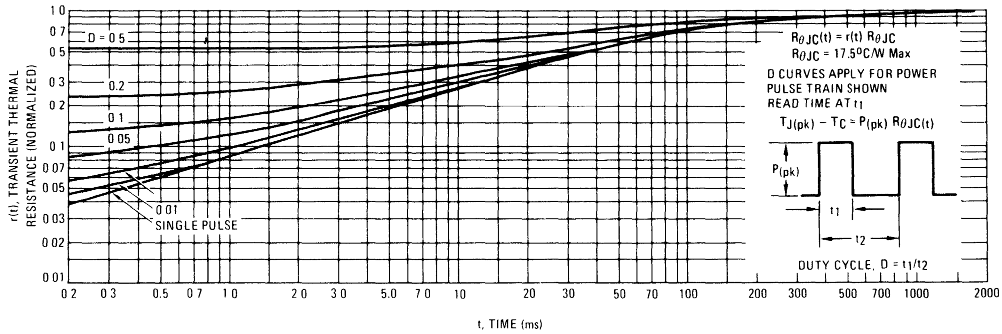


FIGURE 7 — ACTIVE-REGION SAFE OPERATING AREA

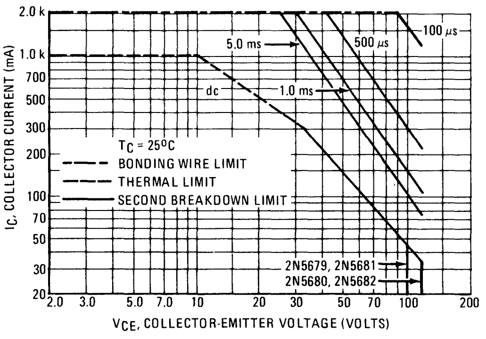
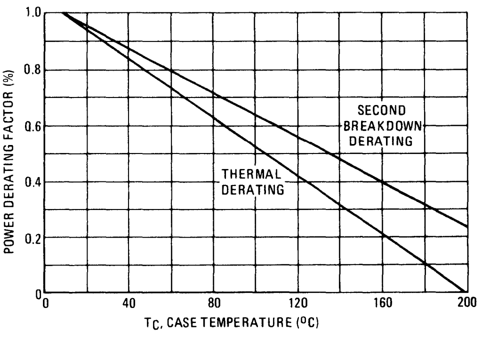


FIGURE 8 — POWER DERATING



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

The data of Figure 7 is based on T_C = 25°C; $T_{J(pk)}$ is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leqslant 200°C$. $T_{J(pk)}$ may be calculated from the data in Figure 6. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 7 may be found at any case temperature by using the appropriate curve on Figure 8.

PNP
2N5679, 2N5680

NPN
2N5681, 2N5682

FIGURE 9 — DC CURRENT GAIN

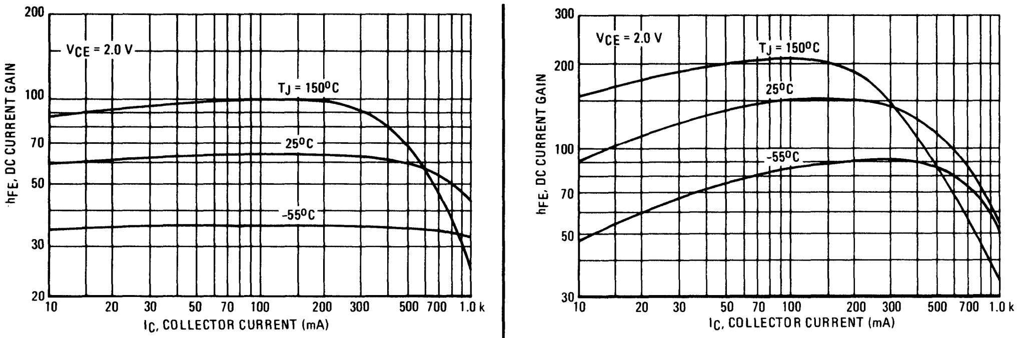


FIGURE 10 — COLLECTOR SATURATION REGION

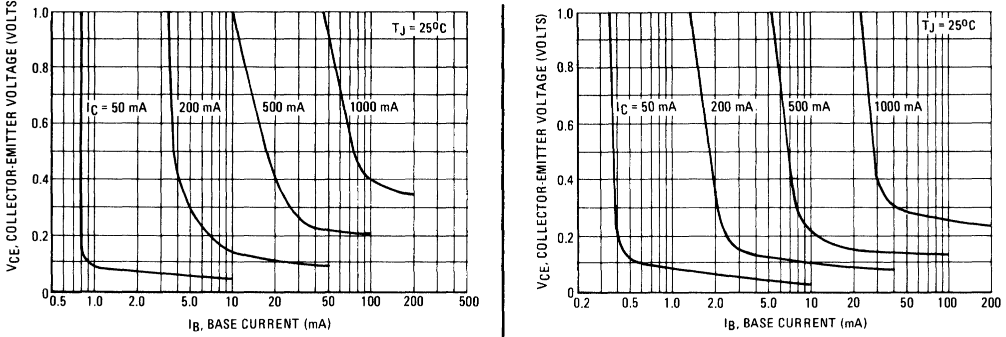
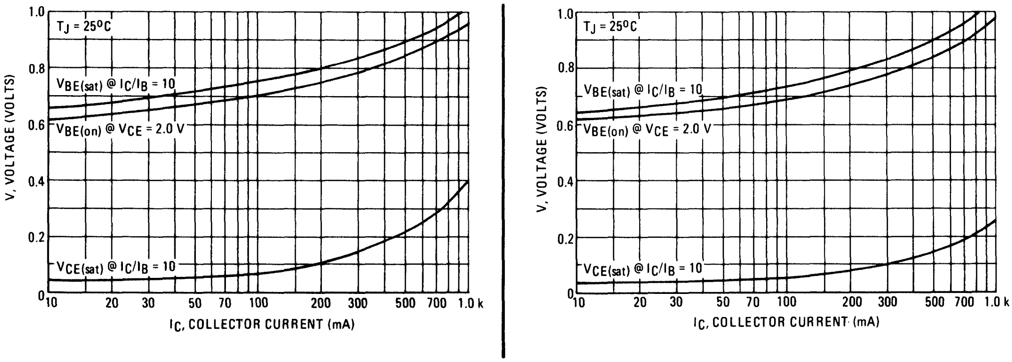


FIGURE 11 — "ON" VOLTAGES



PNP
2N5679, 2N5680

NPN
2N5681, 2N5682

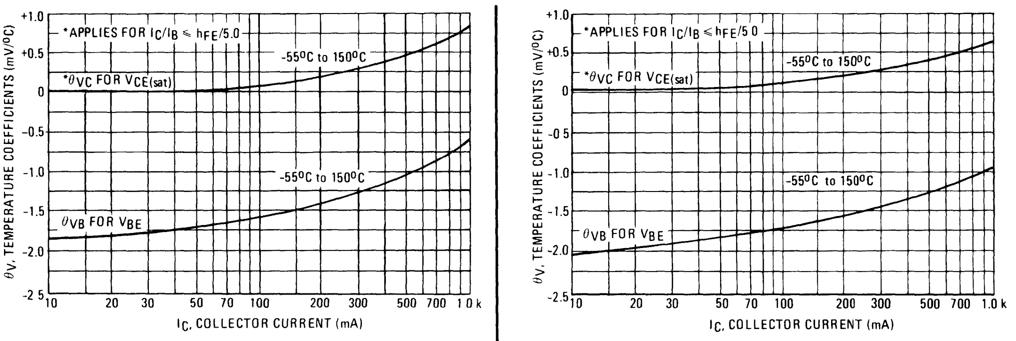


FIGURE 12 — TEMPERATURE COEFFICIENTS

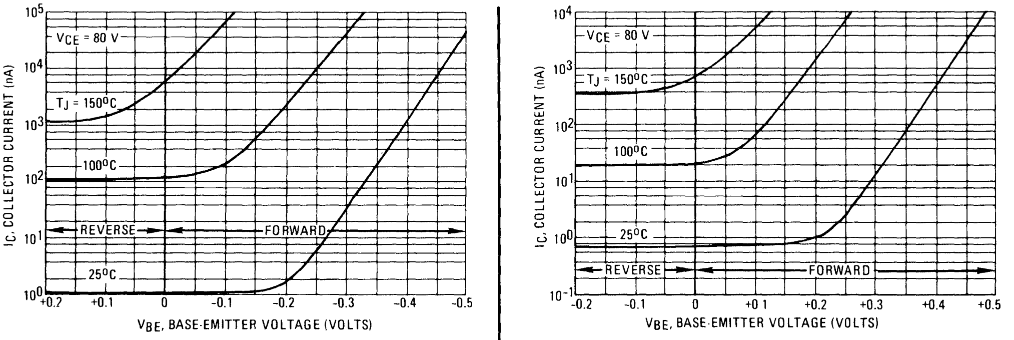


FIGURE 13 — COLLECTOR CUTOFF REGION

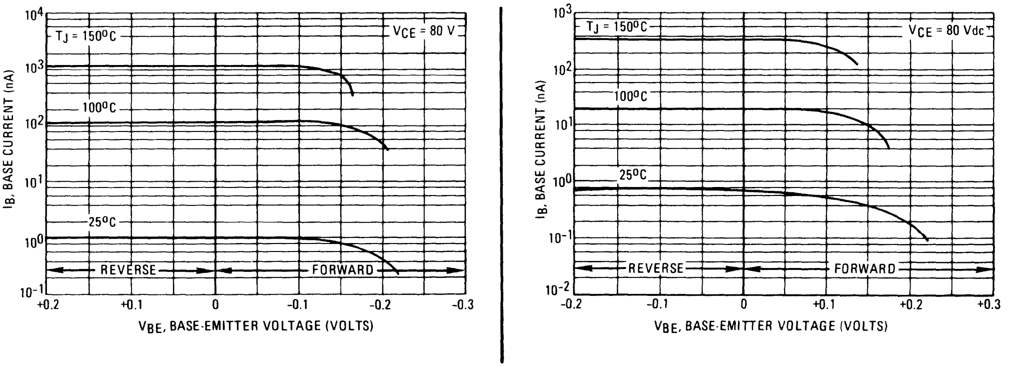
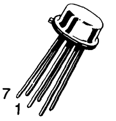
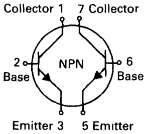


FIGURE 14 — BASE CUTOFF REGION

2N5793
2N5794

JAN, JTX, JTXV AVAILABLE
CASE 654-07, STYLE 1





DUAL TRANSISTORS

NPN SILICON

Refer to MD2218,A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	75		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	Both Die Equal Power	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	500 2.9	600 3.4	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9	2.0 11.43	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	75	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$)	I_{CBO}	—	10	nAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)	I_{EBO}	—	10	nAdc
Collector 1 to Collector 2 Leakage Current ($V_{1C\text{-}2C} = \pm 50$ Vdc)	$I_{C1\text{-}C2}$	—	±1.0	nAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
($I_C = 100\ \mu$Adc, $V_{CE} = 10$ Vdc) 2N5793		20	—	
2N5794		35	—	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) 2N5793		25	—	
2N5794		50	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N5793		35	—	
2N5794		75	—	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1) 2N5793		20	—	
2N5794		50	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N5793		40	120	
2N5794		100	300	
($I_C = 300$ mAdc, $V_{CE} = 10$ Vdc)(1) 2N5793		25	—	
2N5794		40	—	
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{CE(sat)}$	— —	0.3 0.9	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{BE(sat)}$	0.6 —	1.2 1.8	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product(2) ($I_C = 20$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	250	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{cb}	—	8.0	pF
Emitter-Base Capacitance ($V_{EB} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{eb}	—	25	pF

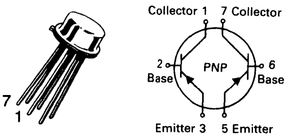
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Delay Time	($V_{CC} = 30$ Vdc, $V_{BE(off)} = 0.5$ Vdc, $I_C = 150$ mAdc, $I_{B1} = 15$ mAdc)	t_d	—	15	ns
Rise Time		t_r	—	30	ns
Storage Time	($V_{CC} = 30$ Vdc, $I_C = 150$ mAdc, $I_{B1} = I_{B2} = 15$ mAdc)	t_s	—	250	ns
Fall Time		t_f	—	60	ns

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

2N5795
2N5796

JAN, JTX, JTXV AVAILABLE
CASE 654-07, STYLE 1



DUAL TRANSISTORS

PNP SILICON

Refer to MD2904,A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	500 2.9	600 3.4	mW mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.9	2.0 11.43	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

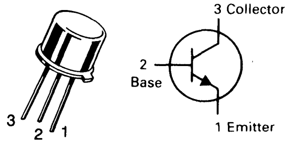
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$)		I_{CBO}	—	20	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	100	nAdc
Collector 1 to Collector 2 Leakage Current ($V_{1C-2C} = \pm 50$ Vdc		I_{C1-C2}	—	±1.0	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc)	2N5795		40	—	
	2N5796		75	—	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	2N5795		40	—	
	2N5796		100	—	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N5795		40	—	
	2N5796		100	—	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)(1)	2N5795		20	—	
	2N5796		50	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N5795		40	120	
	2N5796		100	300	
($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)(1)	2N5795		40	—	
	2N5796		50	—	
Collector-Emitter Saturation Voltage(1)	($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	— —	0.4 1.6	Vdc
Base-Emitter Saturation Voltage(1)	($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{BE(sat)}$	— —	1.3 2.6	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	200	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)		C_{cb}	—	8.0	pF
Emitter-Base Capacitance ($V_{EB} = 2.0$ Vdc, $I_C = 0$, f = 100 kHz)		C_{eb}	—	30	pF
SWITCHING CHARACTERISTICS (See Figure 1)					
Delay Time	($V_{CC} = 30$ Vdc, $V_{BE(off)} = 0.5$ Vdc, $I_C = 150$ mAdc, $I_{B1} = 15$ mAdc)	t_d	—	12	ns
Rise Time		t_r	—	35	ns
Storage Time	($V_{CC} = 30$ Vdc, $I_C = 150$ mAdc, $I_{B1} = I_{B2} = 15$ mAdc)	t_s	—	100	ns
Fall Time		t_f	—	40	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

2N5859

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	80	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 6.0	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

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

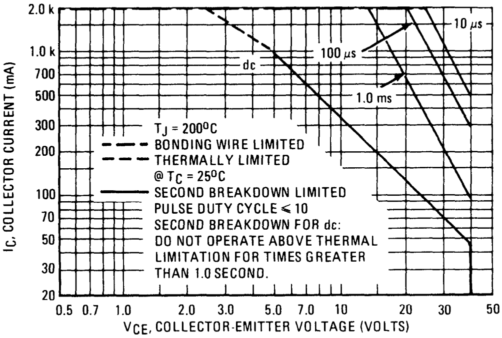
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	80	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 2.0 Vdc) (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 2.0 Vdc, T_A = 75°C)	I_{CEX}	— —	0.2 5.0	μAdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 75°C)	I_{CBO}	— —	0.25 5.0	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 500 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 1.0 Vdc) (I_C = 1.0 Adc, V_{CE} = 1.0 Vdc, T_A = −55°C)	h_{FE}	30 15 10	120 100 —	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{CE(sat)}$	— —	0.4 0.7	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{BE(sat)}$	0.8 0.9	1.0 1.25	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	250	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	—	7.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{eb}	—	60	pF
SWITCHING CHARACTERISTICS				
Delay Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc) (Figures 8 and 10)	t_d	—	6.0	ns
Rise Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc) (Figures 8 and 10)	t_r	—	30	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc) (Figures 9 and 11)	t_s	—	35	ns
Fall Time (V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc) (Figures 9 and 11)	t_f	—	35	ns

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

Characteristic	Symbol	Min	Max	Unit
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc) (Figures 8 and 10)	t_{on}	—	35	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc) (Figures 9 and 11)	t_{off}	—	60	ns

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

FIGURE 1 – ACTIVE-REGION SAFE OPERATING AREA



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

The data of Figure 1 is based on $T_{J(pk)}$ = 200°C; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leq$ 200°C. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

TYPICAL DC CHARACTERISTICS

FIGURE 2 – DC CURRENT GAIN

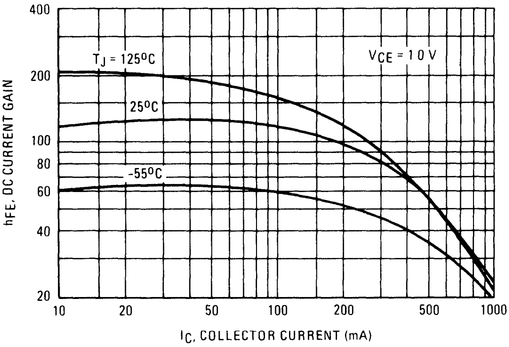


FIGURE 3 – "ON" VOLTAGES

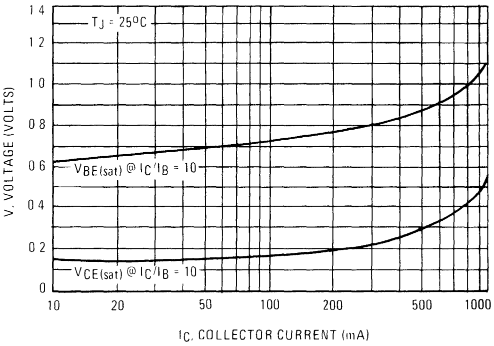


FIGURE 4 – COLLECTOR SATURATION REGION

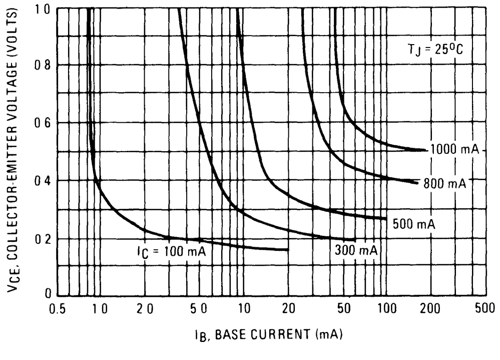
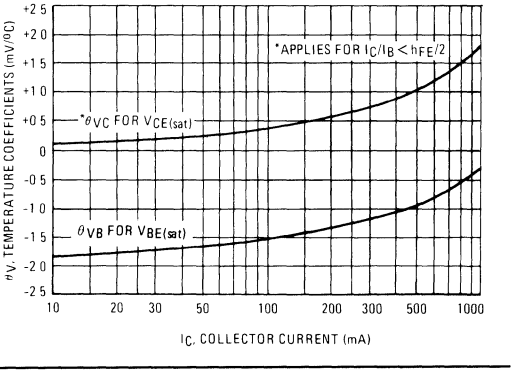


FIGURE 5 – TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 6 – CURRENT-GAIN–BANDWIDTH PRODUCT

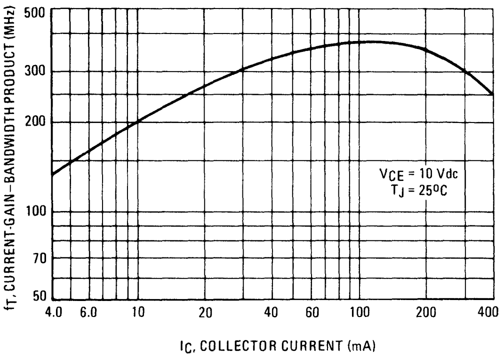


FIGURE 7 – CAPACITANCE

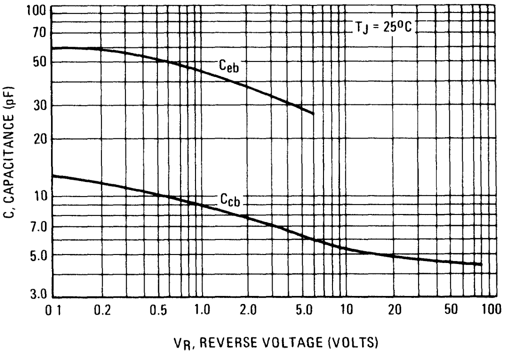


FIGURE 8 – TURN-ON TIME

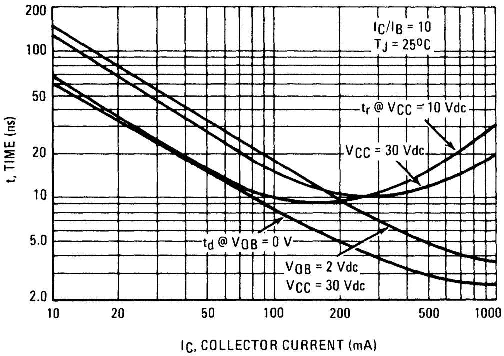


FIGURE 9 – TURN-OFF TIME

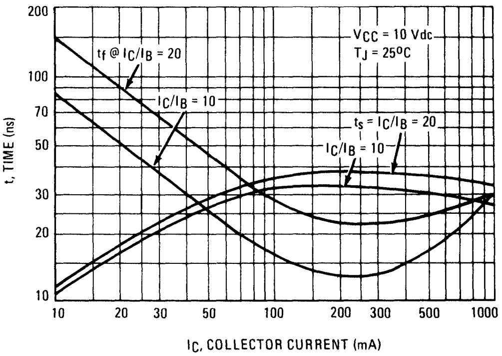
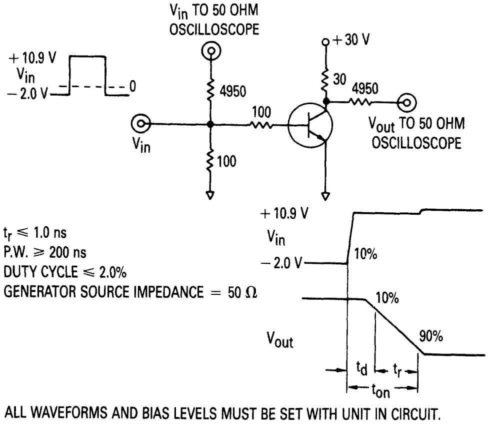


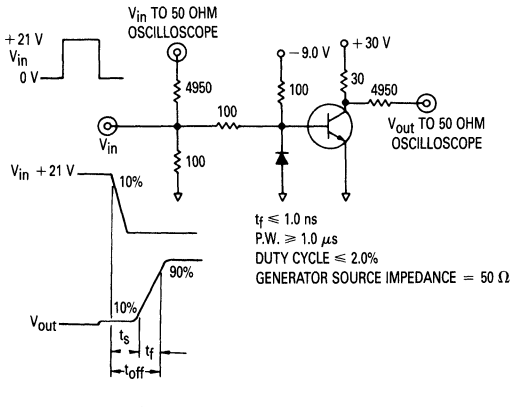
FIGURE 10 – TURN-ON TIME TEST CIRCUIT



$t_r \leq 1.0$ ns
P.W. ≥ 200 ns
DUTY CYCLE ≤ 2.0%
GENERATOR SOURCE IMPEDANCE = 50 Ω

ALL WAVEFORMS AND BIAS LEVELS MUST BE SET WITH UNIT IN CIRCUIT.

FIGURE 11 – TURN-OFF TIME TEST CIRCUIT

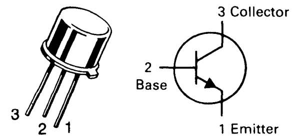


$t_f \leq 1.0$ ns
P.W. ≥ 1.0 μs
DUTY CYCLE ≤ 2.0%
GENERATOR SOURCE IMPEDANCE = 50 Ω

ALL WAVEFORMS AND BIAS LEVELS MUST BE SET WITH UNIT IN CIRCUIT.

2N5861

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 6.0	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 2.0 Vdc) (V_{CE} = 50 Vdc, $V_{BE(off)}$ = 2.0 Vdc, T_A = 75°C)	I_{CEX}	 — —	 0.3 10	μAdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = +75°C)	I_{CBO}	 — —	 0.3 10	μAdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS(1)				
DC Current Gain (I_C = 500 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc, T_A = −55°C)	h_{FE}	 25 10	 100 —	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	0.8	1.1	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	200	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	—	7.0	pF
Emitter-Base Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{eb}	—	60	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn-On Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc)	t_{on}	—	25	ns
Delay Time		t_d	—	8.0	ns
Rise Time		t_r	—	18	ns

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

Characteristic		Symbol	Min	Max	Unit
Turn-Off Time	(V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_{off}	—	60	ns
Storage Time		t_s	—	35	ns
Fall Time		t_f	—	35	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 1 — CURRENT-GAIN — BANDWIDTH PRODUCT

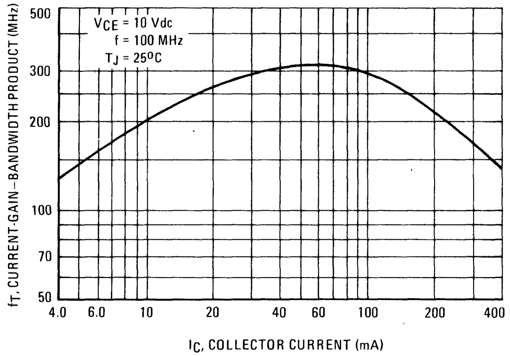


FIGURE 2 — CAPACITANCE

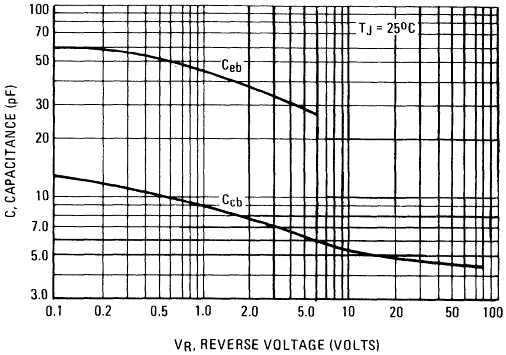


FIGURE 3 — TURN-ON TIME

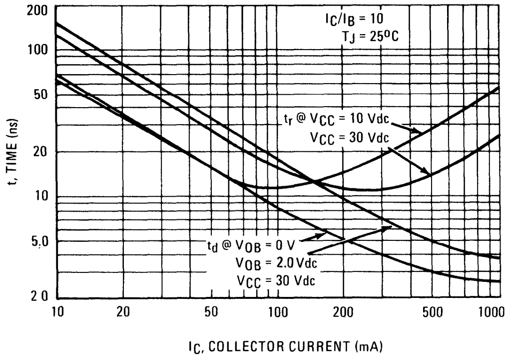


FIGURE 4 — TURN-OFF TIME

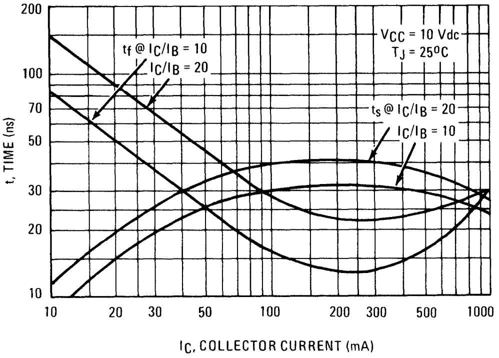
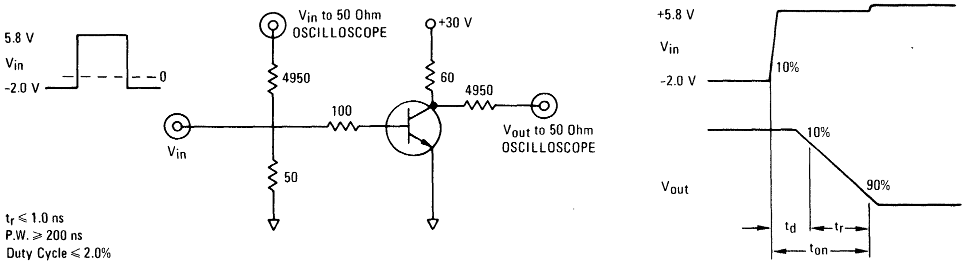


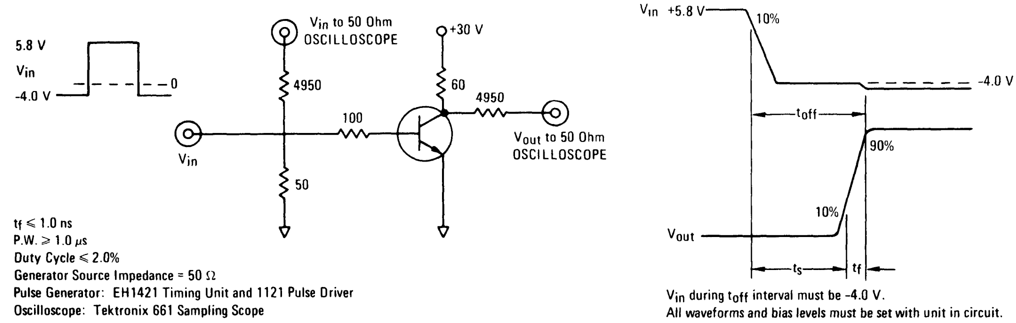
FIGURE 5 — TURN-ON TIME TEST CIRCUIT



t_r ≤ 1.0 ns
P.W. ≥ 200 ns
Duty Cycle ≤ 2.0%
Generator Source Impedance = 50 Ω
Pulse Generator: EH1421 Timing Unit and 1121 Pulse Driver
Oscilloscope: Tektronix 661 Sampling Scope

V_{in} during t_{on} interval must be +5.8 V.
All waveforms and bias levels must be set with unit in circuit.

FIGURE 6 — TURN-OFF TIME TEST CIRCUIT



tf ≤ 1.0 ns
P.W. ≥ 1.0 μs
Duty Cycle ≤ 2.0%
Generator Source Impedance = 50 Ω
Pulse Generator: EH1421 Timing Unit and 1121 Pulse Driver
Oscilloscope: Tektronix 661 Sampling Scope

Vin during toff interval must be -4.0 V.
All waveforms and bias levels must be set with unit in circuit.

FIGURE 7 — DC CURRENT GAIN

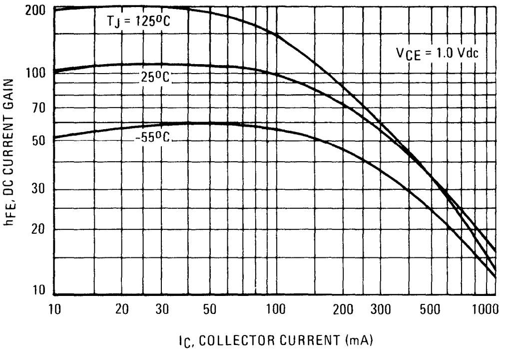


FIGURE 8 — "ON" VOLTAGES

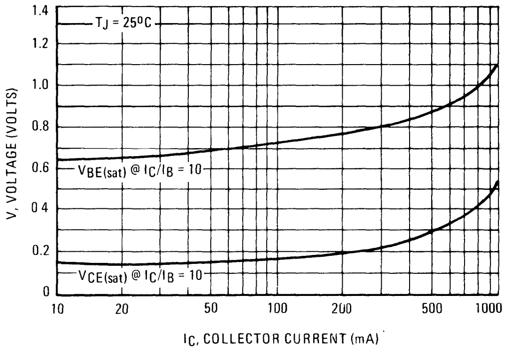


FIGURE 9 — ACTIVE-REGION SAFE OPERATING AREA

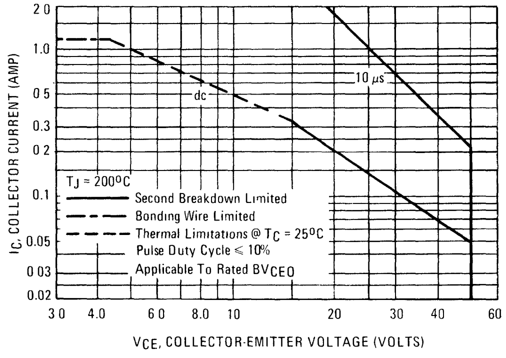
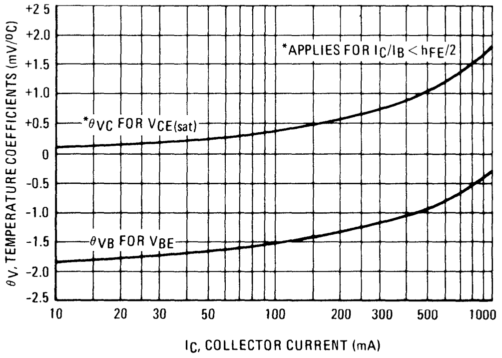


FIGURE 10 — TEMPERATURE COEFFICIENTS

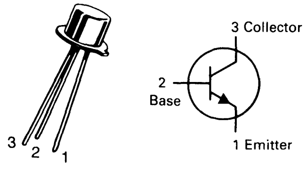


There are two limitations on the power handling ability of a transistor: junction temperature and secondary breakdown. Safe operating area curves indicate $I_C - V_{CE}$ limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation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

The data of Figure 9 is based on $T_{J(pk)} = 200°C$; T_C is variable depending on conditions. Pulse curves are valid for duty cycles of 10% provided $T_{J(pk)} \leq 200°C$. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

2N6430
2N6431

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	2N6430	2N6431	Unit
Collector-Emitter Voltage	V_{CEO}	200	300	Vdc
Collector-Base Voltage	V_{CBO}	200	300	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	50		mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	500 2.86		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10.3		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

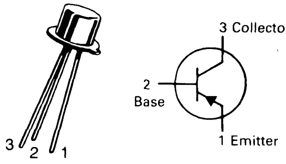
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	 2N6430 2N6431	$V_{(BR)CEO}$	 200 300	 — —	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	 2N6430 2N6431	$V_{(BR)CBO}$	 200 300	 — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 160$ Vdc) ($V_{CB} = 200$ Vdc)	 2N6430 2N6431	I_{CBO}	 — —	 0.1 0.1	μAdc
Emitter Cutoff Current ($V_{EB} = 4.0$ Vdc, $I_C = 0$)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)		h_{FE}	 25 40 50	 — — 200	—
Collector-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 20$ mAdc, $I_B = 2.0$ mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	50	500	MHz
Collector-Base Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{cb}	—	4.0	pF

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

2N6432
2N6433

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N3743 for graphs.

MAXIMUM RATINGS

Rating	Symbol	2N6432	2N6433	Unit
Collector-Emitter Voltage	V_{CEO}	200	300	Vdc
Collector-Base Voltage	V_{CBO}	200	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	500 2.86		mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10.3		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 1.0 mAdc, I_B = 0)	 2N6432 2N6433	$V_{(BR)CEO}$	 200 300	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	 2N6432 2N6433	$V_{(BR)CBO}$	 200 300	 — —	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 160 Vdc) (V_{CB} = 200 Vdc)	 2N6432 2N6433	I_{CBO}	 — —	 0.25 0.25	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 30 mAdc, V_{CE} = 10 Vdc)		h_{FE}	 25 40 30	 — — 150	—
Collector-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 20 mAdc, I_B = 2.0 mAdc)		$V_{BE(sat)}$	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)		f_T	50	500	MHz
Collector-Base Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	6.0	pF

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

PNP Hermetic Silicon

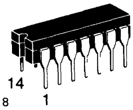
Quad General-Purpose Transistors Dual-In-Line and Flatpack Full Mil-S-19500 Qualified to JAN, JTX and JTXV Levels

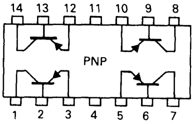
. . . designed for general-purpose switching circuits and DC to VHF amplifier applications.

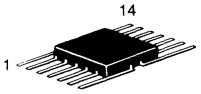
- Four Isolated Transistors
- DC Current Gain Specified — 0.1 to 500 mAdc
- Low Collector-Cutoff Current — I_{CBO} = 10 nAdc (Max) @ V_{CB} = 50 Vdc
- High Collector Breakdown Voltages — $V_{(BR)CEO}$ = 60 Vdc (Min)
  — $V_{(BR)CBO}$ = 60 Vdc (Min)
- Transistors Similar to 2N2907A
- M19500/2N6987, 2N6988

2N6987
2N6988

2N6987
CERAMIC
CASE 632-08, STYLE 1
TO-116







2N6988
CERAMIC
CASE 607-04
STYLE 1

QUAD TRANSISTORS
PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	60		Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		Each Transistor	**Total Device**	
2N6987 Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.525 3.0	1.5 8.57	Watts mW/°C
2N6988 Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.14 0.8	0.4 2.29	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

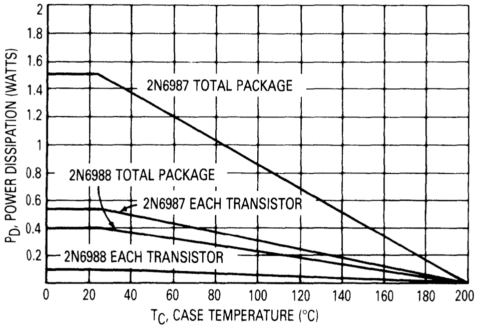


Figure 1. Power Temperature Derating Curve

Table 1. Product Classifications

JAN	— Controlled Lot with Sample Environmental and Life Testing
JTX	— 100% Processing Plus Sample Environmental and Life Testing
JTXV	— Same as JTX Plus 100% Internal Visual Inspection

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	60	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (I_E = 0, V_{CB} = 50 Vdc) (I_E = 0, V_{CB} = 50 V, T_A = 150°C)	I_{CBO}	— —	10 10	nAdc μA
Emitter Cutoff Current (I_C = 0, V_{CB} = 3.5 Vdc)	I_{EBO}	—	50	nAdc

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain[1]	h_{FE}			
(I_C = 0.1 mA, V_{CE} = 10 Vdc)		75	—	
(I_C = 1.0 mA, V_{CE} = 10 Vdc)		100	450	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		100	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)		100	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)		50	—	
(I_C = 10 mA, V_{CE} = 10 V, T_A = −55°C)		50	—	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	1.6	
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	1.3	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)		—	2.6	
DYNAMIC CHARACTERISTICS				
Small Signal Current Gain (V_{CE} = 10 V, I_C = 1.0 mA, f = 1.0 kHz)	h_{fe}	100	—	—
Magnitude of Small Signal Current-Gain (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	$\|h_{fe}\|$	2.0	8.0	—
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz to 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz to 1.0 MHz)	C_{ibo}	—	30	pF
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 2)	t_{on}	—	45	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 3)	t_{off}	—	300	ns

[1] Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2%.

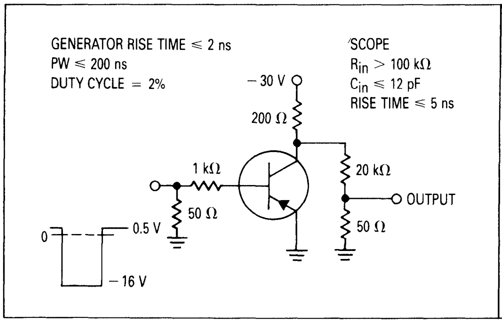


Figure 2. t_{on} Test Circuit

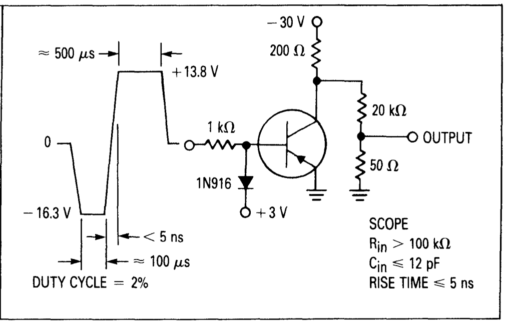


Figure 3. t_{off} Test Circuit

Table 2. JTX, JTXV 100% Processing Steps

	JTX	JTXV
Internal Visual (Mil-Std-750, Method 2072)	—	100%
High Temperature Storage (Mil-Std-750, Method 1032)	100%	100%
Thermal Shock (Mil-Std-750, Method 1051 Cond. F*)	100%	100%
Constant Acceleration (Mil-Std-750, Method 2006, 20 KG^S, Y_1)	100%	100%
Hermetic Seal (Fine + Gross Leak) (Mil-Std-750, Method 1071, Cond. G or H)**	100%	100%
READ Electrical Parameters (Group A)	100%	100%
High Temperature Reverse Bias (Mil-Std-750, Method 1039, Cond. A)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
Power Burn-In (Mil-Std-750, Method 1039, Cond. B)	100%	100%
READ Electrical Parameters (Group A)	100%	100%

*$T_{(LOW)}$ = −55°C
**Cond. G, Fine Leak = 1 x 10^{-7} ATM. CC/sec.

Table 3. Simplified Hi-Rel Product Flow

JAN	JTX	JTXV
Commercial Product ↓ Group A, B, C Sample Test ↓ Ship	Commercial Product ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship	100% Pre Cap Visual ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship

NPN Hermetic Silicon

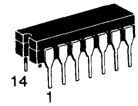
Quad General-Purpose Transistors Dual-In-Line and Flatpack Full Mil-S-19500 Qualified to JAN, JTX and JTXV Levels

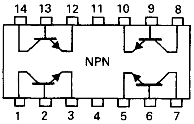
... designed for general-purpose switching circuits and DC to VHF amplifier applications.

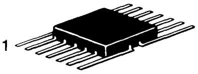
- Four Isolated Transistors
- DC Current Gain Specified — 0.1 to 500 mAdc
- Low Collector-Cutoff Current — I_{CBO} = 10 nAdc (Max) @ V_{CB} = 60 Vdc
- High Collector Breakdown Voltages — $V_{(BR)CEO}$ = 50 Vdc (Min)
  — $V_{(BR)CBO}$ = 75 Vdc (Min)
- Transistors Similar to 2N2222A
- M19500/2N6989, 2N6990

2N6989
2N6990

2N6989
CERAMIC
CASE 632-08, STYLE 1
TO-116







2N6990
CERAMIC
CASE 607-04
STYLE 1

QUAD TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	50		Vdc
Collector-Base Voltage	V_{CB}	75		Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current — Continuous	I_C	800		mAdc
		Each Transistor	Total Device	
2N6989 Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.525 3.0	1.5 8.57	Watts mW/°C
2N6990 Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.14 0.8	0.4 2.29	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

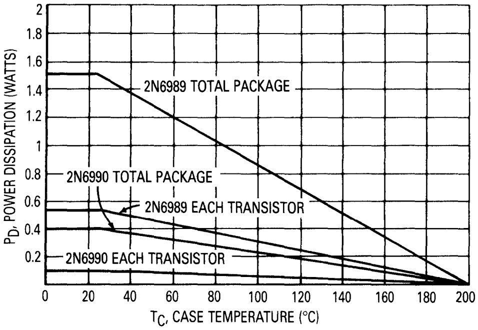


Figure 1. Power Temperature Derating Curve

Table 1. Product Classifications

JAN	— Controlled Lot with Sample Environmental and Life Testing
JTX	— 100% Processing Plus Sample Environmental and Life Testing
JTXV	— Same as JTX Plus 100% Internal Visual Inspection

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (I_E = 0, V_{CB} = 60 Vdc) (I_E = 0, V_{CB} = 60 V, T_A = 150°C)	I_{CBO}	— —	10 10	nAdc μA
Emitter Cutoff Current (I_C = 0, V_{CB} = 4.0 Vdc)	I_{EBO}	—	10	nAdc

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

Characteristic	Symbol	Min	Max	Unit
ON CHARACTERISTICS				
DC Current Gain(1) (I_C = 0.1 mA, V_{CE} = 10 Vdc) (I_C = 1.0 mA, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 150 mAdc, V_{CE} = 10 Vdc) (I_C = 500 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mA, V_{CE} = 10 V, T_A = −55°C)	h_{FE}	 50 75 100 100 30 35	 — 325 — 300 — —	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	— —	0.3 1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	0.6 —	1.2 2.0	Vdc
DYNAMIC CHARACTERISTICS				
Small Signal Current Gain (V_{CE} = 10 V, I_C = 1.0 mA, f = 1.0 kHz)	h_{fe}	50	—	—
Magnitude of Small Signal Current-Gain (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	$\|h_{fe}\|$	2.5	8.0	—
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz to 1.0 MHz)	C_{obo}	—	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz to 1.0 MHz)	C_{ibo}	—	25	pF
SWITCHING CHARACTERISTICS				
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc) (Figure 2)	t_{on}	—	35	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) (Figure 3)	t_{off}	—	300	ns

(1)Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2%.

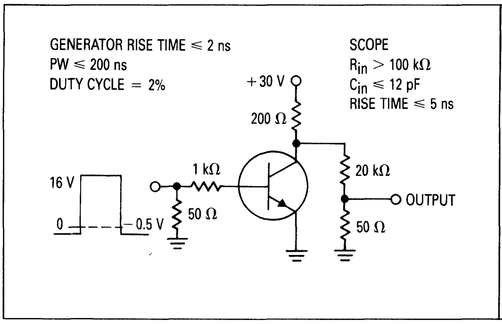


Figure 2. t_{on} Test Circuit

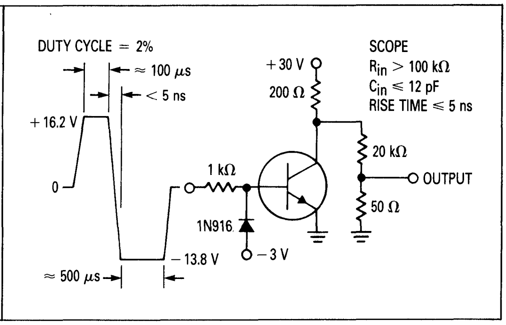


Figure 3. t_{off} Test Circuit

Table 2. JTX, JTXV 100% Processing Steps

	JTX	JTXV
Internal Visual (Mil-Std-750, Method 2072)	—	100%
High Temperature Storage (Mil-Std-750, Method 1032)	100%	100%
Thermal Shock (Mil-Std-750, Method 1051 Cond. F*)	100%	100%
Constant Acceleration (Mil-Std-750, Method 2006, 20 KG^S, Y_1)	100%	100%
Hermetic Seal (Fine + Gross Leak) (Mil-Std-750, Method 1071, Cond. G or H)**	100%	100%
READ Electrical Parameters (Group A)	100%	100%
High Temperature Reverse Bias (Mil-Std-750, Method 1039, Cond. A)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
Power Burn-In (Mil-Std-750, Method 1039, Cond. B)	100%	100%
READ Electrical Parameters (Group A)	100%	100%

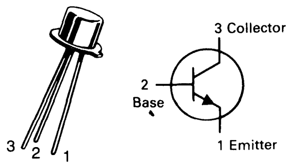
*$T_{(LOW)}$ = −55°C
**Cond. G, Fine Leak = 1 x 10^{-7} ATM. CC/sec.

Table 3. Simplified Hi-Rel Product Flow

JAN	JTX	JTXV
Commercial Product ↓ Group A, B, C Sample Test ↓ Ship	Commercial Product ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship	100% Pre Cap Visual ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship

BC107, A, B, C
thru
BC109, A, B, C

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTORS
NPN SILICON

3

MAXIMUM RATINGS

Rating	Symbol	BC 107	BC 108	BC 109	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	30	Vdc
Emitter-Base Voltage	V_{EBO}	6	5	5	Vdc
Collector Current – Continuous	I_C	0.2			Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 2.28			Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1 6.67			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	175	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Base Leakage Current		I_{CBO}				
(I_E = 0, V_{CB} = 45 V)	BC107				15	nA
(I_E = 0, V_{CB} = 45 V, T_{Amb} = 125°C)	BC107				4	µA
(I_E = 0, V_{CB} = 25 V)	BC108/109				15	nA
(I_E = 0, V_{CB} = 25 V, T_{Amb} = 125°C)	BC108/109				4	µA
Emitter Base Breakdown Voltage		$V_{(BR)EBO}$				V
(I_E = 10 µA, I_C = 0)	BC107		6			
	BC108/109		5			
Collector Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
(I_C = 2 mA, I_E = 0)	BC107		45			
	BC108/109		25			
ON CHARACTERISTICS						
DC Current gain		h_{FE}				
(V_{CE} = 5 V, I_C = 2 mA)	BC107		110		450	
	BC108		110		800	
	BC109		200		800	
	A group		110		220	
	B group		200		450	
	C group		420		800	
(V_{CE} = 5 V, I_C = 10 µA)	B group		40			
	C group		100			
Base Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)				0.7	0.83	
(I_C = 100 mA, I_B = 5 mA)				1.0	1.05	
Collector Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 10 mA, I_B = 0.5 mA)					0.25	
(I_C = 100 mA, I_B = 5 mA)					0.60	
Base Emitter on Voltage		$V_{BE(on)}$				V
(I_C = 2 mA, V_{CE} = 5 V)			0.55		0.70	
(I_C = 10 mA, V_{CE} = 5 V)					0.77	
Collector Knee Voltage		$V_{CE(K)}$				V
(I_C = 10 mA, I_B = the value for which I_C = 11 mA at V_{CE} = 1 V)				0.4	0.6	
DYNAMIC CHARACTERISTICS						
Transition Frequency		f_T				MHz
(I_C = 10 mA, f = 100 MHz, V_{CE} = 5 V)			150	300		
Noise Figure		NF				dB
(V_{CE} = 5 V, I_C = 0.2 mA, R_g = 2 KΩ)						
F = 30 Hz to 15 kHz	BC109				4	
F = 1 kHz, ΔF = 200 Hz	BC109				4	
	BC107/108				10	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Output Capacitance (V_{CB} = 10 V, f = 1 MHz)		C_{obo}			4.5	pF
h_{21e} Parameters (V_{CE} = 5 V, I_C = 2 mA, f = 1 kHz)	BC107/108	h_{21e}	125		500	
	BC109		240		900	
	A group		125		260	
	B group		240		500	
	C group		450		900	
h_{11e} Parameters (V_{CE} = 5 V, I_C = 2 mA, f = 1 kHz)	A group	h_{11e}	1.6		4.5	KΩ
	B group		3.2		8.5	
	C group		6.0		15	
h_{22e} Parameters (V_{CE} = 5 V, I_C = 2 mA, f = 1 kHz)	A group	h_{22e}			30	µhos
	B group				60	
	C group				110	

FIGURE 1 — EMITTER-BASE CAPACITANCE COLLECTOR-BASE CAPACITANCE

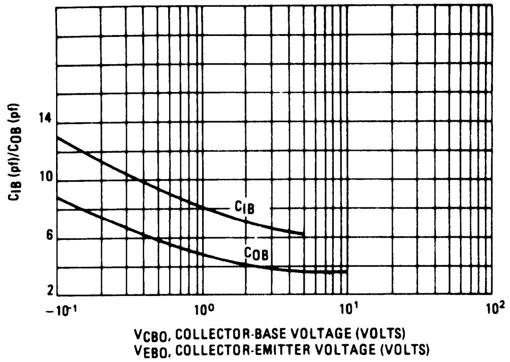


FIGURE 2 — CURRENT GAIN — BANDWIDTH PRODUCT

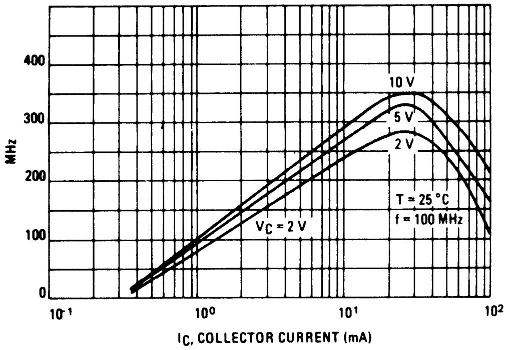
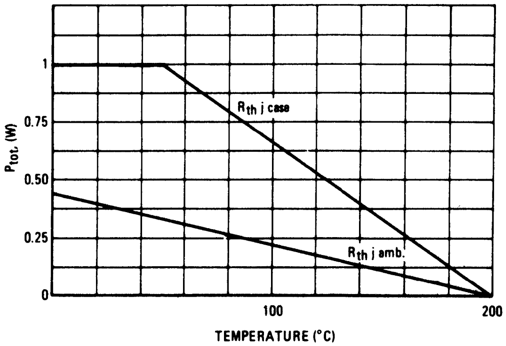
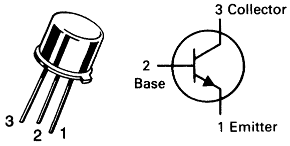


FIGURE 3 — TOTAL PERMISSIBLE POWER DISSIPATION



BC140-10, -16
BC141-10, -16

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 140	BC 141	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	7		Vdc
Collector Current – Continuous	I_C	1		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.6		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.7 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

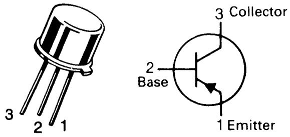
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector Cutoff Current ($I_E = 0$, $V_{CE} = 60$ V) $T_A = 150°C$	I_{CES}		100 100	nA µA
Collector-Emitter Breakdown Voltage BC140 Series ($I_{CES} = 100$ µA, $I_E = 0$) BC141 Series	$V_{(BR)CES}$	80 100		V
Collector-Emitter Breakdown Voltage(1) ($I_C = 30$ mA, $I_B = 0$) BC140 Series BC141 Series	$V_{(BR)CEO}$	40 60		V
Emitter-Base Breakdown Voltage ($I_E = 100$ µA, $I_C = 0$)	$V_{(BR)EBO}$	7		V
ON CHARACTERISTICS				
DC Current Gain(1) ($I_C = 100$ mA, $V_{CE} = 1$ V) for BC140, 141, -10 for BC140, 141, -16	h_{FE}	63 100	160 250	
Collector-Emitter Saturation Voltage(1) ($I_C = 1$ A, $I_B = 0.1$ A)	$V_{CE(sat)}$		1	V
Base-Emitter Voltage(1) ($I_C = 1$ A, $V_{CE} = 1$ V)	$V_{BE(on)}$		2	V
SMALL SIGNAL CHARACTERISTICS				
Gain Bandwidth Product ($I_C = 50$ mA, $V_{CE} = 10$ V, f = 20 MHz)	f_T	50		MHz
Input Capacitance ($V_{EB} = 0{,}5$ V, $I_C = 0$, f = 1 MHz	C_{ib}		80	pF
Capacitance ($I_E = 0$, $V_{CB} = 10$ V, f = 1 MHz)	C_{ob}		25	pF
Turn On Time ($I_C = 150$ mA, $I_{B1} = 7.5$ mA)	t_{on}		250	ns
Turn Off Time ($I_C = 150$ mA, $I_{B1} = I_{B2} = 7.5$ mA)	t_{off}		850	ns

(1) Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

BC160, -6, -10, -16
BC161, -6, -10, -16

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N4033 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BC 160	BC 161	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	40	60	Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
Collector Current − Continuous	I_C	1		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.6		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.7 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

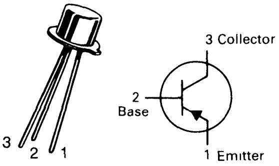
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector Cutoff Current I_E = 0, V_{CES} = −40 V for BC160 V_{CES} = −60 V for BC161 V_{CES} = −40 V for BC160 T_{Amb} = 150°C V_{CES} = −60 V for BC161 T_{Amb} = 150°C	I_{CES}		 −100 −100 −100 −100	 nA μA
Collector Emitter Breakdown Voltage I_C = −100 μA, I_E = 0 for BC160 Series for BC161 Series	$V_{(BR)CES}$	 −40 −60		V
Collector-Emitter Breakdown Voltage(1) I_C = −10 mA, I_B = 0 for BC160 Series for BC161 Series	$V_{(BR)CEO}$	 −40 −60		V
Emittor-Base Breakdown Voltage I_E = −100 μA, I_C = 0	$V_{(BR)EBO}$	 −5		V
ON CHARACTERISTICS				
DC Current Gain(1) I_C = −100 mA, V_{CE} = −1 V for BC160, BC161 for BC160, BC161, -6 for BC160, BC161, -10 for BC160, BC161, -16	h_{FE}	 40 40 63 100	 400 100 160 250	
Collector-Emitter Saturation Voltage(1) (I_C = −1 A, I_B = −0.1 A)	$V_{CE(sat)}$		 −1	V
Base-Emitter Voltage(1) (I_C = −1 A, V_{CE} = −1 V)	$V_{BE(on)}$		 −1.7	V
SMALL SIGNAL CHARACTERISTICS				
Gain Bandwidth Product (I_C = −50 mA, V_{CE} = −10 V, f = 20 MHz	f_T	 50		MHz
Input Capacitance (V_{EB} = −10 V, f = 1 MHz)	C_{ib}		 180	pF
Output Capacitance (V_{CB} = −10 V, I_E = 0, f = 1 MHz)	C_{obo}		 30	pF
Turn On Time (I_C = −100 mA, I_{B1} = −5 μA)	T_{on}		 500	ns
Turn Off Time (I_C = −100 mA, I_{B1} = I_{B2} = −5 μA)	T_{off}		 650	ns

(1) Pulsed: Pulse Duration = 300 μs, Duty Cycle = 1%.

BC177, A, B, C
thru
BC179, A, B, C

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BC 177	BC 178	BC 179	Unit
Collector-Emitter Voltage	V_{CEO}	45	25	20	Vdc
Collector-Emitter Voltage	V_{CES}	50	30	25	Vdc
Collector-Base Voltage	V_{CBO}	50	30	25	Vdc
Emitter-Base Voltage	V_{EBO}	5			Vdc
Collector Current − Continuous	I_C	0.2			Amp
Total Device Dissipation @T_A = 25°C Derate above 25°C	P_D	0.6 2.28			Watt mW/°C
Total Device Dissipation @T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1 6.67			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	175	°C/W

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

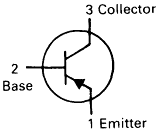
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Emitter Leakage Current (V_{CE} = 20 V, I_E = 0) (V_{CE} = 20 V, I_E = 0, T_{Amb} = 125°C)		I_{CES}			 100 4	 nA μA
Collector Base Breakdown Voltage (I_C = 10 μA)	BC177 BC178 BC179	$V_{(BR)CBO}$	50 30 25			V
Collector Emitter Breakdown Voltage (I_C = 2 mA, I_E = 0)	BC177 BC178 BC179	$V_{(BR)CEO}$	45 25 20			V
Emitter Base Breakdown Voltage (I_E = 10 μA, I_C = 0)		$V_{(BR)EBO}$	5			V
ON CHARACTERISTICS						
DC Current Gain (I_C = 2 mA, V_{CE} = 5 V)	BC177 BC178 BC179 A Group B Group C Group	h_{FE}	120 120 180 120 180 380		460 800 800 220 460 800	
Collector Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5 mA)		$V_{CE(sat)}$			 0.2 0.6	V
Base Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.5 mA) (I_C = 100 mA, I_B = 5 mA)		$V_{BE(sat)}$		 0.7 0.9	 0.8	V
Base Emitter on Voltage (I_C = 2 mA, V_{CE} = 5 V)		$V_{BE(on)}$	 0.6		 0.75	V
Collector Knee Voltage (I_C = 10 mA, I_B = the value for which (I_C = 11 mA, at V_{CE} = 1V)		$V_{CE(K)}$		 0.4	 0.6	V
DYNAMIC CHARACTERISTICS						
Transition Frequency (V_{CE} = 5 V, I_C = 10 mA, f = 50 MHz)		f_T	 200	 300		MHz
Noise Figure (V_{CE} = 5 V, I_C = 0.2 mA, R_g = 2 KΩ) F = 30 Hz to 15 kHz F = 1 kHz, F = 200 Hz	 BC179 BC179 BC177/178	NF			 4 4 10	dB

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

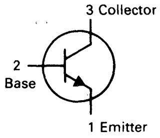
Characteristic		Symbol	Min	Typ	Max	Unit
Output Capacitance (V_{CB} = 10 V, f = 1 MHz)		C_{obo}		3.5	4	pF
h_{21e} Parameters (V_{CE} = 5 V, I_C = 2 mA, f = 1 kHz)	BC177	h_{21e}	125		500	
	BC178		125		900	
	BC179		240		900	
	A Group		125		260	
	B Group		240		500	
	C Group		450		900	
h_{11e} Parameters (V_{CE} = 5 V, I_C = 2 mA, f = 1 kHz)	A Group	h_{11e}	1.6		4.5	KΩ
	B Group		3.2		8.5	
	C Group		6.0		15.0	
h_{22e} Parameters (V_{GE} = 5 V, I_C = 2 mA, f = 1 kHz)	A Group	h_{22e}			30	µmhos
	B Group				60	
	C Group				110	

BC393 BC394

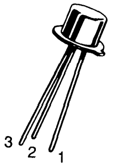
BC393
PNP



BC394
NPN



CASE 22-03, STYLE 1
TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	BC 393	BC 394	Unit
Collector-Emitter Voltage	V_{CEO}	180	180	Vdc
Collector-Base Voltage	V_{CBO}	180	180	Vdc
Emitter-Base Voltage	V_{EBO}	6	6	Vdc
Collector Current – Continuous	I_C	0.5		Amp
Total Device Dissipation @T_A = 25°C Derate above 25°C	P_D	0.4 2.66		Watt mW/°C
Total Device Dissipation @T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.5 10.0		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W

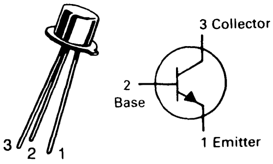
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	180			Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	180			Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	6			Vdc
Collector Cutoff Current (V_{CB} = 100 V, I_E = 0)	I_{CBO}			50	nA
Collector-Emitter Cutoff (V_{CE} = 100 V, I_B = 0) (T_{Amb} = 150°C)	I_{CEO}			50	μA
ON CHARACTERISTICS(1)					
DC Current Gain (I_C = 10 mA, V_{CE} = 10 V)	h_{FE}	50	100		
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1 mAdc)	$V_{CE(sat)}$		0.15	0.3	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1 mAdc)	$V_{BE(sat)}$		0.7	0.9	Vdc
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	50	110	200	MHz
Output Capacitance (I_E = 0, V_{CB} = 20 Vdc, f = 1 MHz)	C_{obo}	—	3.5	7	pF
Input Capacitance (I_C = 0, V_{EB} = 0.5 Vdc, f = 1 MHz)	C_{ib}	—	75	—	pF
Turn-On Time (I_{B1} = 10 mA, I_C = 50 mAdc, V_{CC} = 100 Vdc))	t_{on}	—	100	—	ns
Turn-Off Time (I_{B2} = 10 mAdc, I_C = 50 mAdc, V_{CC} = 100 Vdc))	t_{off}	—	400	—	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.

BCY58 -VII, -VIII, -IX, -X
BCY59 -VII, -VIII, -IX, -X

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BCY 58	BCY 59	Unit
Collector-Emitter Voltage	V_{CEO}	32	45	Vdc
Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CES}	32	45	Vdc
Emitter-Base Voltage	V_{EBO}	7		Vdc
Collector Current − Continuous	I_C	0.2		Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 2.28		Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1 6.67		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	150	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	450	°C/W

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_C = 0)	BCY58 BCY59	$V_{(BR)CEO}$	32 45			Vdc
Emitter-Base Breakdown Voltage (I_E = 1μAdc, I_C = 0)	all	$V_{(BR)EBO}$	7			Vdc
Collector Cutoff Current						nAdc
(V_{CE} = 32 V)	BCY58	I_{CES}		0.2	10	
(V_{CE} = 45 V)	BCY59			0.2	10	
(V_{CE} = 32 V, T_A = 100°C, V_{BE} = 0.2 V)	BCY58	I_{CEX}			20	μAdc
(V_{CE} = 45 V, T_A = 100°C, V_{BE} = 0.2 V)	BCY59				20	
(V_{CE} = 32 V, T_A = 150°)	BCY58	I_{CES}		0.2	10	μAdc
(V_{CE} = 45 V, T_A = 150°)	BCY59			0.5	10	
Emitter Base Cutoff Current (V_{EB} = 5 V)	all	I_{EBO}			10	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 10 μAdc, V_{CE} = 5 Vdc)	BCY59-VII, BCY58-VII					
	BCY59-VIII, BCY58-VIII		20	145		
	BCY59-IX, BCY58-IX		40	220		
	BCY59-X, BCY58-X		100	300		
(I_C = 2 mAdc, V_{CE} = 5 Vdc)	BCY59-VII, BCY58-VII		120	170	220	
	BCY59-VIII, BCY58-VIII		180	250	310	
	BCY59-IX, BCY58-IX		250	350	460	
	BCY59-X, BCY58-X		380	500	630	
(I_C = 10 mAdc, V_{CE} = 1 Vdc)	BCY59-VII, BCY58-VII		80	190		
	BCY59-VIII, BCY58-VIII		120	260	400	
	BCY59-IX, BCY58-IX		160	380	630	
	BCY59-X, BCY58-X		240	550	1000	
(I_C = 100 mAdc, V_{CE} = 1 Vdc)	BCY59-VII, BCY58-VII		40			
	BCY59-VIII, BCY58-VIII		45			
	BCY59-IX, BCY58-IX		60			
	BCY59-X, BCY58-X		60			
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 2.5 mAdc) (I_C = 10 mAdc, I_B = 0.25 mA)	all	$V_{CE(sat)}$	0.15 0.05	0.30 0.12	0.70 0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.25 mA) (I_C = 100 mA, I_B = 2.5 mA)	all	$V_{BE(sat)}$	0.6 0.75	0.70 0.90	0.85 1.2	Vdc
Base-Emitter on Voltage (I_C = 2 mAdc, V_{CE} = 5 Vdc)	all	$V_{BE(on)}$	0.55	0.62	0.70	Vdc

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS SMALL SIGNAL CHARACTERISTICS						
Current Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 V, f = 100 MHz)	all	f_T	125	200		MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1 MHz)	all	C_{ob}		3.5	6	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1 MHz)	all	C_{ib}		8	15	pF
Small Signal Current Gain (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY58-VII, BCY59-VII	h_{fe} (h_{21e})	125	200	250	
	BCY58-VIII, BCY59-VIII		175	260	350	
	BCY58-IX, BCY59-IX		250	330	500	
	BCY58-X, BCY59-X		350	520	700	
Output Admittance (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY58-VII, BCY59-VII	h_{oe} (h_{22e})			30	μmhos
	BCY58-VIII, BCY59-VIII				50	
	BCY58-IX, BCY59-IX				60	
	BCY58-X, BCY59-X				100	
Input Impedance (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY58-VII, BCY59-VII	h_{ie} (h_{11e})	1.6		4.5	Kohms
	BCY58-VIII, BCY59-VIII		2.5		6	
	BCY58-IX, BCY59-IX		3.2		8.5	
	BCY58-X, BCY59-X		4.5		12	
Voltage Feedback Ratio (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = kHz)	BCY58-VII, BCY59-VII	h_{re} (h_{12e})		1.5		$\times 10^{-4}$
	BCY58-VIII, BCY59-VIII			2		
	BCY58-IX, BCY59-IX			2		
	BCY58-X, BCY59-X			3		
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 1 kHz)	all	N_F		2	6	dB
SWITCHING CHARACTERISTICS						
I_C = 10 mA, I_{B1} = 1 mA, I_{B2} = 1 mA		t_d		35		nS
V_{BB} = 3.6 V, R_1 = R_2 = 5 KΩ		t_r		50		
R_L = 990 ohms		t_{on}		85	150	
* See test circuit.		t_s		400		
		t_f		80		
		t_{off}		480	800	
I_C = 100 mA, I_{B1} = 10 mA, I_{B2} = 10 mA		t_d		5		nS
V_{BB} = 5 V, R_1 = 500 Ω, R_2 = 700 Ω		t_r		50		
R_L = 98 ohms		t_{on}		55	150	
* See test circuit.		t_s		250		
		t_f		200		
		t_{off}		450	800	

TEST CIRCUIT

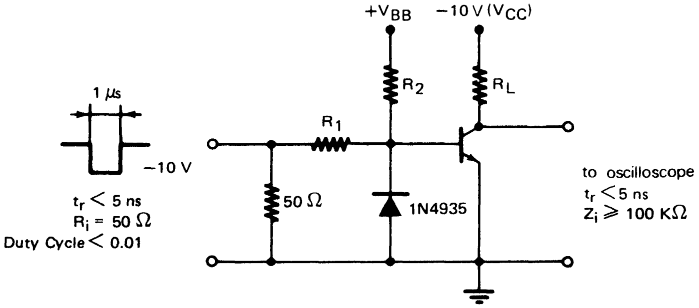


FIGURE 1 – CURRENT GAIN (BCY58-VII/BCY59-VII)

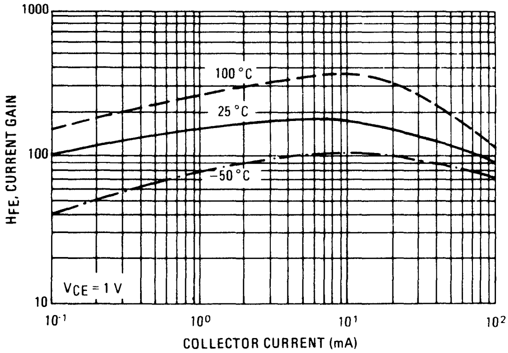


FIGURE 2 – CURRENT GAIN (BCY58-VIII/BCY59-VIII)

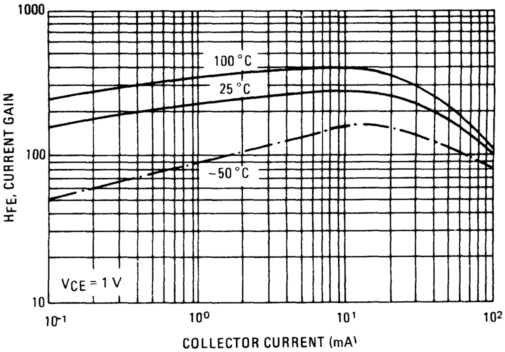


FIGURE 3 – CURRENT GAIN (BCY58-IX/BCY59-IX)

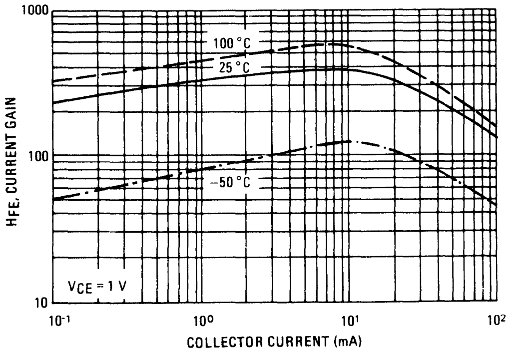


FIGURE 4 – CURRENT GAIN (BCY58-X/BCY59-X)

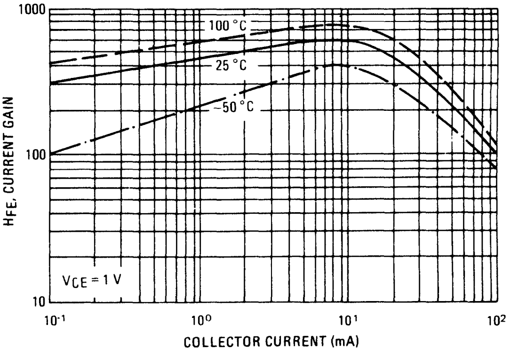


FIGURE 5 – SATURATION VOLTAGE

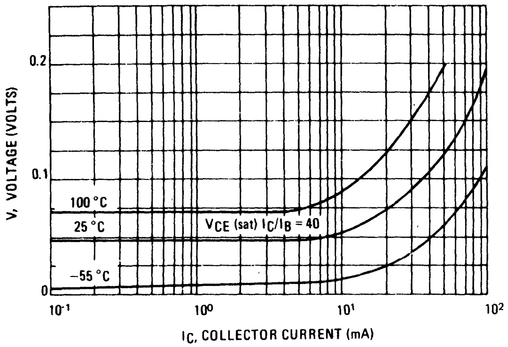


FIGURE 6 – SATURATION VOLTAGE

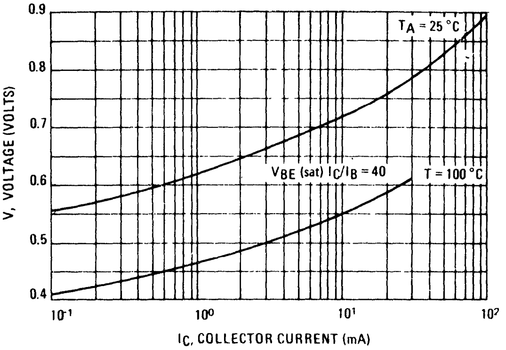


FIGURE 7 – INPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

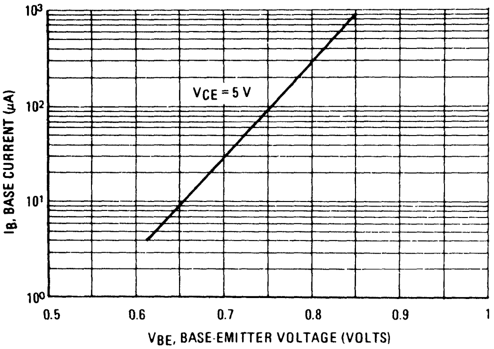


FIGURE 8 – OUTPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

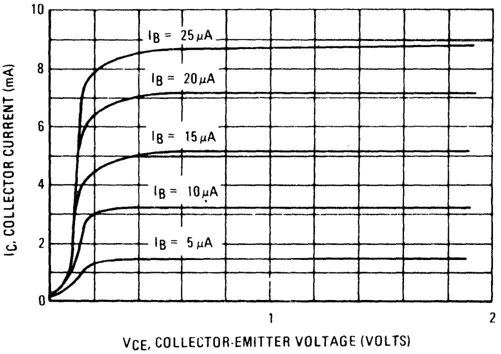


FIGURE 9 – OUTPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

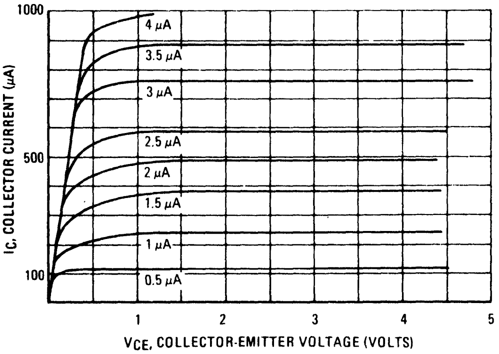


FIGURE 10 – OUTPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

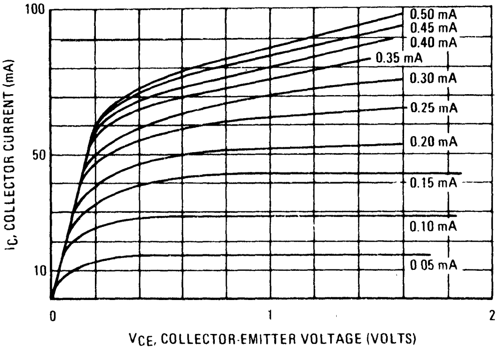


FIGURE 11 — OUTPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

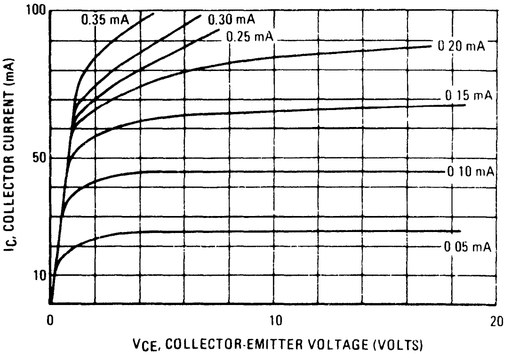


FIGURE 12 — EMITTER-BASE CAPACITANCE COLLECTOR-BASE CAPACITANCE

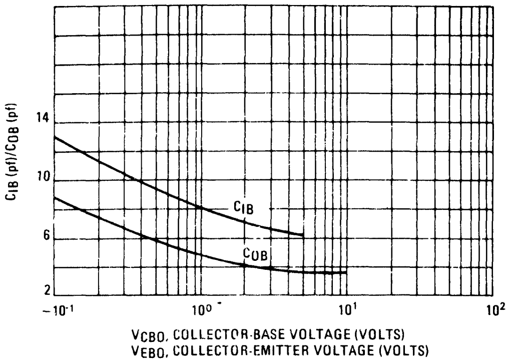


FIGURE 13 — CURRENT GAIN — BANDWIDTH PRODUCT

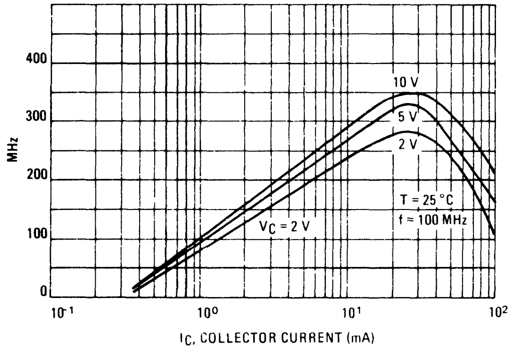
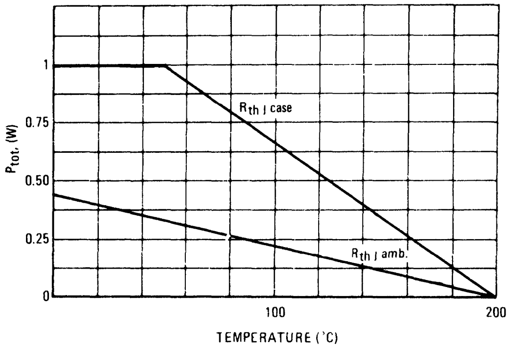
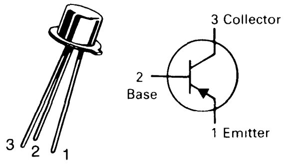


FIGURE 14 — TOTAL PERMISSIBLE POWER DISSIPATION (BCY58/BCY59)



BCY70
thru
BCY72

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTORS

PNP SILICON

Refer to 2N3798 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BCY 70	BCY 71	BCY 72	Unit
Collector-Emitter Voltage	V_{CEO}	40	45	25	Vdc
Collector-Base Voltage	V_{CBO}	50	45	25	Vdc
Emitter-Base Voltage	V_{EBO}	5			Vdc
Collector Current − Continuous	I_C	0.2			Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.06			mWatt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	0.6 4.0			mWatt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	175	°C/W

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

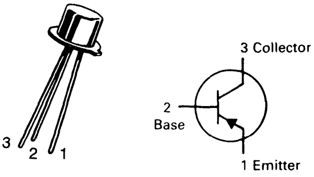
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 2 mA, I_B = 0)	BCY70		40			
	BCY71		45			
	BCY72		25			
Collector Base Leakage Current		I_{CBO}				
(I_E = 0, V_{CB} = 50 V)	BCY70				0.5	μA
(I_E = 0, V_{CB} = 45 V)	BCY71				0.5	
(I_E = 0, V_{CB} = 25 V)	BCY72				0.5	
(I_E = 0, V_{CB} = 40 V, T_{Amb} = 100°C)	BCY70				2	
(I_E = 0, V_{CB} = 40 V, T_{Amb} = 100°C)	BCY71				2	
(I_E = 0, V_{CB} = 20 V, T_{Amb} = 100°C)	BCY72				2	
(I_E = 0, V_{CB} = 40 V)	BCY70				10	nA
(I_E = 0, V_{CB} = 40 V)	BCY71				50	
(I_E = 0, V_{CB} = 20 V)	BCY72				50	
Emitter Base Leakage Current		I_{EBO}				
(V_{EB} = 5 V, I_C = 0)					0.5	μA
(V_{EB} = 4 V, I_C = 0)					10	nA
(V_{EB} = 4 V, I_C = 0, T_{Amb} = 100°C)					2	μA
Collector Emitter Leakage Current		I_{CEX}				nA
(V_{CE} = 50 V, V_{BE} = 3 V)	BCY70				20	
ON CHARACTERISTICS						
DC Current Gain		HFE				
(V_{CE} = 1 V, I_C = 10 μA)	BCY71		40			
(V_{CE} = 1 V, I_C = 100 μA)	BCY70		40			
	BCY71		80			
(V_{CE} = 1 V, I_C = 1 mA)	BCY70		45			
	BCY71		90			
	BCY72		40			
(V_{CE} = 1 V, I_C = 10 mA)	BCY70		50			
	BCY71		100		600	
	BCY72		50			
(V_{CE} = 1 V, I_C = 50 mA)	BCY70		15			
Base Emitter Saturation Voltage		$V_{BE(sat)}$				V
(I_C = 50 mA, I_B = 5 mA)	BCY70/71				1.2	
(I_C = 10 mA, I_B = 1 mA)	BCY70/71		0.6		0.9	
Collector Emitter Saturation Voltage		$V_{CE(sat)}$				V
(I_C = 50 mA, I_B = 5 mA)					0.50	
(I_C = 10 mA, I_B = 1 mA)					0.25	

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

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Transition Frequency	f_T				MHz
(I_C = 10 mA, f = 100 MHz, V_{CE} = 20 V) All types		250			
(I_C = 100 µA, f = 10.7 MHz, V_{CE} = 20 V) BCY71 only		15			
Noise Figure (V_{CE} = 5 V, I_C = 100 µA, Rg = 2 KΩ, 30 to 15 kHz at −3 dB points)	NF				dB
BCY70/72				6	
BCY71				2	
Switching Times					ns
(I_C = 10 mA, I_{B1} = I_{B2} = 1 mA) BCY70/72	ton			65	
BCY70/72	toff			420	
BCY70/72	td			35	
BCY70/72	tr			35	
BCY70/72	ts			350	
BCY70/72	tf			80	
h parameters (V_{CE} = 10 V, I_C = 1 mA, f = 1 kHz) BCY71	h_{12e}	—		20×10^{-4}	—
	h_{21e}	100		400	—
	h_{22e}	10		60	µs
	h_{11e}	2		12	KΩ
Common Base Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}			6	pF
Input Capacitance (V_{BE} = 1 V, I_C = 0, f = 1 MHz	C_{ib}			8	pF

BCY78-VII, -VIII, -IX, -X
BCY79-VII, -VIII, -IX, -X

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BCY 78	BCY 79	Unit
Collector-Emitter Voltage	V_{CEO}	32	45	Vdc
Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CES}	32	45	Vdc
Emitter-Base Voltage	V_{EBO}	5		Vdc
Collector Current – Continuous	I_C	0.2		Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 2.28		Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1 6.67		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	150	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	450	°C/W

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_C = 0)	BCY78 Series BCY79 Series	$V_{(BR)CEO}$	32 45			Vdc
Emitter-Base Breakdown Voltage (I_E = 2 μAdc, I_C = 0)	all	$V_{(BR)EBO}$	5			Vdc
Collector Cutoff Current						
(V_{CE} = 32 V)	BCY78 Series	I_{CES}		0.2	100	nA
(V_{CE} = 45 V)	BCY79 Series			0.2	100	
(V_{CE} = 32 V, T_A = 100°C, V_{BE} = 0.2 V)	BCY78 Series	I_{CEX}			20	μAdc
(V_{CE} = 45 V, T_A = 100°C, V_{BE} = 0.2 V)	BCY79 Series				20	
(V_{CE} = 25 V, T_A = 150°)	BCY78 Series	I_{CES}		0.2	10	μAdc
(V_{CE} = 35 V, T_A = 150°)	BCY79 Series			0.5	10	
Emitter Base Cutoff Current (V_{EB} = 4 V)	all	I_{EBO}			20	nA
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				
(I_C = 10 μAdc, V_{CE} = 5 Vdc)	BCY79-VII, BCY78-VII					
	BCY79-VIII, BCY78-VIII		30	145		
	BCY79-IX, BCY78-IX		40	220		
	BCY79-X, BCY78-X		100	300		
(I_C = 2 mAdc, V_{CE} = 5 Vdc)	BCY79-VII, BCY78-VII		120	170	220	
	BCY79-VIII, BCY78-VIII		180	250	310	
	BCY79-IX, BCY78-IX		250	350	460	
	BCY79-X, BCY78-X		380	500	630	
(I_C = 10 mAdc, V_{CE} = 1 Vdc)	BCY79-VII, BCY78-VII		80	190		
	BCY79-VIII, BCY78-VIII		120	260	400	
	BCY79-IX, BCY78-IX		160	380	630	
	BCY79-X, BCY78-X		240	550	1000	
(I_C = 100 mAdc, V_{CE} = 1 Vdc)	BCY79-VII, BCY78-VII		40			
	BCY79-VIII, BCY78-VIII		45			
	BCY79-IX, BCY78-IX		60			
	BCY79-X, BCY78-X		60			
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 2.5 mAdc) (I_C = 10 mAdc, I_B = 0.25 mA)	all	$V_{CE(sat)}$	0.15 0.05	0.30 0.12	0.80 0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 0.25 mA) (I_C = 100 mA, I_B = 2.5 mA)	all	$V_{BE(sat)}$	0.6 0.75	0.70 0.90	0.85 1.2	Vdc
Base-Emitter on Voltage (I_C = 2 mAdc, V_{CE} = 5 Vdc)	all	$V_{BE(on)}$	0.60	0.62	0.75	Vdc

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

Characteristic	Type	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS SMALL SIGNAL CHARACTERISTICS						
Current Gain-Bandwidth Product (I_C = 10 mAdc, V_{CE} = 5 V, f = 100 MHz)	all	f_T	180	300		MHz
Output Capacitance (V_{CE} = 10 Vdc, I_C = 0, f = 1 MHz)	all	C_{ob}		3.5	7	pF
Input Capacitance (V_{BE} = 0.5 V, I_C = 0, f = 1 MHz)	all	C_{ib}		8	15	pF
Small Signal Current Gain (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY78-VII, BCY79-VII	h_{fe} (h_{21e})		200		
	BCY78-VIII, BCY79-VIII			260		
	BCY78-IX, BCY79-IX			330		
	BCY78-X, BCY79-X			520		
Input Impedance (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY78-VII, BCY79-VII	h_{ie} (h_{11e})	1.6		4.5	Kohms
	BCY78-VIII, BCY79-VIII		2.5		6	
	BCY78-IX, BCY79-IX		3.2		8.5	
	BCY78-X, BCY79-X		7.5		12	
Voltage Feedback Ratio (I_C = 2 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	BCY78-VII, BCY79-VII	h_{re} (h_{12e})		1.5		$\times 10^{-4}$
	BCY78-VIII, BCY79-VIII			2		
	BCY78-IX, BCY79-IX			2		
	BCY78-X, BCY79-X			3		
Noise Figure (I_C = 0.2 mAdc, V_{CE} = 5 Vdc, R_S = 2 Kohms, f = 1 kHz)	all	N_F		2	6	dB
SWITCHING CHARACTERISTICS						
I_C = 10 mA, I_{B1} = 1 mA, I_{B2} = 1 mA		t_d		35		nS
V_{BB} = 3.6 V, R_1 = R_2 = 5 KΩ		t_r		50		
R_L = 990 ohms		t_{on}		85	150	
* See test circuit.		t_s		400		
		t_f		80		
		t_{off}		480	800	
I_C = 100 mA, I_{B1} = 10 mA, I_{B2} = 10 mA		t_d		5		nS
V_{BB} = 5 V, R_1 = 500 Ω, R_2 = 700 Ω		t_r		50		
R_L = 98 ohms		t_{on}		55	150	
* See test circuit.		t_s		250		
		t_f		200		
		t_{off}		450	800	

TEST CIRCUIT

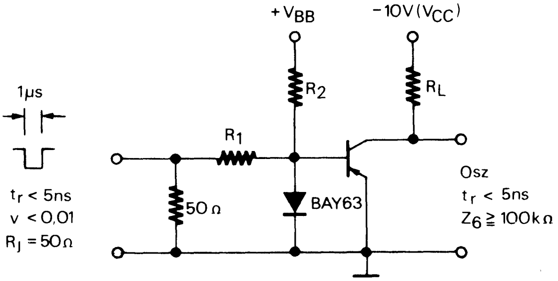


FIGURE 1 — CURRENT GAIN
(BCY78-VII/BCY79-VII)

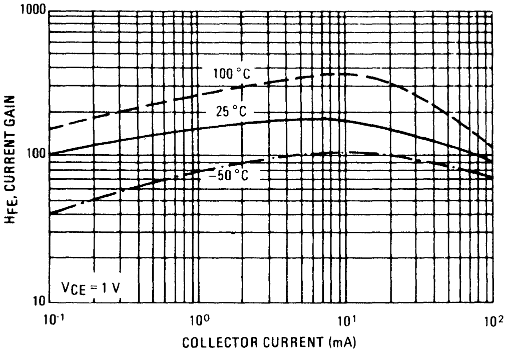


FIGURE 2 — CURRENT GAIN
(BCY78-VIII/BCY79-VIII)

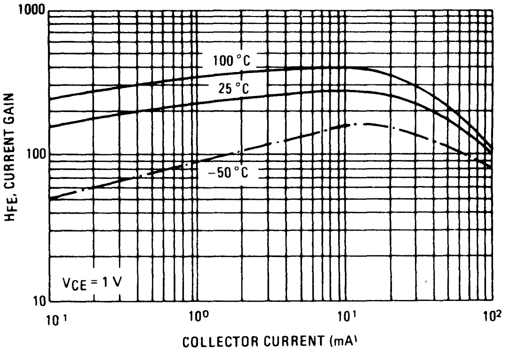


FIGURE 3 — CURRENT GAIN
(BCY78-IX/BCY79-IX)

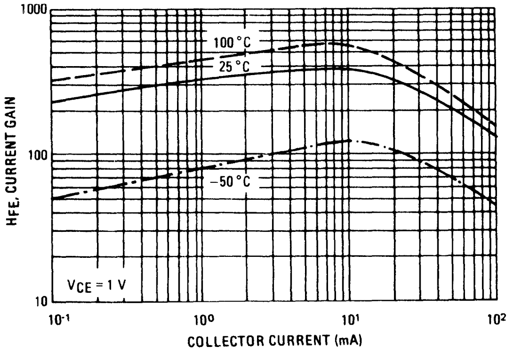


FIGURE 4 — CURRENT GAIN
(BCY78-X/BCY79-X)

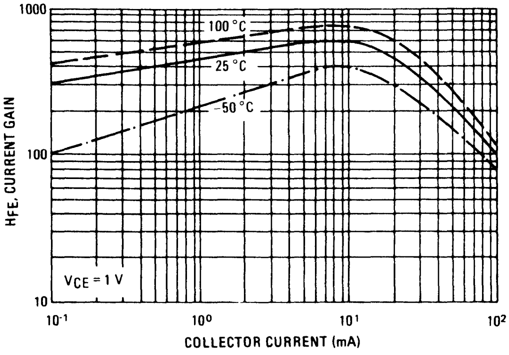


FIGURE 5 — SATURATION VOLTAGE

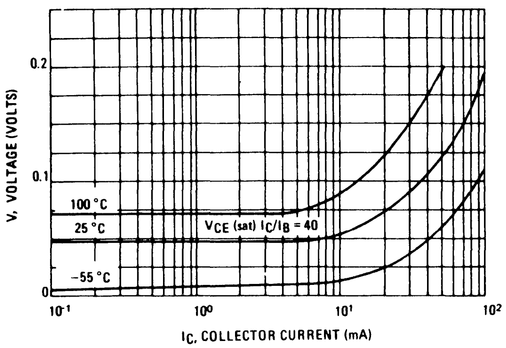


FIGURE 6 — SATURATION VOLTAGE

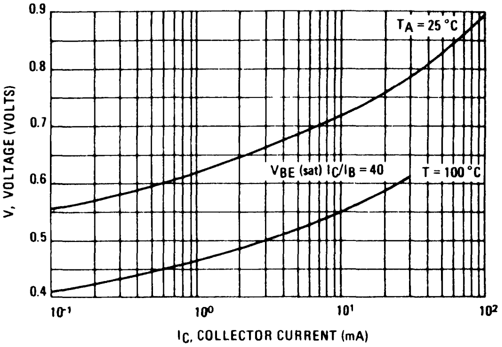


FIGURE 7 — INPUT CHARACTERISTIC (COMMON EMITTER CIRCUIT)

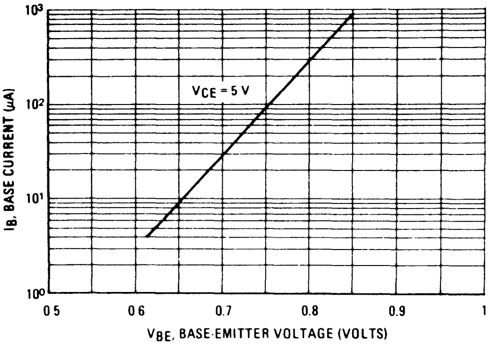


FIGURE 8 — TOTAL PERMISSIBLE POWER DISSIPATION (BCY78/BCY79)

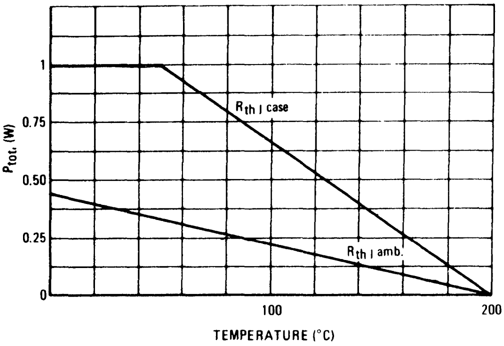


FIGURE 9 — CURRENT GAIN BANDWIDTH PRODUCT

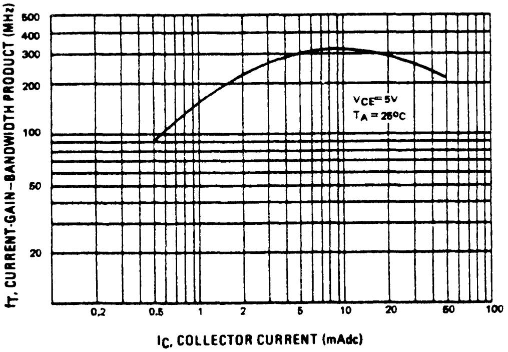
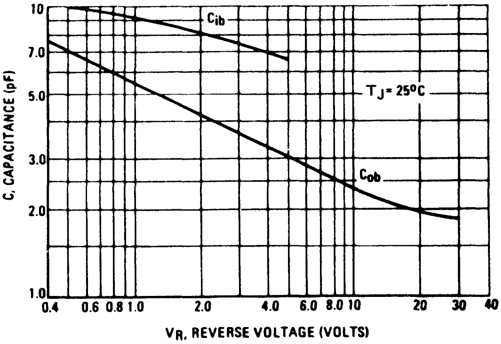
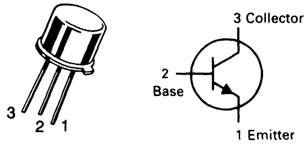


FIGURE 10 — CAPACITANCES



BF257
thru
BF259

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BF 257	BF 258	BF 259	Unit
Collector-Emitter Voltage	V_{CEO}	160	250	300	Vdc
Collector-Emitter Voltage	V_{CER}	160	250	300	Vdc
Collector-Base Voltage	V_{CBO}	160	250	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	0.1			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.57			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

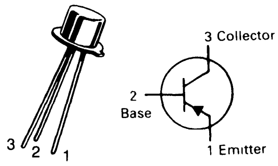
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 30 mAdc, I_B = 0)	BF257		160	—	—	
	BF258		250	—	—	
	BF259		300	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BF257		160	—	—	
	BF258		250	—	—	
	BF259		300	—	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current		I_{CBO}				nAdc
(V_{CB} = 100 Vdc, I_E = 0)	BF257		–	1	50	
(V_{CB} = 200 Vdc, I_E = 0)	BF258		—	1	50	
(V_{CB} = 250 Vdc, I_E = 0)	BF259		—	1	50	
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc)		h_{FE}	25	80	—	—
Collector-Emitter Saturation Voltage (I_C = 30 mAdc, I_B = 6.0 mAdc)		$V_{CE(sat)}$	—	0.1	1.0	Vdc
DYNAMIC CHARACTERISTICS						
Current Gain Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	—	110	—	MHz
Reverse Transfer Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 500 kHz)		C_{re}	—	3.5	—	pF
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 500 kHz)		C_{cb}	—	5.5	—	pF

BFW43

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	150	Vdc
Collector-Base Voltage	V_{CBO}	150	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	0.1	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.4 2.66	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.4 8.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	438	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 2$ mA, $I_B = 0$)	$V_{(BR)CEO}$	150			Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ µAdc, $I_E = 0$)	$V_{(BR)CBO}$	150			Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ µAdc, $I_C = 0$)	$V_{(BR)EBO}$	6			Vdc
Collector Cutoff Current ($V_{CB} = 100$ V, $I_E = 0$)	I_{CBO}			10	nA
Collector-Emitter Cutoff Current ($V_{CB} = 100$ V, $I_B = 0$) $T_A = 125°C$	I_{CEO}			10	µA
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 1$ mA, $V_{CE} = 10$ V) ($I_C = 10$ mA, $V_{CE} = 10$ V) ($I_C = 10$ µA, $V_{CE} = 10$ V, $T_A = -55°C$)	h_{FE}	 40 40 	 30		
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1$ mAdc)	$V_{CE(sat)}$		0.15	0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1$ mAdc)	$V_{BE(sat)}$		0.7	0.9	Vdc
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 10 MHz)	f_T	60	110	200	MHz
Output Capacitance ($I_E = 0$, $V_{CB} = 20$ Vdc, f = 1 MHz)	C_{obo}	—	3.5	7	pF
Turn On Time ($I_{B1} = 10$ mA, $I_C = 50$ mAdc, $V_{CC} = 100$ Vdc)	t_{on}	—	100	—	ns
Turn Off Time ($I_{B2} = 10$ mAdc, $I_C = 50$ mAdc, $V_{CC} = 100$ Vdc)	t_{off}	—	400	—	ns

(1) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2%.

FIGURE 1 – CURRENT-GAIN–BANDWIDTH PRODUCT

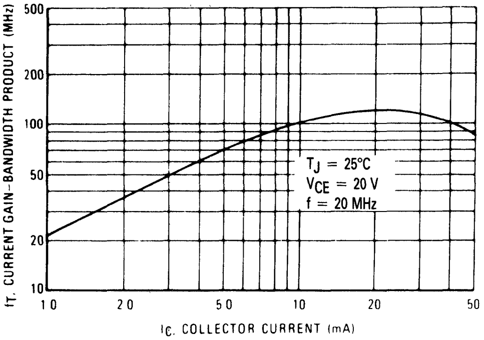


FIGURE 2 – TURN-ON TIME

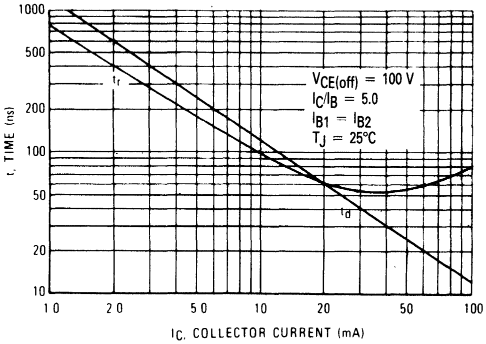


FIGURE 3 – TURN-OFF TIME

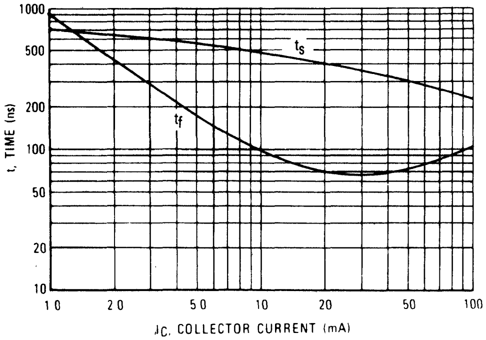
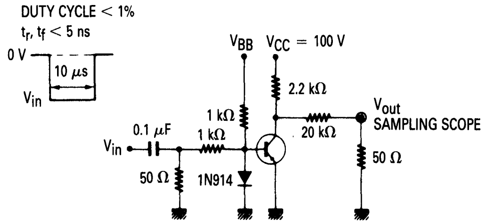


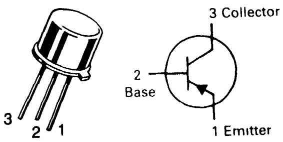
FIGURE 4 – SWITCHING TIME TEST CIRCUIT



	V_{in}	V_{BB}
t_{on}	−10.6 V	
t_{off}	−20 V	+9.2 V

BFX38
BFX40

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



HIGH CURRENT TRANSISTORS

PNP SILICON

Refer to 2N4405 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BFX38	BFX40	Unit
Collector-Emitter Voltage	V_{CEO}	55	75	Vdc
Collector-Base Voltage	V_{CBO}	55	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.25 7.15		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	7.0 40		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			V
(I_C = 10 mA)(1)	BFX38		55	—	
	BFX40		75	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			V
(I_C = 10 μA)	BFX38		55	—	
	BFX40		75	—	
Emitter-Base Breakdown Voltage (I_E = 10 μA)		$V_{(BR)EBO}$	5.0	—	V
Collector Cutoff Current		I_{CBO}			
(V_{CB} = 40 V)	BFX38		—	50	nA
(V_{CB} = 50 V)	BFX40		—	50	
(V_{CB} = 40 V, T_A = 125°C)	BFX38		—	50	μA
(V_{CB} = 50 V, T_A = 125°C)	BFX40		—	50	
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)(1)			—	0.15	
(I_C = 500 mA, I_B = 50 mA)(1)			—	0.5	
DC Current Gain		h_{FE}			—
(I_C = 100 μA, V_{CE} = 5.0 V)(1)	BFX38/40		60	—	
(I_C = 100 mA, V_{CE} = 5.0 V)(1)	BFX38/40		85	—	
(I_C = 500 mA, V_{CE} = 5.0 V)(1)	BFX38/40		60	—	
(I_C = 1.0 A, V_{CE} = 5.0 V)(1)	BFX38		30	—	
	BFX40		25	—	
Emitter-Base Saturation Voltage		$V_{BE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)(1)			—	0.9	
(I_C = 500 mA, I_B = 50 mA)(1)			—	1.1	
DC Current Gain (I_C = 100 mA, V_{CE} = 5.0 V, T_A = 125°C)(1)	BFX38/40	h_{FE}	30	—	—

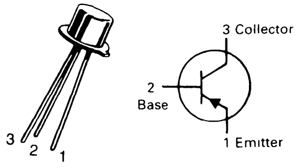
(1) Pulsed: Pulse Duration = 300 μs, Duty Cycle = 1.0%.

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

Characteristic	Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS				
Current Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 10 V, f = 100 MHz)	f_T	100		MHz
Output Capacitance (V_{CB} = 10 V)	C_{ob}		20	pF
Input Capacitance (V_{EB} = 0.5 V)	C_{ib}		120	pF
Turn On Time (I_C = 500 mA, I_{B1} = 50 mA)	t_{on}		100	ns
Turn Off Time (I_C = 500 mA, I_{B1} = I_{B2} = 50 mA)	t_{off}		350	ns
Fall Time (I_C = 500 mA, I_{B1} = I_{B2}= 50 mA)	t_f		50	ns

BFX48

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	0.1	Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.36 2.06	Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.2 0.686 6.86	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	°C/W

Refer to 2N869A for graphs.

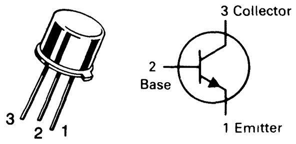
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mA)(1)	$V_{(BR)CEO}$	30		V
Collector-Base Breakdown Voltage (I_C = 10 µA)	$V_{(BR)CBO}$	30		V
Emitter-Base Breakdown Voltage (I_E = 10 µA)	$V_{(BR)EBO}$	5		V
Collector Cutoff Current (V_{CE} = 20 V) (V_{CE} = 20 V, T_A = 125°C)	I_{CES}		 15 15	 nA µA
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 µA, V_{CE} = 1 V) (I_C = 100 µA, V_{CE} = 1 V) (I_C = 10 mA, V_{CE} = 1 V) (I_C = 50 mA, V_{CE} = 1 V) (I_C = 10 mA, V_{CE} = 1 V, T_A = −55°C)	h_{FE}	 40 70 90 20 30		
Collector-Emitter Saturation Voltage (I_C = 1 mA, I_B = 0.1 mA) (I_C = 10 mA, I_B = 1 mA) (I_C = 50 mA, I_B = 5 mA)(1)	$V_{CE(sat)}$		 0.13 0.14 0.3	V
Emitter-Base Saturation Voltage (I_C = 1 mA, I_B = 0.1 mA) (I_C = 10 mA, I_B = 1 mA) (I_C = 50 mA, I_B = 5 mA)(1)	$V_{BE(sat)}$		 0.75 0.9 1.1	V
SMALL SIGNAL CHARACTERISTICS				
Current Gain — Bandwidth Product (I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz)	f_T	400		MHz
Output Capacitance (V_{CB} = 10 V)	C_{ob}		3.5	pF
Input Capacitance (V_{EB} = 0.5 V)	C_{ib}		5.5	pF
Noise Figure (I_C = 1 mA, V_{CE} = 20 V, f = 100 MHz)	NF		6	dB
Turn On Time (I_C = 50 mA, I_{B1} = 5 mA)	t_{on}		50	ns
Turn Off Time (I_C = 50 mA, I_{B1} = I_{B2} = 5 mA)	t_{off}		160	ns
Collector-Base Time Constant (I_C = 10 mA, V_{CE} = 20 V, f = 80 MHz)	$r_{b'}C_c$		40	ps

(1) Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

BFX85

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current – Continuous	I_C	1.0	Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	220	°C/W

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

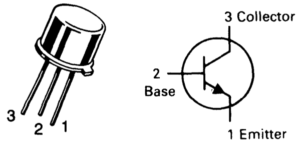
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CEO}$	60		Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_B = 0)	$V_{(BR)CBO}$	100		Vdc
Collector Cutoff Current (V_{CB} = 80 Vdc, I_E = 0) (V_{CB} = 80 Vdc, I_E = 0, T_J = 100°C) (V_{CB} = 100 Vdc, I_E = 0) (V_{CB} = 100 Vdc, I_E = 0, T_J = 100°C)	I_{CBO}		50 2.5 500 2.5	nAdc μAdc nAdc μAdc
Emitter Cutoff Current (V_{EB} = 5 Vdc, I_C = 0) (V_{EB} = 5 Vdc, I_C = 0, T_J = 100°C) (V_{EB} = 6 Vdc, I_C = 0)	I_{EBO}		50 2.5 500	nAdc μAdc nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 150 mAdc, V_{CE} = 10 Vdc) (I_C = 500 mAdc, V_{CE} = 10 Vdc) (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	50 70 30 15		
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{CE(sat)}$		0.15 0.35 1.00 1.60	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)	$V_{BE(sat)}$		1.2 1.3 1.5 2.0	Vdc

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

Characteristic	Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 35 MHz)	f_T	50		MHz
Collector Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{obo}		12	pF
Small Signal Current Gain (I_C = 1 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	h_{fe}	 20 25		
Input Impedance (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	h_{ie}		750	Ω
Voltage Feedback Ratio (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	h_{re}		5.0	$\times 10^{4}$
Output Admittance (I_C = 10 mAdc, V_{CE} = 5 Vdc, f = 1 kHz)	h_{oe}		80	μmhos

BFY50
thru
BFY52

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BFY 50	BFY 51	BFY 52	Unit
Collector-Emitter Voltage	V_{CEO}	35	30	20	Vdc
Collector-Base Voltage	V_{CBO}	80	60	40	Vdc
Emitter-Base Voltage	V_{EBO}	6			Vdc
Collector Current − Continuous	I_C	1			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.6			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5 28.6			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	16.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	89.5	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			V
(I_C = 10 mA)	BFY50		35		
	BFY51		30		
	BFY52		20		
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			V
(I_C = 10 μA)	BFY50		80		
	BFY51		60		
	BFY52		40		
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$			V
(I_E = 10 μA)			6		
Collector Cutoff Current		I_{CBO}			nA
(V_{CB} = 60 V)	BFY50			50	
(V_{CB} = 40 V)	BFY51				
(V_{CB} = 30 V)	BFY52				
Collector Cutoff Current		I_{CBO}			μA
(V_{CB} = 60 V, T_J = 100°C)	BFY50			2.5	
(V_{CB} = 40 V, T_J = 100°C)	BFY51				
(V_{CB} = 30 V, T_J = 100°C)	BFY52				
Emitter Cutoff Current		I_{EBO}			
(V_{EB} = 5 V)				50	nA
(V_{EB} = 5 V, T_J = 100°C)				2.8	μA
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			
(I_C = 10 mA, V_{CE} = 6 V)	BFY50		20		
	BFY51-52		30		
(I_C = 150 mA, V_{CE} = 6 V)	BFY50		30		
	BFY51		40		
	BFY52		60		
(I_C = 1 A, V_{CE} = 6 V)			15		
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA(1))	BFY50			0.2	
	BFY51-52			0.35	
(I_C = 1 A, I_B = 100 mA(1))	BFY50			1	
	BFY51-52			1.6	
Emitter-Base Saturation Voltage		$V_{BE(sat)}$			V
(I_C = 1 A, I_B = 100 mA(1))				2	

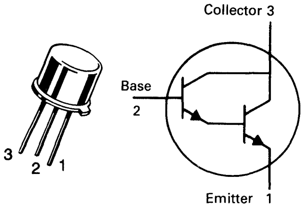
(1) Pulsed: Pulse Duration = 300 μs, Duty Cycle = 1%.

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

Characteristic		Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS					
Small Signal Current Gain (I_C = 1 mA, V_{CE} = 6 V, f = 1 kHz)	BFY50 BFY51-52	h_{fe}	10 30		
Output Capacitance (V_{CB} = 12 V, f = 500 kHz)		C_{ob}		12	pF
Current Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 6 V, f = 20 MHz)	BFY50 BFY51-52	f_T	60 50		MHz

BSS50
thru
BSS52

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



DARLINGTON TRANSISTORS
NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BSS 50	BSS 51	BSS 52	Unit
Collector-Emitter Voltage	V_{CEO}	45	60	80	Vdc
Collector-Emitter Voltage	V_{CER}	45	60	80	Vdc
Collector-Base Voltage	V_{CBO}	60	80	100	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current – Continuous	I_C	1.0			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 5.3			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5 28.6			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

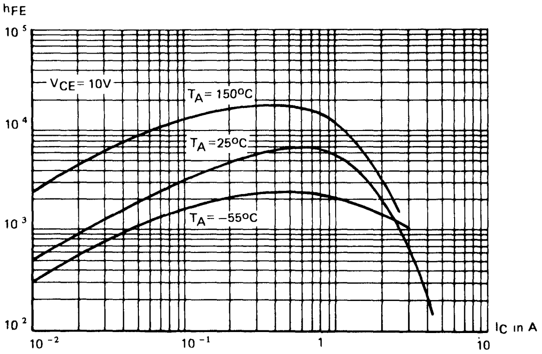
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	220	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Cutoff Current		I_{CBO}				nA
(V_{CB} = 45 V, I_E = 0)	BSS50				50	
(V_{CB} = 60 V, I_E = 0)	BSS51				50	
(V_{CB} = 80 V, I_E = 0)	BSS52				50	
Emitter-Cutoff Current (V_{EB} = 4 V, I_C = 0)		I_{EBO}			50	nA
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				V
(I_C = 10 mA, I_B = 0)	BSS50		45			
	BSS51		60			
	BSS52		80			
Emitter-Base Breakdown Voltage (I_B = 100 μA, I_C = 0)		$V_{(BR)EBO}$	5			V
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				
(I_C = 150 mA, V_{CE} = 10 V)			1500			
(I_C = 500 mA, V_{CE} = 10 V)			2000			
Base-Emitter Voltage(1)		$V_{BE(on)}$				V
(I_C = 150 mA, V_{CE} = 10 V)			1.4		1.55	
(I_C = 500 mA, V_{CE} = 10 V)			1.5		1.65	
Saturation Voltage(1)						V
(I_C = 500 mA, I_B = 0.5 mA)		$V_{CE(sat)}$			1.3	
(I_C = 500 mA, I_B = 0.5 mA)		$V_{BE(sat)}$			1.9	
(I_C = 1 A, I_B = 1 mA)	BSS51	$V_{CE(sat)}$			1.6	
(I_C = 1 A, I_B = 1 mA)	BSS51	$V_{BE(sat)}$			2.2	
(I_C = 1 A, I_B = 4 mA)	BSS50-52	$V_{CE(sat)}$			1.6	
(I_C = 1 A, I_B = 4 mA)	BSS50-52	$V_{BE(sat)}$			2.2	
DYNAMIC CHARACTERISTICS						
Current Gain Bandwidth Product (I_C = 500 mA, V_{CE} = 5, f = 20 MHz)		f_T		70		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)		C_{ob}		11	25	pF
Turn On Time (I_C = 500 mA, I_{B1} = $-I_{B2}$ = 0.5 mA)		t_{on}		400		ns
Turn Off Time (I_C = 500 mA, I_{B1} = $-I_{B2}$ = 0.5 mA)		t_{off}		1500		

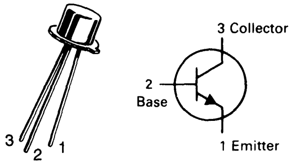
(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2%, unless otherwise specified.

FIGURE 1 — CURRENT GAIN versus COLLECTOR CURRENT



BSS71
thru
BSS73

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BSS 71	BSS 72	BSS 73	Unit
Collector-Emitter Voltage	V_{CEO}	200	250	300	Vdc
Collector-Base Voltage	V_{CBO}	200	250	300	Vdc
Emitter-Base Voltage	V_{EBO}	6.0			Vdc
Collector Current − Continuous	I_C	0.5			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.86			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 14.3			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	70	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 10 mA, I_B = 0)	BSS71		200	—	—	
	BSS72		250	—	—	
	BSS73		300	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BSS71		200	—	—	
	BSS72		250	—	—	
	BSS73		300	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 100 μAdc, I_C = 0)	BSS71		6	—	—	
	BSS72		6	—	—	
	BSS73		6	—	—	
Collector Cutoff Current		I_{CBO}				nA
(V_{CB} = 150 V, I_E = 0)	BSS71		—	—	50	
(V_{CB} = 200 V, I_E = 0)	BSS72		—	—	50	
(V_{CB} = 250 V, I_E = 0)	BSS73		—	—	50	
Collector-Emitter Cutoff Current		I_{CEO}				nA
(V_{CE} = 150 V, I_B = 0)	BSS71		—	—	500	
(V_{CE} = 200 V, I_B = 0)	BSS72		—	—	500	
(V_{CE} = 300 V, I_B = 0)	BSS73		—	—	500	
Emitter-Cutoff Current		I_{EBO}				nA
(V_{BE} = 5 Vdc, I_C = 0)	ALL		—	—	50	
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				
(I_C = 0.1 mA, V_{CE} = 1 V)	BSS71		20	40	—	—
(I_C = 1 mA, V_{CE} = 10 V)	ALL		30	45	—	
(I_C = 10 mA, V_{CE} = 10 V)	ALL		50	120	—	
(I_C = 30 mA, V_{CE} = 10 V)	ALL		40	140	250	
(I_C = 100 mA, V_{CE} = 10 V)	BSS73		—	35	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)	ALL		—	0.15	0.3	
(I_C = 30 mAdc, I_B = 3 mAdc)	ALL		—	0.25	0.4	
(I_C = 50 mAdc, I_B = 5 mAdc)	ALL		—	0.35	0.5	
(I_C = 100 mAdc, I_B = 20 mAdc)	BSS73		—	0.25	—	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)	ALL		—	0.7	0.8	
(I_C = 30 mAdc, I_B = 3 mAdc)	ALL		—	0.8	0.9	
(I_C = 50 mAdc, I_B = 5 mAdc)	ALL		—	0.85	1.0	
(I_C = 100 mAdc, I_B = 10 mAdc)	BSS73		—	0.9	—	

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_t	50	70	200	MHz
Output Capacitance (I_E = 0, V_{CB} = 20 Vdc, f = 1 MHz)	C_{ob}	—	3.5	—	pF
Input Capacitance (I_C = 0, V_{EB} = 0.5 Vdc, f = 1 MHz)	C_{ib}	—	45	—	pF
Turn On Time (I_{B1} = 10 mA, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{on}	—	100	—	ns
Turn Off Time (I_{B2} = 10 mAdc, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{off}	—	400	—	ns

FIGURE 1 — DC CURRENT GAIN

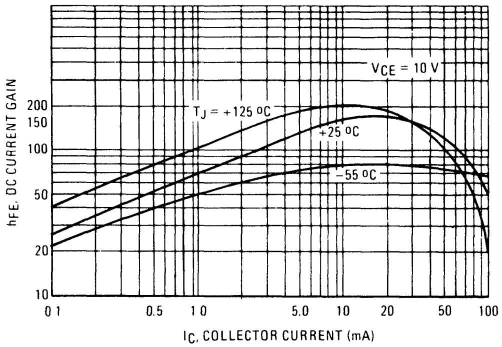


FIGURE 2 — CAPACITANCES

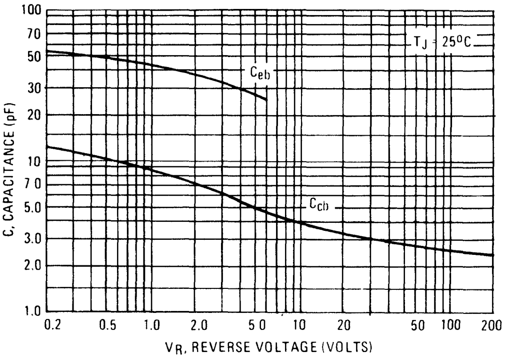


FIGURE 3 — CURRENT-GAIN — BANDWIDTH PRODUCT

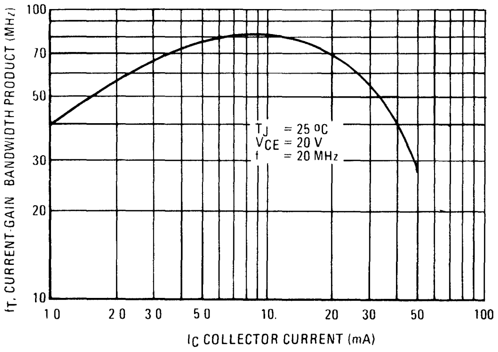


FIGURE 4 — ACTIVE-REGION SAFE OPERATING AREA

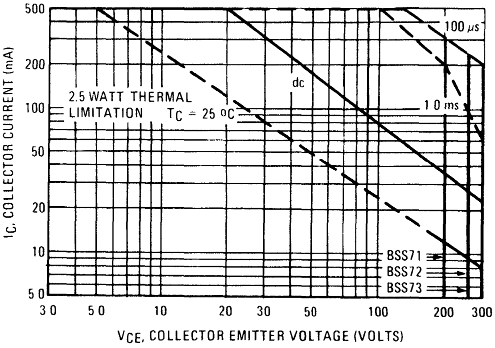


FIGURE 5 – "ON" VOLTAGES

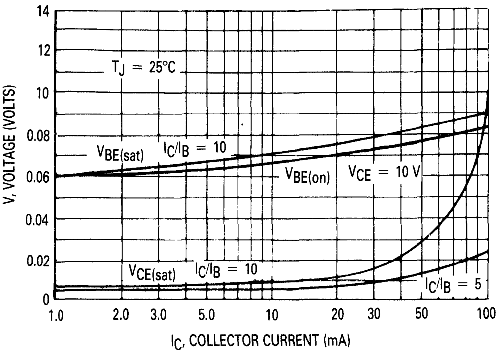


FIGURE 6 – TEMPERATURE COEFFICIENTS

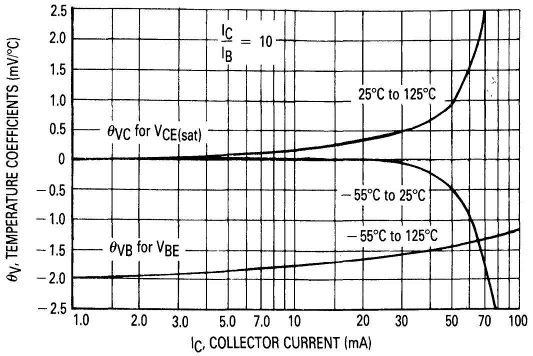


FIGURE 7 – TURN ON TIME

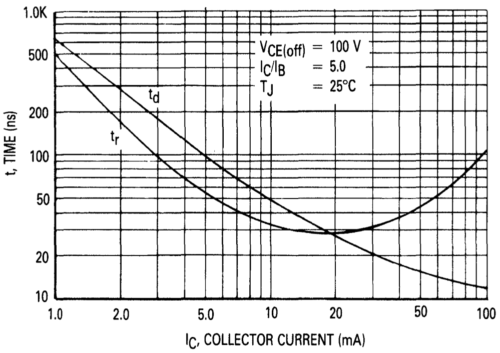


FIGURE 8 – TURN-OFF TIME

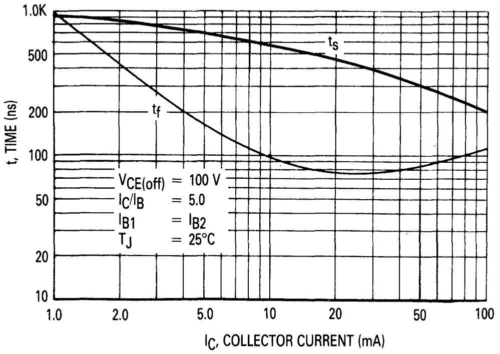
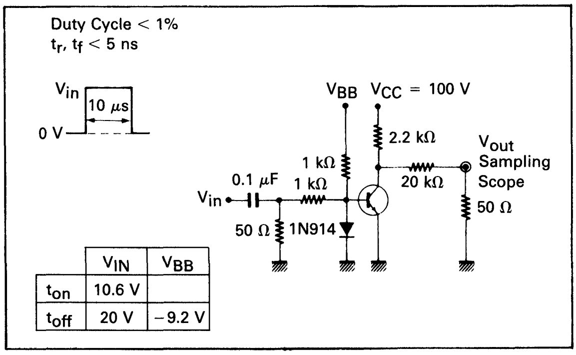


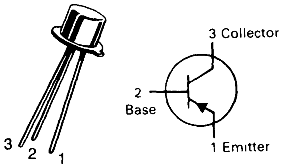
FIGURE 9 – SWITCHING TIME TEST CIRCUIT



	V_{IN}	V_{BB}
t_{on}	10.6 V	
t_{off}	20 V	−9.2 V

BSS74
thru
BSS76

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



HIGH VOLTAGE TRANSISTORS
PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	BSS 74	BSS 75	BSS 76	Unit
Collector-Emitter Voltage	V_{CEO}	200	250	300	Vdc
Collector-Base Voltage	V_{CBO}	200	250	300	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current − Continuous	I_C	0.5			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.5 2.86			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 14.3			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	70	°C/W

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 10 mA, I_B = 0)	BSS74		200	—	—	
	BSS75		250	—	—	
	BSS76		300	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 100 μAdc, I_E = 0)	BSS74		200	—	—	
	BSS75		250	—	—	
	BSS76		300	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 100 μAdc, I_C = 0)	BSS74		6	—	—	
	BSS75		6	—	—	
	BSS76		6	—	—	
Collector Cutoff Current		I_{CBO}				nA
(V_{CB} = 150 V, I_E = 0)	BSS74		—	—	50	
(V_{CB} = 200 V, I_E = 0)	BSS75		—	—	50	
(V_{CB} = 250 V, I_E = 0)	BSS76		—	—	50	
Collector-Emitter Cutoff Current		I_{CEO}				nA
(V_{CE} = 150 V, I_B = 0)	BSS74		—	—	500	
(V_{CE} = 200 V, I_B = 0)	BSS75		—	—	500	
(V_{CE} = 300 V, I_B = 0)	BSS76		—	—	500	
Emitter-Cutoff Current		I_{EBO}				nA
(V_{BE} = 5 Vdc, I_C = 0)	ALL		—	—	50	
ON CHARACTERISTICS(1)						
DC Current Gain		h_{FE}				
(I_C = 0.1 mA, V_{CE} = 1 V)	BSS74		20	40	—	—
(I_C = 1 mA, V_{CE} = 10 V)	ALL		30	45	—	
(I_C = 10 mA, V_{CE} = 10 V)	ALL		35	50	—	
(I_C = 30 mA, V_{CE} = 10 V)	ALL		35	55	150	
(I_C = 100 mA, V_{CE} = 10 V)	BSS76		—	40	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)	ALL		—	0.15	0.3	
(I_C = 30 mAdc, I_B = 3 mAdc)	ALL		—	0.25	0.4	
(I_C = 50 mAdc, I_B = 5 mAdc)	ALL		—	0.35	0.5	
(I_C = 100 mAdc, I_B = 20 mAdc)	BSS76		—	0.40	—	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)	ALL		—	0.7	0.8	
(I_C = 30 mAdc, I_B = 3 mAdc)	ALL		—	0.8	0.9	
(I_C = 50 mAdc, I_B = 5 mAdc)	ALL		—	0.85	1.0	
(I_C = 100 mAdc, I_B = 10 mAdc)	BSS76		—	0.9	—	

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

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

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_t	50	110	200	MHz
Output Capacitance (I_E = 0, V_{CB} = 20 Vdc, f = 1 MHz)	C_{ob}	—	3.5	—	pF
Input Capacitance (I_C = 0, V_{EB} = 0.5 Vdc, f = 1 MHz)	C_{ib}	—	45	—	pF
Turn On Time (I_{B1} = 10 mA, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{on}	—	100	—	ns
Turn Off Time (I_{B2} = 10 mAdc, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{off}	—	400	—	ns

FIGURE 1 — DC CURRENT GAIN

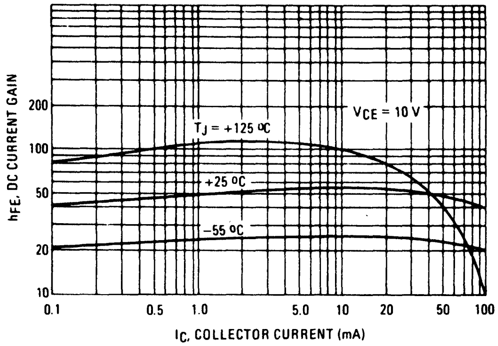


FIGURE 2 — CAPACITANCES

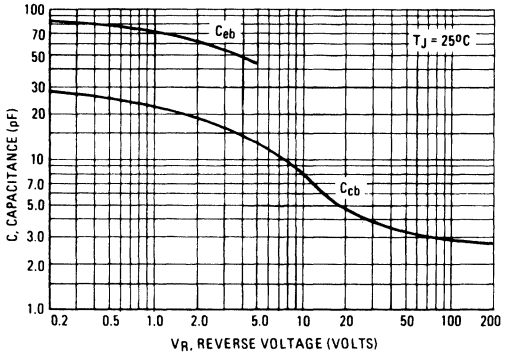


FIGURE 3 — "ON" VOLTAGES

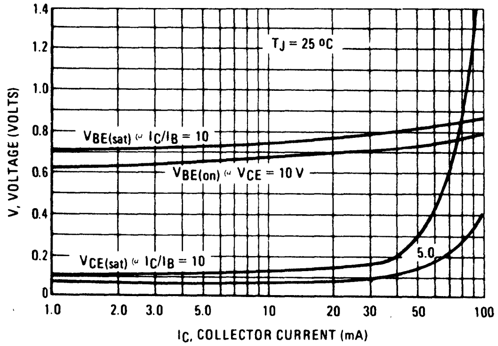


FIGURE 4 — TEMPERATURE COEFFICIENTS

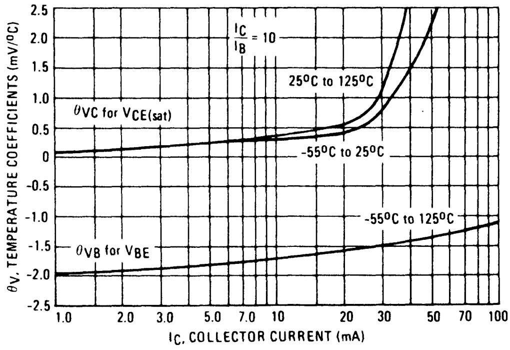


FIGURE 5 — CURRENT-GAIN—BANDWIDTH PRODUCT

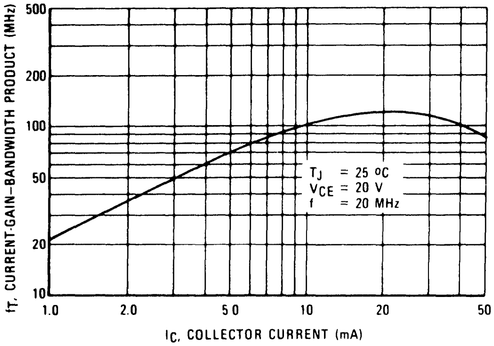


FIGURE 6 — TURN-ON TIME

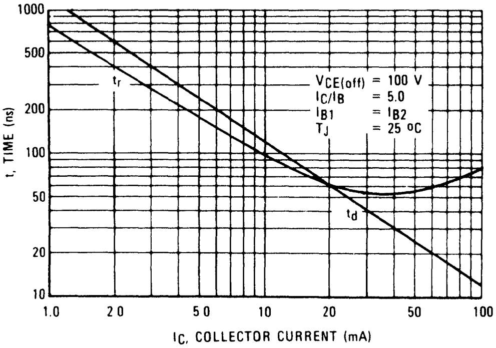


FIGURE 7 — TURN-OFF TIME

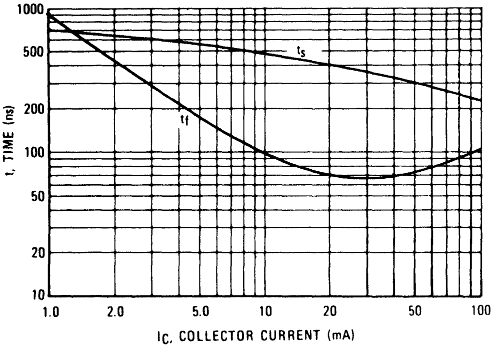
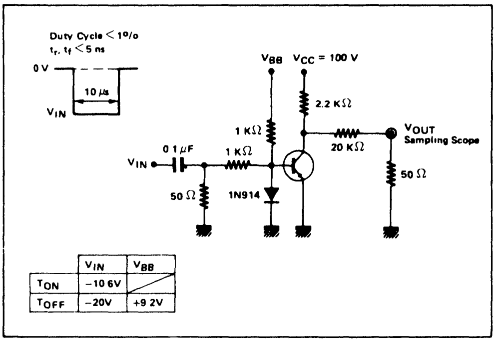
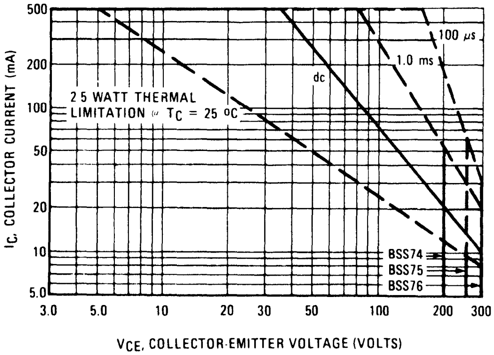


FIGURE 8 — SWITCHING TIME TEST CIRCUIT



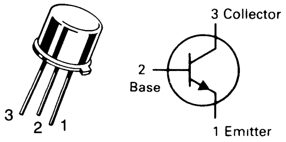
	V_{IN}	V_{BB}
T_{ON}	−10 6V	
T_{OFF}	−20V	+9 2V

FIGURE 9 — ACTIVE-REGION SAFE OPERATING AREA



BSS78

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



HIGH VOLTAGE TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	250	Vdc
Collector-Base Voltage	V_{CBO}	250	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.57	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	250	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	250	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 200$ V, $I_E = 0$)	I_{CBO}	—	—	50	nA
Collector-Emitter Cutoff Current ($V_{CE} = 200$ V, $I_B = 0$)	I_{CEO}	—	—	500	nA
Emitter-Base Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	50	nA
ON CHARACTERISTICS(1)					
DC Current Gain	h_{FE}				—
($I_C = 0.1$ mA, $V_{CE} = 1.0$ V)		20	40	—	
($I_C = 1.0$ mA, $V_{CE} = 10$ V)		30	45	—	
($I_C = 10$ mA, $V_{CE} = 10$ V)		50	120	—	
($I_C = 30$ mA, $V_{CE} = 10$ V)		40	140	250	
($I_C = 100$ mA, $V_{CE} = 10$ V)		—	35	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		—	0.15	0.3	
($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)		—	0.25	0.4	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		—	0.35	0.5	
($I_C = 100$ mAdc, $I_B = 20$ mAdc)		—	0.25	—	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		—	0.7	0.8	
($I_C = 30$ mAdc, $I_B = 3.0$ mAdc)		—	0.8	0.9	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		—	0.85	1.0	
($I_C = 100$ mAdc, $I_B = 10$ mAdc)		—	0.9	—	

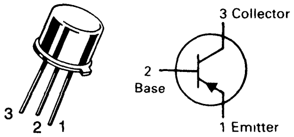
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

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

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current Gain Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_t	50	70	200	MHz
Output Capacitance (I_E = 0, V_{CB} = 20 Vdc, f = 1 MHz)	C_{ob}	—	3.5	—	pF
Input Capacitance (I_C = 0, V_{EB} = 0.5 Vdc, f = 1 MHz)	C_{ib}	—	45	—	pF
Turn On Time (I_{B1} = 10 mA, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{on}	—	100	—	ns
Turn Off Time (I_{B2} = 10 mAdc, I_C = 50 mAdc, V_{CC} = 100 Vdc)	t_{off}	—	400	—	ns

BSV15-10, -16
thru
BSV17-10, -16

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N4405 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BSV 15	BSV 16	BSV 17	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	Vdc
Collector-Emitter Voltage	V_{CES}	40	60	90	Vdc
Collector-Base Voltage	V_{CBO}	40	60	90	Vdc
Emitter-Base Voltage	V_{EBO}	5			Vdc
Collector Current − Continuous	I_C	1			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.25 7.15			Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	7 40			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	140	°C/W

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

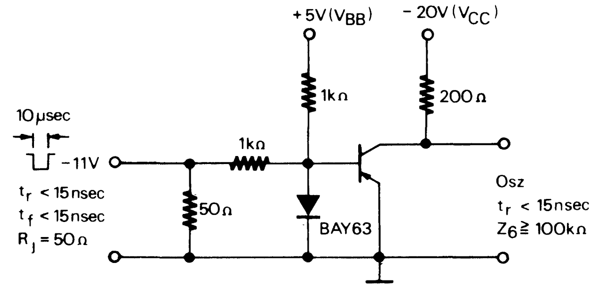
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector Cutoff Current		I_{CES}			
(V_{CE} = 40 V)				50	nA
(V_{CE} = 40 V, T_A = 150°C)	BSV15 Series			50	µA
(V_{CE} = 60 V)				50	nA
(V_{CE} = 60 V, T_A = 150°C)	BSV16 Series			50	µA
(V_{CE} = 80 V)				50	nA
(V_{CE} = 80 V, T_A = 150°C)	BSV17 Series			50	µA
(V_{CE} = 40 V, V_{BE} = −0.2 V, T_A = 100°C)	BSV15 Series	I_{CEX}		50	µA
(V_{CE} = 60 V, V_{BE} = −0.2 V, T_A = 100°C)	BSV16 Series			50	
(V_{CE} = 80 V, V_{BE} = −0.2 V, T_A = 100°C)	BSV17 Series			50	
Emitter Cutoff Current (V_{EB} = 4 V)		I_{EBO}		50	nA
Collector-Emitter Breakdown Voltage (I_C = 50 mA(1))	BSV15 Series	$V_{(BR)CEO}$	40		V
	BSV16 Series		60		
	BSV17 Series		80		
Collector-Emitter Breakdown Voltage (I_C = 10 µA)	BSV15 Series	$V_{(BR)CES}$	40		V
	BSV16 Series		60		
	BSV17 Series		90		
Emitter-Base Breakdown Voltage (I_E = 10 µA)		$V_{(BR)EBO}$	5		V
Emitter Cutoff Current (V_{EB} = 4 V)		I_{EBO}		50	nA
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			
(V_{CE} = 1 V, I_C = 0.1 mA)	BSV15,16 − 10		20		
	BSV15,16 − 16		30		
(V_{CE} = 1 V, I_C = 100 mA)(1)	BSV15,16 − 10		63	160	
	BSV15,16 − 16		100	250	
(V_{CE} = 1 V, I_C = 500 mA)(1)	BSV15,16 − 10		25		
	BSV15,16 − 16		35		
Base-Emitter Voltage		$V_{BE(on)}$			V
(V_{CE} = 1 V, I_C = 100 mA)(1)				1	
(V_{CE} = 1 V, I_C = 500 mA)(1)			0.7	1.4	

(1) Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

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

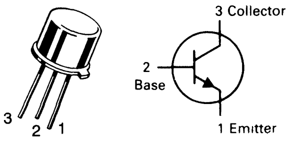
Characteristic	Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 10 V, f = 20 MHz)	f_T	50		MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}		25	pF
Small Signal Current Gain (I_C = 1 mA, V_{CE} = 5 V, f = 1 MHz)	h_{fe}	20		
Turn On Time (Fig. 1) (I_C = 100 mA, I_{B1} = I_{B2} = 5 mA) Storage Time (Fig. 1) (I_C = 100 mA, I_{B1} = I_{B2} = 5 mA)	t_{on} t_s		500 500	ns
Fall Time (Fig. 1) (I_C = 100 mA, I_{B1} = I_{B2} = 5 mA)	t_f		150	ns

FIGURE 1 — SWITCHING TIME CIRCUIT



BSW67A
BSW68A

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	BSW67A	BSW68A	Unit
Collector-Emitter Voltage	V_{CEO}	120	150	Vdc
Collector-Base Voltage	V_{CBO}	120	150	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	2.0		Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.57		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

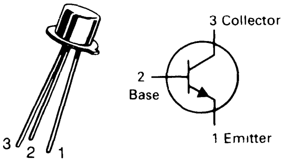
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	220	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	BSW67A		120	—	
	BSW68A		150	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc)	BSW67A		120	—	
	BSW68A		150	—	
Collector-Base Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 60 V, I_E = 0)	BSW67A		—	100	
(V_{CB} = 75 V, I_E = 0)	BSW68A		—	100	
(V_{CB} = 60 V, I_E = 0, T_J = 150°C)	BSW67A		—	100	μAdc
(V_{CB} = 75 V, I_E = 0, T_J = 150°C)	BSW68A		—	100	
Emitter-Base Cutoff Current		I_{EBO}			
(V_{EB} = 3.0 V, I_C = 0)			—	100	nAdc
(V_{EB} = 6.0 V, I_C = 0)			—	100	μAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 10 mA, V_{CE} = 5.0 V)			30	—	
(I_C = 100 mA, V_{CE} = 5.0 V)			40	—	
(I_C = 500 mA, V_{CE} = 5.0 V)			30	—	
(I_C = 1.0 A, V_{CE} = 5.0 V)			15	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 100 mA, I_B = 10 mA)			—	0.15	
(I_C = 500 mA, I_B = 50 mA)			—	0.4	
(I_C = 1.0 A, I_B = 150 mA)			—	1.0	
Emitter-Base Saturation Voltage		$V_{BE(sat)}$			Vdc
(I_C = 100 mA, I_B = 10 mA)			—	0.9	
(I_C = 500 mA, I_B = 50 mA)			—	1.1	
(I_C = 1.0 A, I_B = 150 mA)			—	1.4	
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mA, V_{CE} = 20 V, f = 35 MHz)		f_T	50	—	MHz
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)		C_{obo}	—	20	pF
Input Capacitance (V_{EB} = 0, I_C = 0, f = 1.0 MHz)		C_{ibo}	—	300	pF

BSX20

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CER}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.5	Vdc
Collector Current – Continuous	I_C	500	mAmp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.06	mWatt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.2 6.85	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	°C/W

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

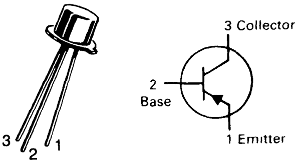
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage	$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)		15		
(I_C = 10 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	20		
Emitter-Base Breakdown Voltage	$V_{(BR)EBO}$			Vdc
(I_E = 10 μAdc, I_C = 0)		4.5		
Collector Cutoff Current	I_{CBO}			
(V_{CB} = 20 Vdc, I_E = 0)			400	nAdc
(V_{CB} = 20 Vdc, I_E = 0, T_J = 150°C)			30	μAdc
Collector Cutoff Current	I_{CES}			μAdc
(V_{CE} = 15 Vdc, V_{BE} = 0, T_J = 55°C)			0.4	
(V_{CE} = 40 Vdc, V_{BE} = 0)			1.0	
Cutoff Current				μAdc
(V_{CE} = 15 Vdc, V_{BE} = –3 V, T_J = 55°C)	I_{CEX}		0.6	
	I_{BEX}		0.6	
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			
(I_C = 10 mAdc, V_{CE} = 1 Vdc)		40	120	
(I_C = 10 mAdc, V_{CE} = 1 Vdc, T_J = –55°C)		20		
(I_C = 100 mAdc, V_{CE} = 2 Vdc)		10		
Base-Emitter On Voltage	$V_{BE(on)}$			Vdc
(I_C = 30 μAdc, V_{CE} = 20 Vdc, T_J = 100°C)			0.35	
Emitter-Collector Saturation Voltage	$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 0.3 mAdc)			0.3	
(I_C = 10 mAdc, I_B = 1 mAdc)			0.25	
(I_C = 100 mAdc, I_B = 10 mAdc)			0.60	
Emitter-Base Saturation Voltage	$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1 mAdc)		0.7	0.85	
(I_C = 100 mAdc, I_B = 10 mAdc)			1.50	

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

Characteristic	Symbol	Min	Max	Unit
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 10 V)	f_T	500		MHz
Output Capacitance (V_{CB} = 5 V, I_E = 0, f = 1 MHz)	C_{obo}		4	pF
Input Capacitance (V_{EB} = 1 V, I_C = o, f = 1 MHz)	C_{ibo}		4.5	pF
Time (I_C = 10 mA, I_{B1} = I_{B2} = 10 mA)	t_s		13	ns
Turn-On Time (I_C = 10 mA, I_{B1} = 3 mA) (I_C = 100 mA, I_{B1} = 40 mA)	t_{on}		12 7	ns
Turn-Off Time (I_C = 10 mA, I_{B1} = 3 mA, I_{B2} = − 1.5 mA) (I_C = 100 mA, I_{B1} = 40 mA, I_{B2} = − 20 mA)	t_{off}		18 21	ns

BSX29

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N869A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	12	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current − Continuous	I_C	200	Amp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D 2.06	.36	Watt mW/°C
Total Device Dissipation @ T_C = 25°C T_C = 100°C Derate above 25°C	P_D	1.2 0.686 6.86	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	146	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	486	°C/W

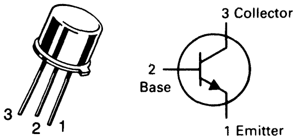
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 10 mA)(1)	$V_{(BR)CEO}$	12		V
Collector-Emitter Breakdown Voltage (I_C = 10 µA)	$V_{(BR)CES}$	12		V
Collector-Base Breakdown Voltage (I_C = 10 µA)	$V_{(BR)CBO}$	12		V
Emitter-Base Breakdown Voltage (I_E = 100 µA)	$V_{(BR)EBO}$	4		V
Collector Cutoff Current (V_{CE} = 6 V, V_{BE} = 0) (V_{CE} = 6 V, V_{BE} = 0, T_A = 85°C)	I_{CES}		 80 5	 nA µA
ON CHARACTERISTICS				
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA) (I_C = 30 mA, I_B = 3 mA) (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$		 0.15 0.2 0.5	V
Emitter-Base Saturation Voltage (I_C = 10 mA, I_B = 1 mA) (I_C = 30 mA, I_B = 3 mA) (I_C = 100 mA, I_B = 10 mA)	$V_{BE(sat)}$	 0.78 0.85 	 0.98 1.2 1.7	V
DC Current Gain (I_C = 10 mA, V_{CE} = 0.3 V)(1) (I_C = 30 mA, V_{CE} = 0.5 V)(1) (I_C = 100 mA, V_{CE} = 1 V)(1)	h_{FE}	 25 30 20	 120 	
Collector-Emitter Saturation Voltage (I_C = 30 mA, I_B = 3 mA, T_A = 85°C)	$V_{CE(sat)}$		0.4	V
SMALL SIGNAL CHARACTERISTICS				
Small Signal Current Gain (I_C = 30 mA, V_{CE} = 10 V, f = 100 MHz)	h_{fe}	4		
Output Capacitance (V_{CB} = 5 V)	C_{ob}		6	pF
Input Capacitance (V_{EB} = 0.5 V)	C_{ib}		6	pF
Turn On Time (I_C = 30 mA, I_{B1} = 1.5 mA)	t_{on}		60	ns
Turn Off Time (I_C = 30 mA, I_{B1} = I_{B2} = 1.5 mA)	t_{off}		90	ns

*Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

BSX32

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTOR

NPN SILICON

Refer to 2N3725 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	6	Vdc
Collector Current − Continuous	I_C	1	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.8 4.6	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.5 2.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

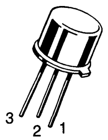
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

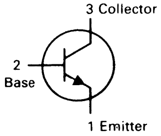
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)(1)	$V_{(BR)CEO}$	40		V
Collector-Base Breakdown Voltage ($I_C = 100$ μA, $I_E = 0$)	$V_{(BR)CBO}$	65		V
Emitter-Base Breakdown Voltage ($I_E = 100$ μA, $I_C = 0$)	$V_{(BR)EBO}$	6		V
Collector Cutoff Current ($V_{CB} = 50$ V, $I_E = 0$)	I_{CBO}		4	μA
ON CHARACTERISTICS				
DC Current Gain ($V_{CE} = 1$ V, $I_C = 10$ mA)(1) ($V_{CE} = 1$ V, $I_C = 100$ mA)(1) ($V_{CE} = 1$ V, $I_C = 500$ mA)(1) ($V_{CE} = 5$ V, $I_C = 1$ A)(1) ($V_{CE} = 1$ V, $I_C = 100$ mA, $T_A = -55°C$)(1) ($V_{CE} = 1$ V, $I_C = 500$ mA)(1)	h_{FE}	 30 60 25 20 30 15	 150	
Collector-Emitter Saturation Voltage ($I_C = 100$ mA, $I_B = 10$ mA)(1) ($I_C = 500$ mA, $I_B = 50$ mA)(1) ($I_C = 1$ A, $I_B = 100$ mA)(1)	$V_{CE(sat)}$		 0.25 0.5 0.85	V
Base-Emitter Saturation Voltage ($I_C = 100$ mA, $I_B = 10$ mA)(1) ($I_C = 500$ mA, $I_B = 50$ mA((1) ($I_C = 1$ A, $I_B = 100$ mA)(1)	$V_{BE(sat)}$		 0.9 1.5 2	V
SMALL SIGNAL CHARACTERISTICS				
Small Signal Current Gain ($I_C = 50$ mA, $V_{CE} = 10$ V, f = 100 MHz)	h_{fe}	3		
Output Capacitance ($V_{CB} = 10$ V)	C_{ob}		10	pF
Input Capacitance ($V_{EB} = 0.5$ V)	C_{ib}		60	pF
Turn On Time ($I_C = 500$ mA, $I_{B1} = 50$ mA)	t_{on}		60	ns
Turn Off Time ($I_C = 500$ mA, $I_{B1} = I_{B2} = 50$ mA)	t_{off}		60	ns

*Pulsed: Pulse Duration = 300 μs, Duty Cycle = 1%.

BSX45-6, -10, -16
thru
BSX47-6, -10, -16

CASE 79-04, STYLE 1
TO-39 (TO-205AD)





AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N3019 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BSX 45	BSX 46	BSX 47	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	Vdc
Collector-Emitter Voltage	V_{CES}	80	100	120	Vdc
Emitter-Base Voltage	V_{EBO}	7			Vdc
Collector Current − Continuous	I_C	1			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1 5.71			Watt mW/°C
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	5 28.6			Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

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

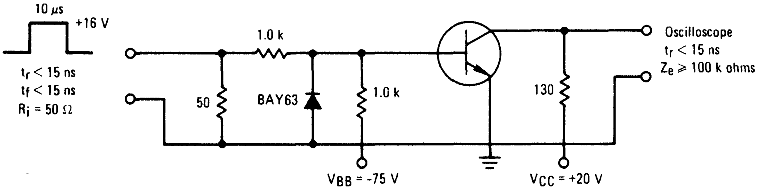
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 30 mAdc, I_B = 0)	BSX45 Series	$V_{(BR)CEO}$	40		Vdc
	BSX46 Series		60		
	BSX47 Series		80		
Collector-Emitter Breakdown Voltage (I_C = 100 µAdc, V_{BE} = 0)	BSX45 Series	$V_{(BR)CES}$	80		Vdc
	BSX46 Series		100		
	BSX47 Series		120		
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0)		$V_{(BR)EBO}$	7		Vdc
Emitter Cutoff Current (V_{BE} = 5.0 Vdc, I_C = 0)		I_{EBO}		10	nAdc
Collector Cutoff Current (V_{CE} = 60 V, V_{BE} = 0)	BSX45,46 Series	I_{CES}		10	nAdc
(V_{CE} = 80 V, V_{BE} = 0)	BSX47 Series			10	
(V_{CE} = 60 V, V_{BE} = 0, T_C = 150°C)	BSX45,46 Series			10	µAdc
(V_{CE} = 80 V, V_{BE} = 0, T_C = 150°C)	BSX47 Series			10	
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	-6	h_{FE}	10		
	-10		15		
	-16		25		
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)(1)	-6		40	100	
	-10		63	160	
	-16		100	250	
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)(1)	-6		15		
	-10		25		
	-16		35		
Base-Emitter On Voltage (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		$V_{BE(on)}$		1	Vdc
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)			0.75	1.5	
(I_C = 1 A, V_{CE} = 1.0 Vdc)				2	
Collector-Emitter Saturation Voltage (I_C = 1 Adc, I_B = 100 mAdc)		$V_{EC(sat)}$		1	Vdc
SMALL SIGNAL CHARACTERISTICS					
Transition Frequency (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	50		MHz
Emitter-Base Capacitance (V_{BE} = 0.5 V, f = 1 MHz)		C_{ib}		80	pF

(1) Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

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

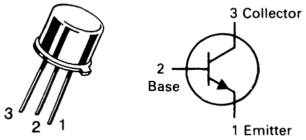
Characteristic		Symbol	Min	Max	Unit
Collector-Base Capacitance (V_{CB} = 10 V, f = 1 MHz)	BSX45 BSX46 BSX47	C_{ob}		25 20 15	pF
Turn On Time	See Figure 1 (I_C = 100 mAdc)	t_{on}		200	ns
Turn Off Time	I_{B1} = $-I_{B2}$ = 5 mAdc)	t_{off}		850	

FIGURE 1 – SWITCHING TIME TEST CIRCUIT



BSX59
BSX60

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

NPN SILICON

Refer to 2N3725 for graphs.

MAXIMUM RATINGS

Rating	Symbol	BSX 59	BSX 60	Unit
Collector-Emitter Voltage	V_{CEO}	45	30	Vdc
Collector-Emitter Voltage	V_{CES}	60	60	Vdc
Collector-Base Voltage	V_{CBO}	70	70	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current – Continuous	I_C	1		Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.8 4.57		Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 20		Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

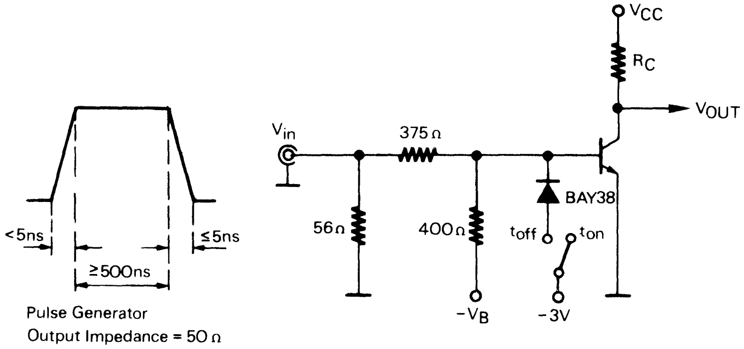
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$			V
(I_C = 10 mAdc, I_B = 0)	[BSX59]		45		
	[BSX60]		30		
Collector-Base Breakdown Voltage (I_C = 10 μA, I_E = 0)		$V_{(BR)CBO}$	70		V
Collector Cutoff Current		I_{CBO}			
(V_{CB} = 40 V, I_E = 0)				500	nA
(V_{CB} = 40 V, I_E = 0, T_J = 150°C)				300	μA
Emitter Cutoff Current		I_{EBO}			
(V_{EB} = 4.0 V, I_C = 0)				300	nA
(V_{EB} = 4.0 V, I_E = 0, T_J = 150°C)				50	μA
Collector Cutoff Current		I_{CEX}			
(V_{CE} = 40 V, $-V_{BE}$ = 4.0 V)				500	nA
(V_{CE} = 40 V, $-V_{BE}$ = 4.0 V, T_J = 150°C)				300	μA
Emitter Cutoff Current		I_{BEX}			
(V_{CE} = 40 V, $-V_{BE}$ = 4.0 V)				500	nA
(V_{CE} = 40 V, $-V_{BE}$ = 4.0 V, T_J = 150°C)				300	μA
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)				0.3	
(I_C = 500 mA, I_B = 50 mA)				0.5	
(I_C = 1.0 A, I_B = 100 mA)				1.0	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			V
(I_C = 150 mA, I_B = 15 mA)				1.0	
(I_C = 500 mA, I_B = 50 mA)	[BSX59]			1.2	
	[BSX60]			1.3	
(I_C = 1.0 A, I_B = 100 mA)				1.8	
DC Current Gain		h_{FE}			
(I_C = 150 mA, V_{CE} = 1.0 V)			30		
(I_C = 500 mA, V_{CE} = 1.0 V)	[BSX59]		25		
	[BSX60]		30	90	
(I_C = 1.0 A, V_{CE} = 5.0 V)	[BSX59]		20		
	[BSX60]		25		
SMALL SIGNAL CHARACTERISTICS					
Small Signal Current Gain (I_C = 50 mA, V_{CE} = 10 V, f = 100 MHz)		$\lvert h_{fe} \rvert$	2.5		
Input Capacitance ($-V_{BE}$ = 0.5 V, I_C = 0, f = 1.0 MHz)		C_{ib}		60	pF

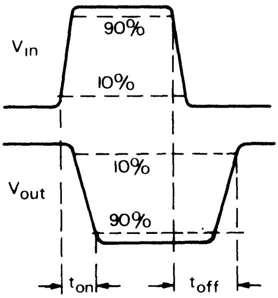
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{ob}		10	pF
Turn On Time (See Figure 1) (I_C = 500 mA, I_B = 50 mA, $-V_{BE}$ = 2.0 V) (V_{CC} = 50 V) [BSX59] (V_{CC} = 30 V) [BSX60]	t_{on}		 35 40	ns
Turn Off Time (See Figure 1) (I_C = 500 mA, I_{B1} = I_{B2} = 50 mA) (V_{CC} = 50 V) [BSX59] (V_{CC} = 30 V) [BSX60]	T_{off}		 60 70	ns

FIGURE 1 — SWITCHING TIME TEST CIRCUIT

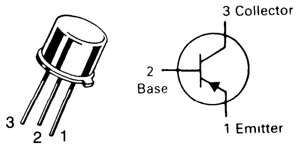


		BSX59 BSX61	BSX60	
Measure-ment	V_{CC} R_C	50 100	30 60	V Ω
t_{on}	$-V_B$ V_{in}	4.0 24.75		V V
t_{off}	$-V_B$ V_{in}	16.7 37.5		V V



CV9507

(CECC 50004-050)
CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTOR

PNP SILICON

Refer to 2N2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current – Continuous	I_C	0.6	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.5 3.33	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +175	°C

THERMAL CHARACTERISTICS

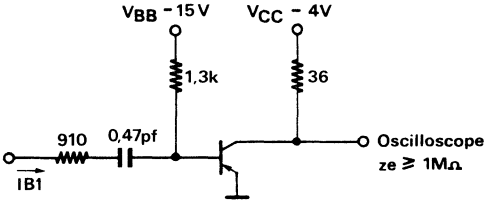
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{CEO(sus)}$	65		Vdc
Collector Cutoff Current ($V_{CB} = 50$ V, $I_E = 0$) ($V_{CB} = 50$ V, $I_E = 0$, $T_A = 100°C$)	I_{CBO}		75 1	nA µA
Emitter Cutoff Current ($V_{EB} = 3$ V, $I_C = 0$) ($V_{EB} = 5$ V, $I_C = 0$)	I_{EBO}		100 10	nA µA
ON CHARACTERISTICS				
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mA, $I_B = 15$ mA)	$V_{CE(sat)}$		0.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mA, $I_B = 15$ mA) ($I_C = 30$ mA, $I_B = 1$ mA)	$V_{BE(sat)}$		1.3 0.9	Vdc
DC Current Gain ($I_C = 1$ mA, $V_{CE} = 0.4$ V) ($I_C = 10$ mA, $V_{CE} = 0.4$ V) ($I_C = 50$ mA, $V_{CE} = 0.4$ V) ($I_C = 150$ mA, $V_{CE} = 0.4$ V)	h_{FE}	40 50 20 10	 200	
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product ($I_C = 50$ mA, $V_{CE} = 10$ V, f = 20 MHz)	f_T	50		MHz
Output Capacitance ($V_{CB} = 10$ V, f = 1 MHz)	C_{obo}		12	pF
SWITCHING CHARACTERISTICS				
Storage Time (See Figure 1) ($V_{CC} = -4$ V, $I_C = -100$ mA) ($I_{B1} = I_{B2} = 10$ mA)	t_s		250	ns

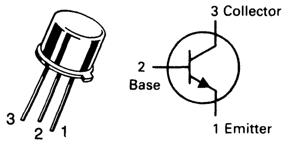
(1) Pulsed: Pulse Duration = 300 µs, Duty Cycle = 1%.

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



CV10253
CV12253

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current − Continuous	I_C	0.6	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 4.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +175	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	250	°C/W

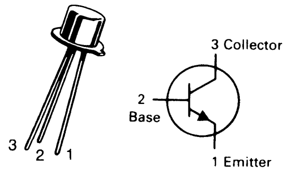
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 10 mA, I_B = 0)	$V_{CEO(sus)}$	65		V
Collector Cutoff Current (V_{CB} = 50 V, I_E = 0)	I_{CBO}		20	nA
Emitter Cutoff Current ($I_{EBO}(1)$ V_{EB} = 3 V, I_C = 0) ($I_{EBO}(2)$ V_{EB} = 5 V, I_C = 0)	I_{EBO}		 20 2	 nA μA
Collector Cutoff Current (V_{CE} = 50 V, T_A = 100°C)	I_{CEO}		80	μA
ON CHARACTERISTICS				
DC Current Gain ($h_{21e}(1)$ I_C = 1.0 mA, V_{CE} = 0.4 V) ($h_{21e}(2)$ I_C = 10 mA, V_{CE} = 0.4 V) ($h_{21e}(3)$ I_C = 150 mA, V_{CE} = 0.75 V)(1) ($h_{21e}(4)$ I_C = 50 mA, V_{CE} = 0.4 V)	h_{FE}	 40 50 25 35	 — 200 — —	
Base-Emitter Saturation Voltage(1) (I_C = 30 mA, I_B = 1 mA) (I_C = 150 mA, I_B = 15 mA)	$V_{BE(sat)}$		 0.9 1.3	V
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 50 mA, V_{CE} = 10 V, f = 35 MHz)	f_T	60		MHz
Storage Time CV10253 (V_{CC} = 45 V, I_C = 100 mA, I_{B1} = I_{B2} = 10 mA) CV12253	t_s	172	250 550	ns
Output Capacitance (V_{CB} = 10 V, f = 1 MHz)	C_{ob}		20	pF

(1) Pulsed: Pulse Duration = 300 μs, Duty Cycle = 1%.

CV10440

(CECC 50004-087)
CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	45	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current – Continuous	I_C	250	mAmp
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.3 2.0	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +175	°C

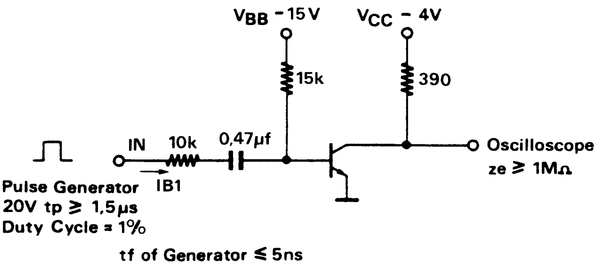
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

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

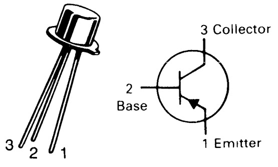
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 10 mA, I_B = 0)	$V_{CEO(sus)}$	45		Vdc
Collector Cutoff Current (Emitter Open) (V_{CB} = 30 V, I_B = 0) (V_{CB} = 30 V, I_B = 0, T_A = 100°C)	I_{CBO}		100 15	nA µA
Emitter Cutoff Current (V_{EB} = 5 V, I_C = 0)	I_{EBO}		500	nA
ON CHARACTERISTICS				
Base-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA) (I_C = 50 mA, I_B = 2.5 mA)	$V_{BE(sat)}$		0.9 1.6	Vdc Vdc
DC Current Gain (I_C = 10 µA, V_{CE} = 0.4 V) (I_C = 1 mA, V_{CE} = 0.4 V) (I_C = 10 mA, V_{CE} = 0.4 V)	h_{FE}	40 175 225	 500 550	
Collector-Emitter Saturation Voltage (I_C = 10 mA, I_B = 1 mA)	$V_{CE(sat)}$		0.3	Vdc
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product (I_C = 10 mA, V_{CE} = 5 V, f = 35 MHz)	f_T	200		MHz
Output Capacitance (V_{CB} = 5 V, I_E = 0, f = 1 MHz)	C_{ob}		8	pF
SWITCHING CHARACTERISTICS				
Storage Time (See Figure 1) (V_{CC} = 4 V, V_{BB} = 15 V, I_C = 10 mA, I_{B1} = I_{B2} = 1 mA)	t_s		750	ns

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



CV10814

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	5	Vdc
Collector Current – Continuous	I_C	100	mAmp
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2.0	mWatt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +175	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	200	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

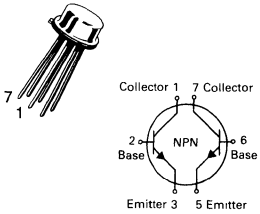
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage ($I_C = 2$ mA, $I_B = 0$)	$V_{CEO(sus}$	40		V
Collector Cutoff Current (Emitter Open) ($V_{CB} = 30$ V, $I_E = 0$) ($V_{CB} = 30$ V, $I_E = 0$, $T_A = 100°C$)	I_{CBO}		100 4	nA μA
Emitter Cutoff Current (Collector Open) ($V_{EB} = 5$ V, $I_C = 0$)	I_{EBO}		500	nA
ON CHARACTERISTICS				
Collector-Emitter Saturation Voltage ($I_C = 10$ mA, $I_B = 1$ mA)	$V_{CE(sat)}$		0.3	V
DC Current Gain ($I_C = 10$ μA, $V_{CE} = 5$ V) ($I_C = 2$ mA, $V_{CE} = 5$ V)	h_{FE}	40 125	 400	
SMALL SIGNAL CHARACTERISTICS				
Current Gain Bandwidth Product ($I_C = 10$ mA, $V_{CE} = 5$ V, f = 100 MHz)	f_T	200		MHz
Small Signal Current Gain ($I_C = 1$ mA, $V_{CE} = 10$ V, f = 1 kHz)	h_{fe}	100	400	
Noise Figure ($R_g = 2$ KΩ, $V_{CE} = 5$ V, $I_E = 200$ μA, f = 30 Hz to 15 kHz	NF		2	dB
Output Capacitance ($V_{CB} = 5$ V, f = 1 MHz)	C_{obo}		8	pF

CV12253 For Specifications, See CV10253 Data.

MD708, A, B

CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2369 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C MD708, MD708A, MD708B	P_D	550 3.13	600 3.42	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.4 8.0	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

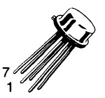
Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	87.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	319	292	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factors		83	40	%

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(2) (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	15 30	nAdc μAdc
ON CHARACTERISTICS				
DC Current Gain(2) (I_C = 500 μAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 150 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	40 40 35 20	— 200 — —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	— — —	0.20 0.35 0.50	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc) (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	0.65 — —	0.85 0.95 1.10	Vdc

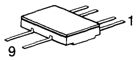
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD918A
MD918B



CASE 654-07, STYLE 1

MD918AF



CASE 610A-04, STYLE 1

DUAL AMPLIFIER TRANSISTORS

NPN SILICON

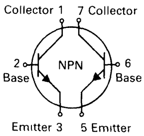
MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CES}	30		Vdc
Emitter-Base Voltage	V_{EBO}	3.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C	P_D			
MD918,A,B		550	600	
MD918AF		350	400	mW
Derate above 25°C				
MD918,A,B		3.14	3.42	
MD918AF		2.0	2.28	mW/°C
Total Device Dissipation @ T_C = 25°C	P_D			
MD918,A,B		1.4	2.0	Watts
MD918AF		0.7	1.4	
Derate above 25°C				
MD918,A,B		8.0	11.4	mW/°C
MD918AF		4.0	8.0	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

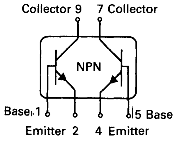
THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD918A,B		125	87.5	
MD918AF		250	125	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD918A,B		319	292	
MD918AF		500	438	
		Junction to Ambient	**Junction to Case**	
Coupling Factors				%
MD918A,B		83	40	
MD918AF		75	0	

PIN CONNECTION DIAGRAMS



CASE 654-07
STYLE 1



CASE 610A-04
STYLE 1

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 15 Vdc, I_E = 0)		—	—	10	nAdc
(V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)		—	—	1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	165	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 Adc)	$V_{CE(sat)}$	—	0.09	0.2	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.86	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	1.1	1.7	pF

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

Characteristic	Symbol	Min	Typ	Max	Unit
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	1.15	2.0	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400Ω, f = 60 MHz)	NF	—	—	6.0	dB

MATCHING CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
DC Current Gain Ratio(3) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) MD918B MD918A,AF	h_{FE1}/h_{FE2}	 0.8 0.9	 — —	 1.0 1.0	—
Base-Emitter Voltage Differential (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) MD918B MD918A,AF	$\lvert V_{BE1}-V_{BE2}\rvert$	 — —	 — —	 10 5.0	mVdc
Base-Emitter Voltage Differential Gradient (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, MD918B,AF T_A = −55 to +125°C) MD918A	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	— —	— —	20 10	μV/dc °C

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

FIGURE 1 – DC CURRENT GAIN

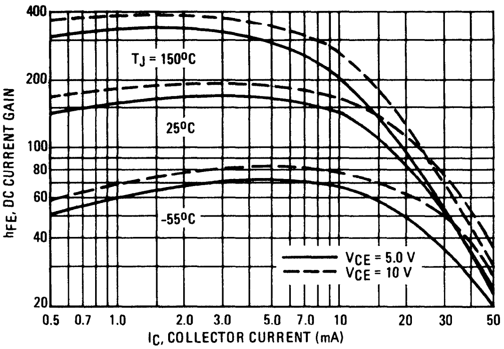


FIGURE 2 – "ON" VOLTAGES

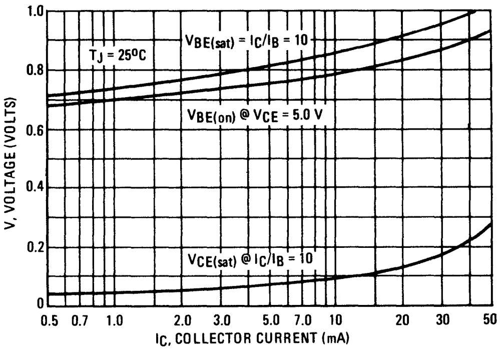


FIGURE 3 – BASE-EMITTER TEMPERATURE COEFFICIENT

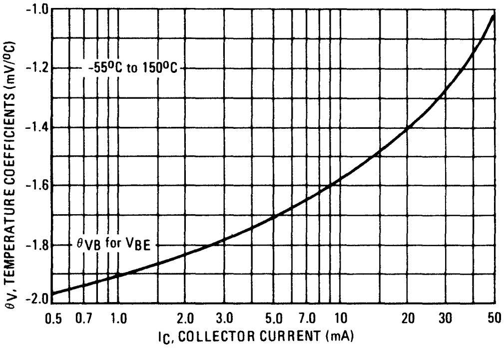


FIGURE 4 – CURRENT-GAIN BANDWIDTH PRODUCT

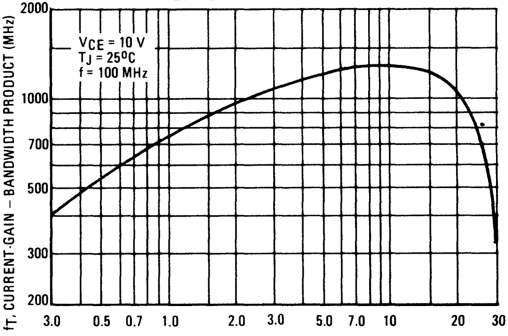
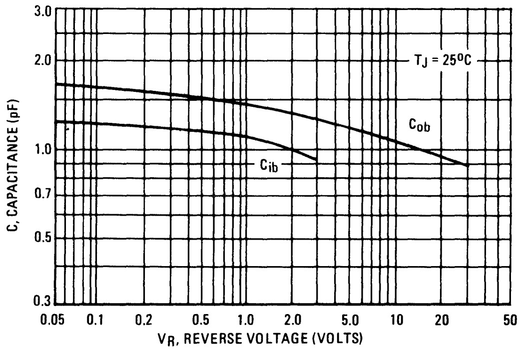
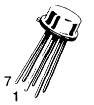


FIGURE 5 – CAPACITANCE

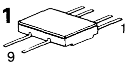


MD982, F
MQ982

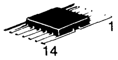
MD982
CASE 654-07, STYLE 1
DUAL



MD982F
CASE 610A-04, STYLE 1
DUAL



MQ982
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

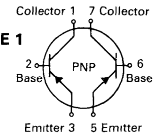
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	50		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	**All Die**	
Total Device Dissipation @ $T_A = 25°C$	P_D			mW
MD982		600	650	
MD982F		350	400	
MQ982		400	600	
Derate above 25°C				mW/°C
MD982		3.42	3.7	
MD982F		2.0	2.28	
MQ982		2.28	3.42	
Total Device Dissipation @ $T_C = 25°C$	P_D			Watts
MD982		2.1	3.8	
MD982F		1.25	2.5	
MQ982		1.0	4.0	
Derate above 25°C				mW/°C
MD982		12	17.2	
MD982F		7.15	14.3	
MQ982		5.71	22.8	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

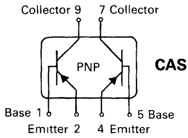
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD982		83.3	58.3	
MD982F		140	70	
MQ982		175	43.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD982		292	270	
MD982F		500	438	
MQ982		438	292	
		Junction to Ambient	**Junction to Case**	
Coupling Factor				%
MD982		85	40	
MD982F		75	0	
MQ982 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

PIN CONNECTION DIAGRAMS

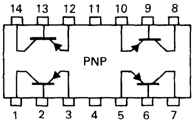
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$) ($V_{CB} = 50$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	— —	— —	0.020 20	μAdc
ON CHARACTERISTICS(2)					
DC Current Gain ($I_C = 0.1$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	20 25 35 40	50 75 90 60	— — — —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.25	0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.88	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	320	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	5.8	8.0	pF
Input Capacitance ($V_{BE} = 2.0$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	16	30	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	20		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		One Die	Both Die Equal Power	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	575 3.29	625 3.57	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10.3	2.5 14.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

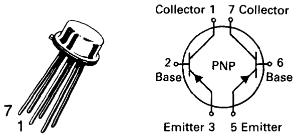
THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	Junction to Case	
Coupling Factor		84	44	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

MD984

CASE 654-07, STYLE 1



DUAL AMPLIFIER TRANSISTORS

PNP SILICON

Refer to MD3250 for graphs.

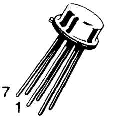
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

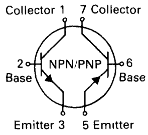
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0) (V_{CB} = 20 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	— —	25 30	nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	75	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)(2)	$V_{CE(sat)}$	— —	0.18 0.38	0.3 0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.8	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	250	550	—	MHz

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD985

CASE 654-07, STYLE 5





COMPLEMENTARY DUAL GENERAL PURPOSE TRANSISTORS

NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	575 3.29 2.0	625 3.57 2.28	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.8 10.3	 2.5 14.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factors		84	44	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = +150°C)	I_{CBO}	 — —	 — —	 20 20	 nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 150 mAdc, V_{CE} = 10 Vdc)	h_{FE}	 20 25 35 40	 50 75 90 90	 — — — —	—
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.3	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	1.0	1.4	Vdc

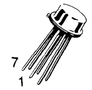
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	320	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	5.8	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	20	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	25	—	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	75	—	ns

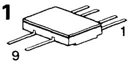
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD1121
MD1122
MQ1120

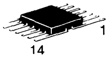
MD1121
CASE 654-07, STYLE 1



MD1122
CASE 610A-04, STYLE 1



MQ1120
CASE 607-04, STYLE 1



DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2218,A for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C MD1121, MD1122 MQ1120 Derate above 25°C MD1121, MD1122 MQ1120	P_D	 575 400 3.29 2.28	 625 600 3.57 3.42	 mW mW/°C
Total Device Dissipation @ T_C = 25°C MD1121, MD1122 MQ1120 Derate above 25°C MD1121, MD1122 MQ1120	P_D	 1.8 0.9 10.3 5.13	 2.5 3.6 14.3 20.5	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

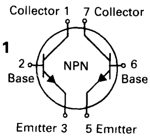
THERMAL CHARACTERISTICS

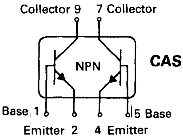
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case MD1121, MD1122 MQ1120	$R_{\theta JC}$	 97 195	 70 48.8	°C/W
Thermal Resistance, Junction to Ambient MD1121, MD1122 MQ1120	$R_{\theta JA}$(1)	 304 438	 280 292	°C/W
		Junction to Ambient	Junction to Case	Unit
Coupling Factors MD1121, MD1122 MQ1120 (Q1-Q2) (Q1-Q3 or Q1-Q4)		 84 57 55	 44 0 0	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

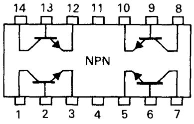
CASE 654-07, STYLE 1





CASE 610A-04, STYLE 1

CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	10	nAdc

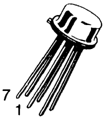
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

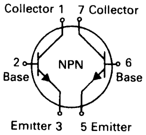
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain(2)	h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 10 Vdc)		20	40	100	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		30	50	120	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		40	60	160	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		50	65	200	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	80	100	mVdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	700	850	mVdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	3.5	8.0	pF
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3)	h_{FE1}/h_{FE2}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc) All Devices		0.8	—	1.0	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc) MD1122		0.9	—	1.0	
Base-Emitter Voltage Differential	$\lvert V_{BE1}-V_{BE2}\rvert$				mVdc
(I_C = 100 μAdc, V_{CE} = 10 Vdc) All Devices		—	—	10	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc) MD1122		—	—	5.0	
Base-Emitter Voltage Differential Change Due to Temperature — MD1121, MD1122	$\Delta(V_{BE1}-V_{BE2})$				mVdc
(I_C = 100 μAdc, V_{CE} = 10 Vdc, T_A = −55 to +25°C)		—	—	0.8	
(I_C = 100 μAdc, V_{CE} = 10 Vdc, T_A = +25 to +125°C)		—	—	1.0	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD1132

CASE 654-07, STYLE 1





DUAL
RF AMPLIFIER TRANSISTOR

NPN SILICON

Refer to MD918 for graphs.

3

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	30		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	550 3.14	600 3.42	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.4 8.0	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	125	87.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	319	292	°C/W
		Junction to Ambient	**Junction to Case**	**Unit**
Coupling Factors		83	40	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

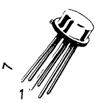
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	— —	10 1.0	nAdc μAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	—	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.2	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.7	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	800	—	—
Output Capacitance (V_{CB} = 0, I_E = 0, f = 140 kHz) (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	— —	1.5 1.3	3.0 1.7	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	1.8	2.0	pF
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE1}/h_{FE2}	0.9	—	1.0	—
Base-Emitter Voltage Differential (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	$\|V_{BE1}-V_{BE2}\|$	—	—	5.0	mVdc
Base-Emitter Voltage Differential Change Due to Temperature (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +25°C) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, T_A = +25 to +125°C)	$\Delta(V_{BE1}-V_{BE2})$	 — —	 — —	 0.8 1.0	mVdc

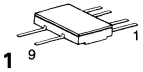
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD2218, A, AF
MD2219A, AF
MQ2218, A MQ2219, A

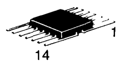
MD2218, A
MD2219A
CASE 654-07, STYLE 1
DUAL



MD2218AF
MD2219AF
CASE 610A-04, STYLE 1
DUAL



MQ2218, A
MQ2219, A
CASE 607-04, STYLE 1
QUAD

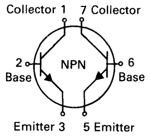


AMPLIFIER TRANSISTORS

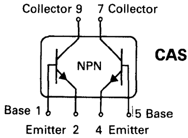
NPN SILICON

PIN CONNECTION DIAGRAMS

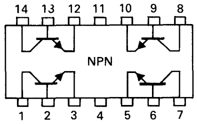
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



MAXIMUM RATINGS

Rating	Symbol	MD2218,A MD2219A,F MQ2218,A MQ2219,A	MD2218AF MD2219AF	Unit
Collector-Emitter Voltage	V_{CEO}	30	40	Vdc
Collector-Base Voltage	V_{CBO}	60	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	6.0	Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD2218,A, MD2219A		575	625	
MD2218AF, MD2219F,AF		350	400	
MQ2218,A, MQ2219,A		400	600	mW/°C
Derate above 25°C				
MD2218,A, MD2219A		3.29	3.57	
MD2218AF, MD2219F,AF		2.0	2.28	
MQ2218,A, MQ2219,A		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD2218,A, MD2219A		1.8	2.5	
MD2218AF, MD2219F,AF		1.0	2.0	
MQ2218,A, MQ2219,A		0.9	3.6	mW/°C
Derate above 25°C				
MD2218,A, MD2219A		10.3	14.3	
MD2218AF, MD2219F,AF		5.71	11.4	
MQ2218,A, MQ2219,A		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD2218,A, MD2219A		97	70	
MD2218AF, MD2219AF		175	87.5	
MQ2218,A, MQ2219,A		195	48.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD2218,A, MD2219A		304	280	
MD2218AF, MD2219AF		500	438	
MQ2218,A, MQ2219,A		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factors				%
MD2218,A, MD2219A		84	44	
MD2218AF, MD2219AF		75	0	
MQ2218,A, MQ2219,A (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$				Vdc
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		30	—	—	
MD2218AF, MD2219AF		40	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$				Vdc
MD2218,A, MD2219A, MQ2218,A, MD2219A		60	—	—	
MD2218AF, MD2219AF		75	—	—	

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

Characteristic	Symbol	Min	Typ	Max	Unit
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$				Vdc
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		5.0	—	—	
MD2218AF, MD2219AF		6.0	—	—	
Collector Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{CEV}				nAdc
MD2218, MD2219F, MQ2218,A		20	—	—	
MD2218A,AF, MD2219A,AF, MQ2219,A		15	—	—	
Base Cutoff Current (V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{BL}	30	—	—	nAdc

ON CHARACTERISTICS(2)

Characteristic	Symbol	Min	Typ	Max	Unit
DC Current Gain	h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)					
MD2218,A,AF, MQ2218,A		20	50	—	
MD2219A,AF, MQ2219,A		35	45	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)					
MD2218,A,AF, MQ2218,A		25	55	—	
MD2219A,AF, MQ2219,A		50	55	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)					
MD2218,A,AF, MQ2218,A		35	65	—	
MD2219A,AF, MQ2219,A		75	85	—	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)					
MD2218,A,AF, MQ2218,A		20	65	—	
MD2219A,AF, MQ2219,A		50	65	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)					
MD2218,A,AF, MQ2218,A		40	30	120	
MD2219A,AF, MQ2219,A		100	120	300	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)					
MD2218,A, MQ2218,A		25	75	—	
MD2219A, MQ2219,A		30	75	—	
Collector-Emitter Saturation Voltage	$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)					
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		—	0.2	0.4	
MD2218AF, MD2219AF		—	—	0.3	
(I_C = 300 mAdc, I_B = 30 mAdc)					
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		—	0.35	1.2	
MD2218AF, MD2219AF		—	—	0.9	
Base-Emitter Saturation Voltage	$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)					
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		0.6	0.95	1.3	
MD2218AF, MD2219AF		0.6	1.0	1.2	
(I_C = 300 mAdc, I_B = 30 mAdc)					
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		—	—	2.0	
MD2218AF, MD2219AF		—	—	1.8	

SMALL-SIGNAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	3.5	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}				pF
MD2218,A, MD2219A, MQ2218,A, MQ2219,A		—	15	20	
MD2218AF, MD2219AF		—	18	25	

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

Characteristic		Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS						
Delay Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, $V_{BE(off)}$ = 0.5 Vdc, I_{B1} = 15 mAdc) MD2218 MD2218A,AF, MD2219A,AF	t_d	— —	— —	20 15	ns
Rise Time	MD2218 MD2218A,AF, MD2219A,AF	t_r	— —	— —	40 30	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc) MD2218 MD2218A,AF, MD2219A,AF	t_s	— —	— —	280 250	ns
Fall Time	MD2218 MD2218A,AF, MD2219A,AF	t_f	— —	— —	70 60	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – NORMALIZED DC CURRENT GAIN

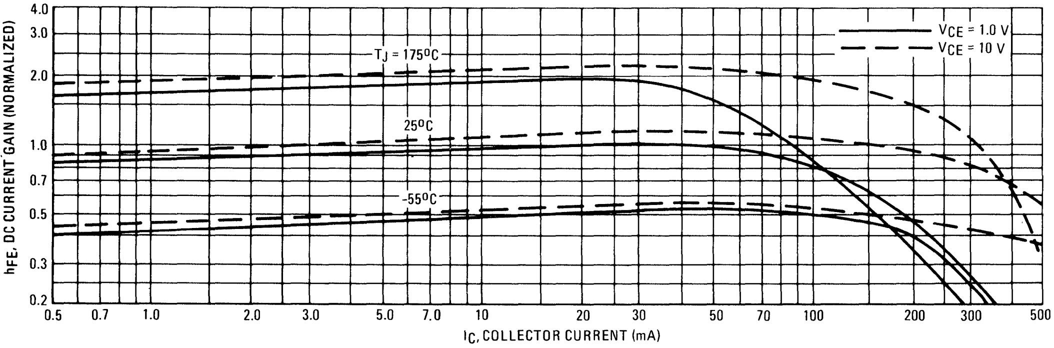


FIGURE 2 – "ON" VOLTAGES

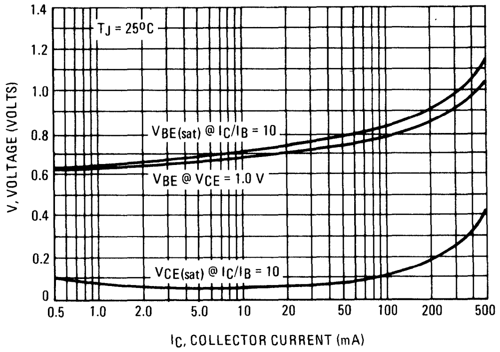
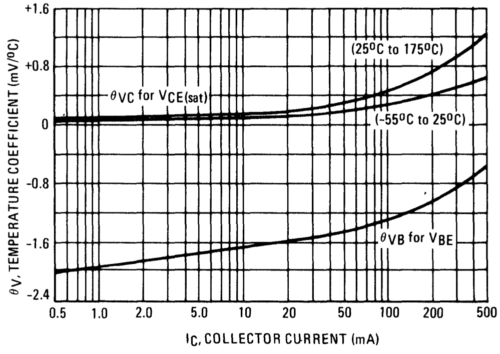


FIGURE 3 – TEMPERATURE COEFFICIENTS



NOISE FIGURE

(V_{CE} = 10 Vdc, T_A = 25°C)

FIGURE 4 — FREQUENCY EFFECTS

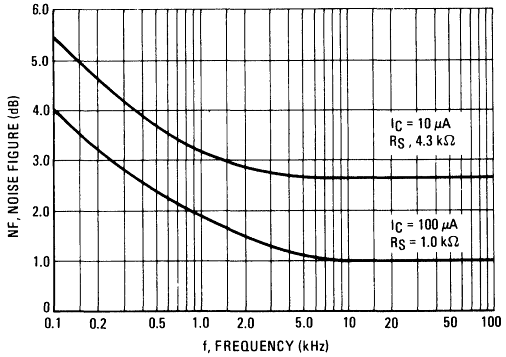


FIGURE 5 — SOURCE RESISTANCE EFFECTS

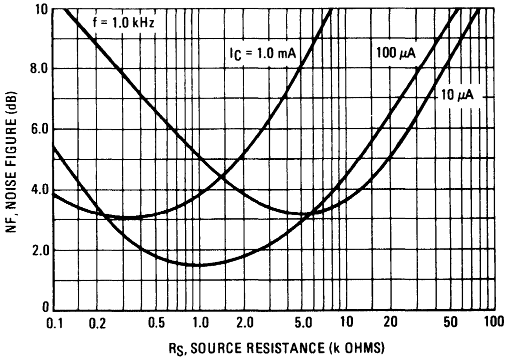


FIGURE 6 — CURRENT-GAIN-BANDWIDTH PRODUCT

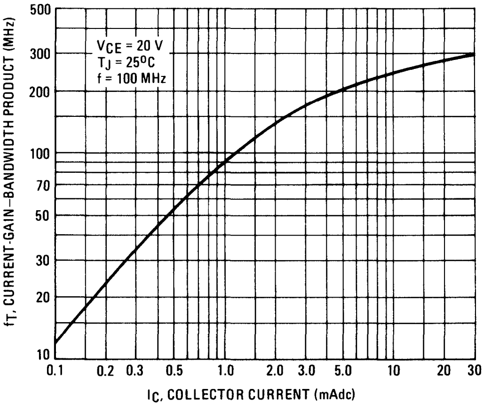
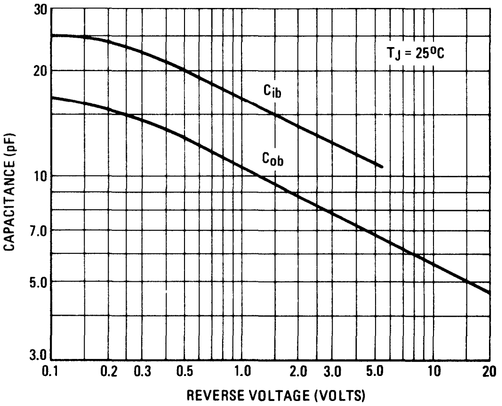


FIGURE 7 — CAPACITANCES



SWITCHING TIME CHARACTERISTICS

FIGURE 8 — TURN-ON TIME

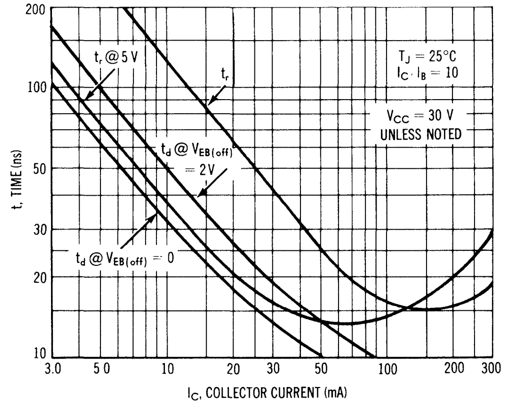


FIGURE 9 — CHARGE DATA

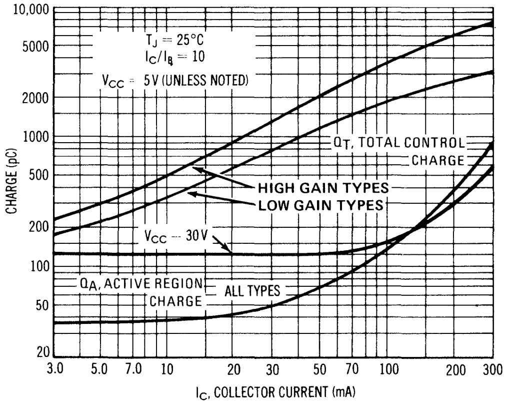


FIGURE 10 — TURN-OFF BEHAVIOR

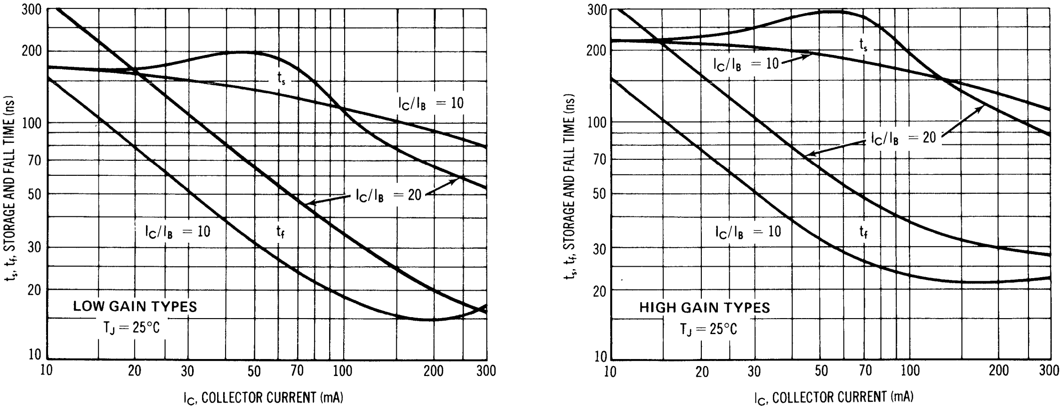


FIGURE 11 — DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

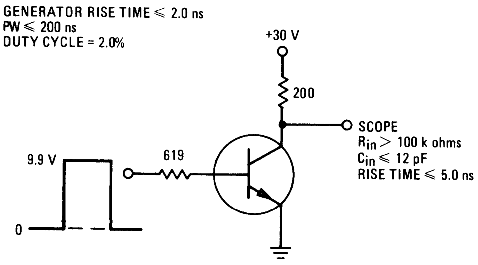
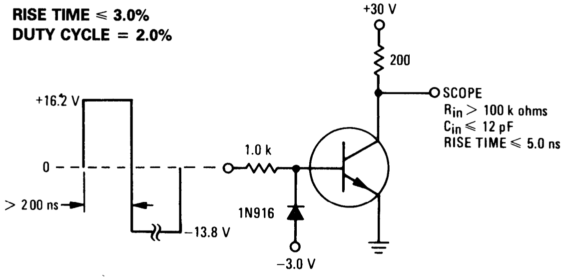
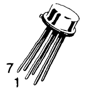


FIGURE 12 — STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT

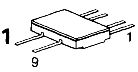


MD2369, A, B, AF, BF
MQ2369

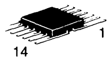
MD2369,A,B
CASE 654-07, STYLE 1
DUAL



MD2369,AF,BF
CASE 610A-04, STYLE 1
DUAL



MQ2369
CASE 607-04, STYLE 1
QUAD



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ $T_A = 25°C$	P_D			mW
MD2369,A,B		550	600	
MD2369,AF,BF		350	400	
MQ2369		400	600	
Derate above 25°C				mW/°C
MD2369,A,B		3.14	3.42	
MD2369F,AF,BF		2.0	2.28	
MQ2369		2.28	3.42	
Total Device Dissipation @ $T_C = 25°C$	P_D			Watts
MD2369,A,B		1.4	2.0	
MD2369,AF,BF		0.7	1.4	
MQ2369		0.7	2.8	
Derate above 25°C				mW/°C
MD2369,A,B		8.0	11.4	
MD2369,AF,BF		4.0	80	
MQ2369		4.0	16	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

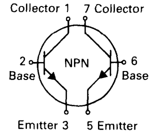
THERMAL CHARACTERISTICS

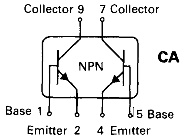
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD2369,A,B		125	87.5	
MD2369,AF,BF		250	125	
MQ2369		250	62.6	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD2369,A,B		319	292	
MD2369,AF,BF		500	438	
MQ2369		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD2369,A,B		83	40	
MD2369,AF,BF		75	0	
MQ2369 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

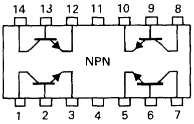
CASE 654-07, STYLE 1





CASE 610A-04, STYLE 1

CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				μAdc
($V_{CB} = 20$ Vdc, $I_E = 0$)		—	—	0.03	
($V_{CB} = 20$ Vdc, $I_E = 0$, $T_A = +150°C$)		—	—	30	
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}				—
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)		40	95	140	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc, $T_A = -55°C$)		20	—	—	

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

Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	0.7	—	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	500	800	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	—	4.0	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 100 MHz)	C_{ibo}	—	—	4.0	pF
SWITCHING CHARACTERISTICS					
Storage Time (V_{CC} = 10 Vdc, I_C = I_{B1} = I_{B2} = 10 mAdc)	t_s	—	—	13	ns
Turn-On Time (V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	—	—	15	ns
Turn-Off Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc)	t_{off}	—	—	20	ns
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3)	h_{FE1}/h_{FE2}				—
(I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc) MD2369A, MD2369AF		0.9	—	1.0	
MD2369B, MD2369BF		0.8	—	1.0	
Base-Emitter Voltage Differential	$\lvert V_{BE1}-V_{BE2}\rvert$				mVdc
(I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc) MD2369A, MD2369AF		—	—	5.0	
MD2369B, MD2369BF		—	—	10	
Base-Emitter Voltage Differential Gradient (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc,	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$				µV/°C
T_A = −55 to +125°C) MD2369A, MD2369AF		—	—	10	
MD2369B, MD2369BF		—	—	20	

(2) Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%.

(3) The lowest h_{FE} reading is taken as h_{FE1} for this test.

FIGURE 1 — STORAGE TIME TEST CIRCUIT

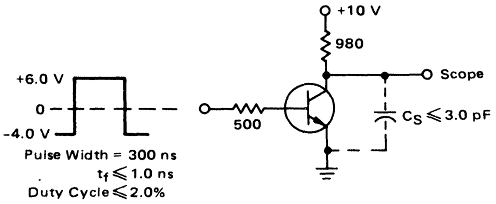


FIGURE 2 — TURN-ON TIME

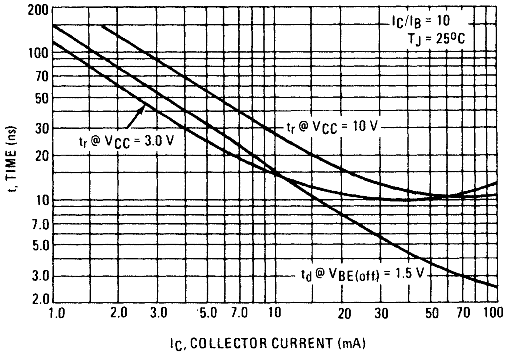


FIGURE 3 — TURN-OFF TIME

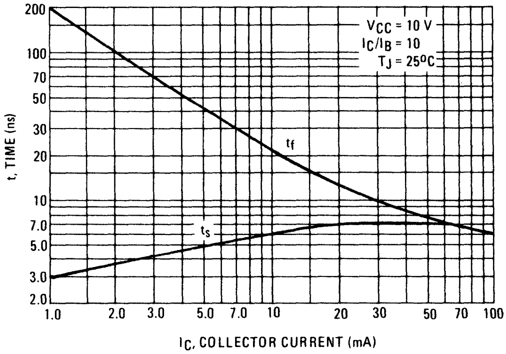


FIGURE 4 — TURN-ON TEST CIRCUIT

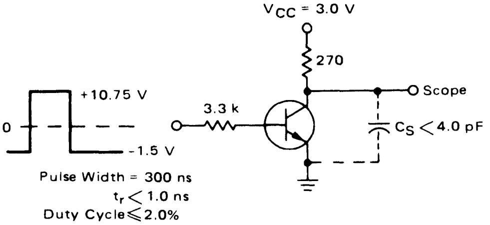


FIGURE 5 — TURN-OFF TEST CIRCUIT

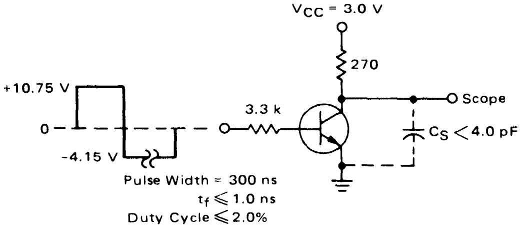


FIGURE 6 — CAPACITANCE

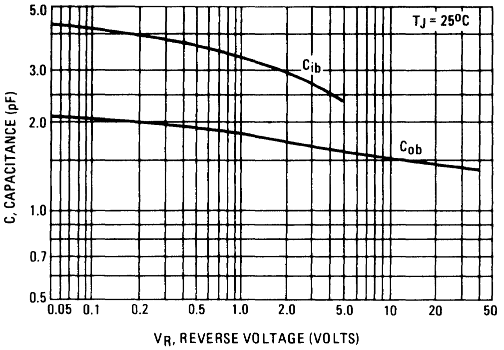


FIGURE 7 — CURRENT-GAIN — BANDWIDTH PRODUCT

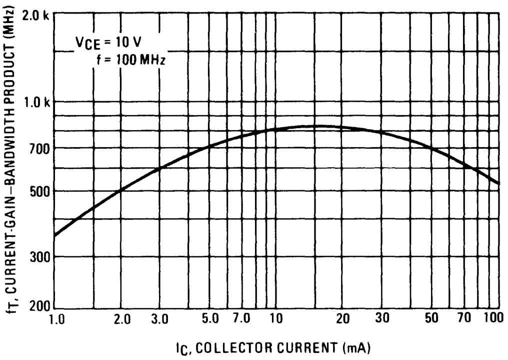


FIGURE 8 — DC CURRENT GAIN

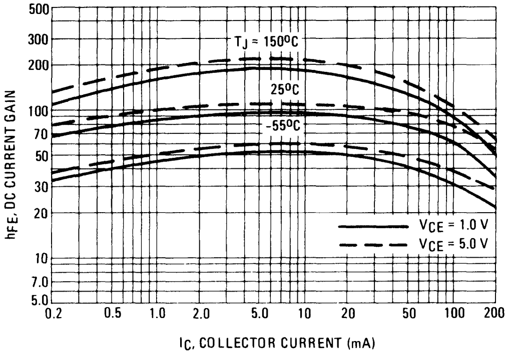


FIGURE 9 — "ON" VOLTAGES

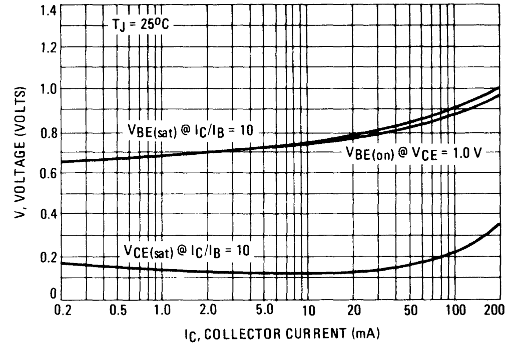


FIGURE 10 — COLLECTOR SATURATION REGION

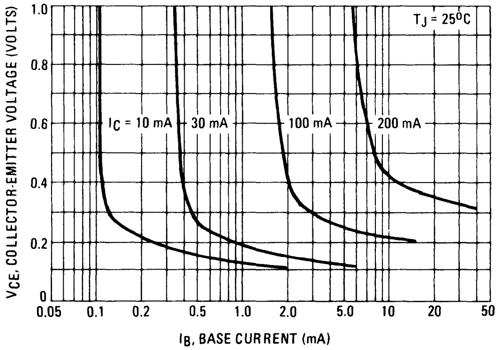
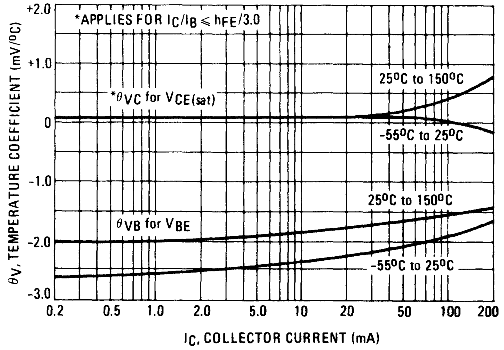
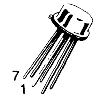


FIGURE 11 — TEMPERATURE COEFFICIENTS

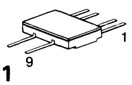


MD2904, A, AF
MD2905, A, AF
MQ2904, MQ2905A

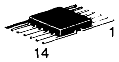
MD2904,A
MD2905,A
CASE 654-07, STYLE 1
DUAL



MD2904,AF
MD2905,AF
CASE 610A-04, STYLE 1
DUAL



MQ2904
MQ2905A
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MD2904 MD2905 MQ2904	MD2904A,AF MD2905A,AF MQ2905A	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD2904,A, MD2905,A		575	625	
MD2904F,AF, MD2905,AF		350	400	
MQ2904, MQ2905A		400	600	mW/°C
Derate above 25°C				
MD2904,A, MD2905,A		3.29	3.57	
MD2904,F,AF, MD2905,AF		2.0	2.28	
MQ2904, MQ2905A		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD2904,A, MD2905,A		1.8	2.5	
MD2904F,AF, MD2905F,AF		1.0	2.0	
MQ2904, MQ2905A		0.9	3.6	mW/°C
Derate above 25°C				
MD2904,A, MD2905,A		10.3	14.3	
MD2904F,AF, MD2905,AF		5.71	11.4	
MQ2904, MQ2905A		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

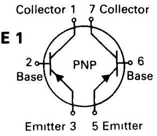
THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD2904,A, MD2905,A		97	70	
MD2904,AF, MD2905,AF		175	87.5	
MQ2904, MQ2905A		195	48.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD2904,A, MD2905,A		304	280	
MD2904,AF, MD2905,AF		500	438	
MQ2904, MQ2905A		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD2904,A, MD2905,A		84	44	
MD2904,AF, MD2905,AF		75	0	
MQ2904, MQ2905A (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

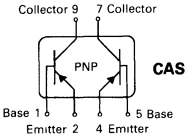
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

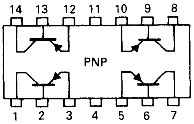
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$				Vdc
MD2904, MD2905		40	—	—	
MD2904A, MD2905A		60	—	—	
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				μAdc
(V_{CB} = 50 Vdc, I_E = 0)		—	—	0.020	
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)		—	—	30	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	30	nAdc
ON CHARACTERISTICS(2)						
DC Current Gain		h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD2904		20	50	—	
	MD2904A		40	70	—	
	MD2905		35	70	—	
	MD2905A		75	150	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD2904		25	75	—	
	MD2904A		40	75	—	
	MD2905		50	100	—	
	MD2905A		100	175	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD2904		35	90	—	
	MD2904A		40	90	—	
	MD2905		75	110	—	
	MD2905A		100	200	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MD2904,A,		40	90	120	
	MD2905,A		100	200	300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	MD2904		20	60	—	
	MD2904A		40	80	—	
	MD2905		30	130	—	
	MD2905A		50	150	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.25	0.4	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	0.5	1.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	0.88	1.3	
(I_C = 500 mAdc, I_B = 50 mAdc)			—	1.0	2.6	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(3) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	320	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	5.8	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	16	30	pF
SWITCHING CHARACTERISTICS						
Turn-On Time	(V_{CC} = 30 Vdc, V_{BE} = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	—	45	ns
Delay Time		t_d	—	—	12	ns
Rise Time		t_r	—	—	35	ns
Turn-Off Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	—	130	ns
Storage Time		t_s	—	—	100	ns
Fall Time		t_f	—	—	40	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — DC CURRENT GAIN

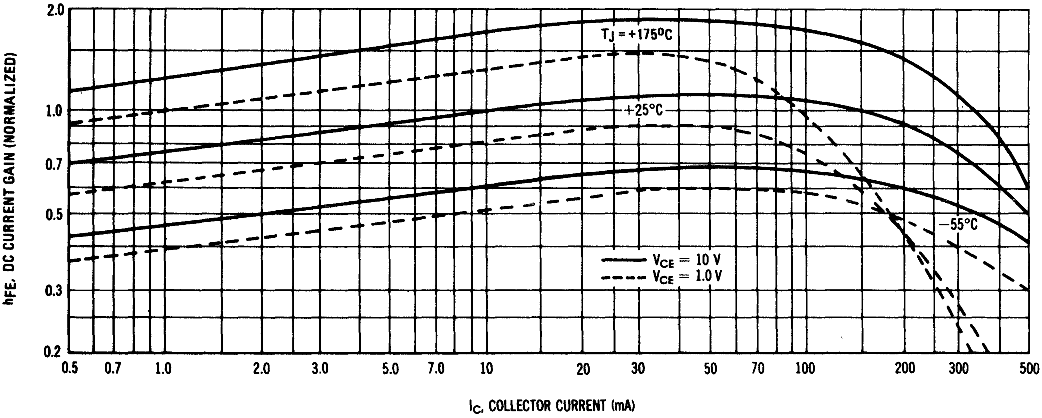


FIGURE 2 — "ON" VOLTAGES

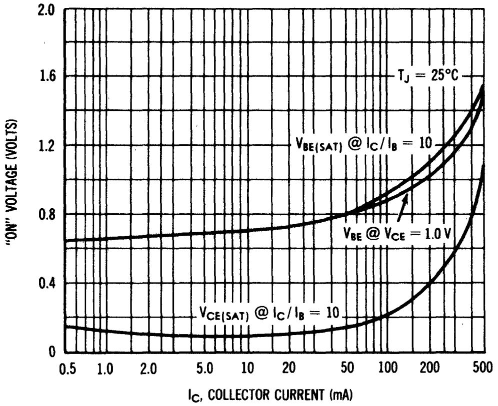
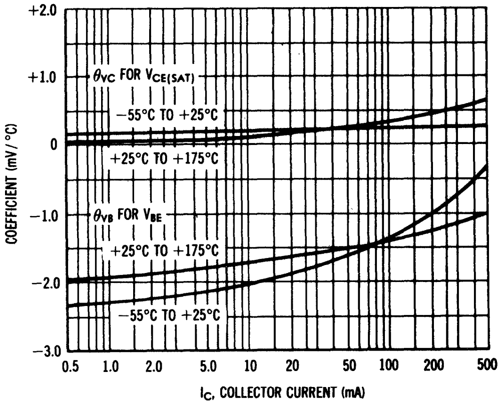


FIGURE 3 — TEMPERATURE COEFFICIENTS



NOISE FIGURE

$V_{CE} = 10$ V, $T_A = 25°C$

FIGURE 4 — FREQUENCY EFFECTS

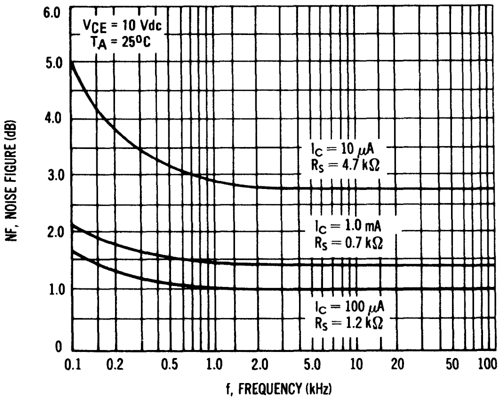


FIGURE 5 — SOURCE RESISTANCE EFFECTS

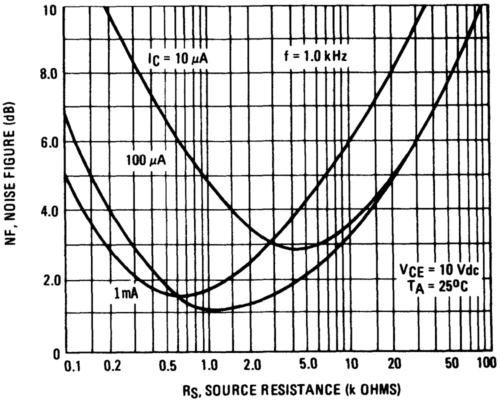


FIGURE 6 — CURRENT-GAIN BANDWIDTH PRODUCT

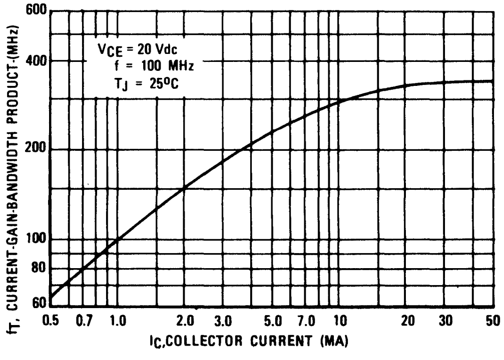


FIGURE 7 — CAPACITANCE

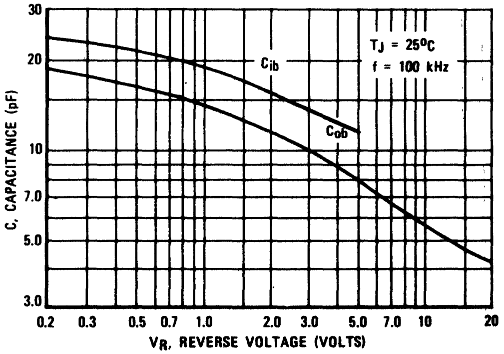


FIGURE 8 — TURN ON TIME

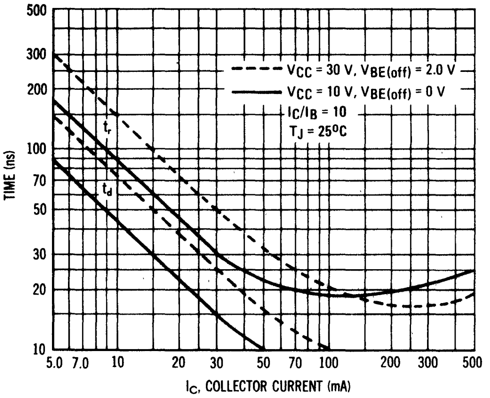


FIGURE 9 — CHARGE DATA

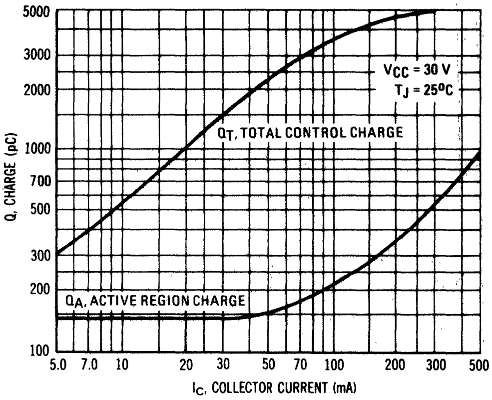


FIGURE 10 — STORAGE TIME

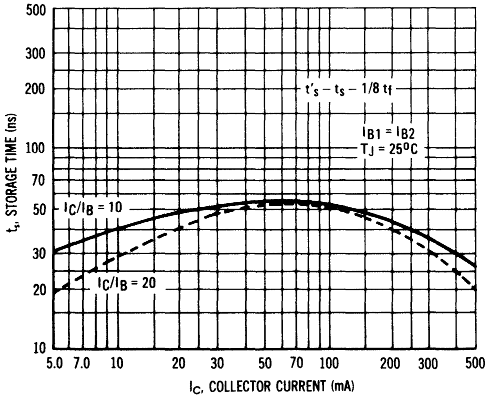


FIGURE 11 — FALL TIME

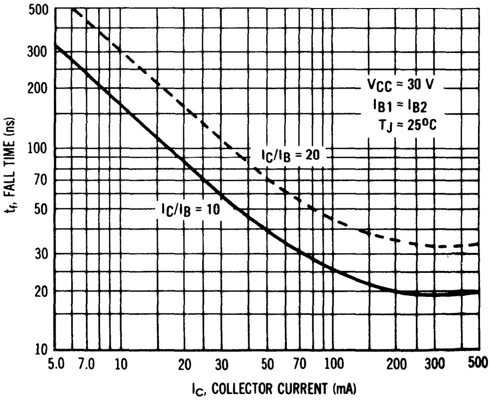


FIGURE 12 – DELAY AND RISE TIME TEST CIRCUIT

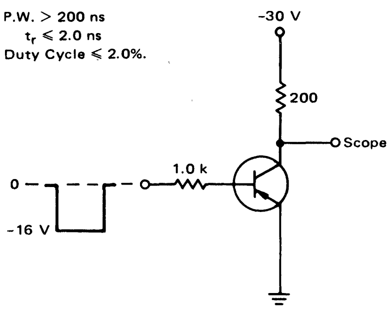
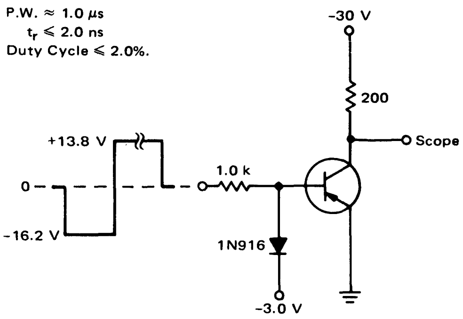
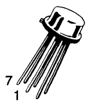


FIGURE 13 – STORAGE AND FALL TIME TEST CIRCUIT

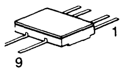


MD3250, A, AF
MD3251, A, AF
MQ3251

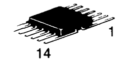
MD3250,A
MD3251,A
CASE 654-07, STYLE 1
DUAL



MD3250,AF
MD3251,AF
CASE 610A-04, STYLE 1
DUAL



MQ3251
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS
PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**All Die Equal Power**	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD3250,A, MD3251,A		575	625	
MD3250,AF, MD3251,AF		350	400	
MQ3251		400	600	
Derate above 25°C				mW/°C
MD3250,A, MD3251,A		3.29	3.57	
MD3250,AF, MD3251,AF		2.0	2.28	
MQ3251		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD3250,A, MD3251,A		1.8	2.5	
MD3250,AF, MD3251,AF		1.0	2.0	
MQ3251		0.9	3.6	
Derate above 25°C				mW/°C
MD3250,A, MD3251,A		10.3	14.3	
MD3250,AF, MD3251,AF		5.71	11.4	
MQ3251		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

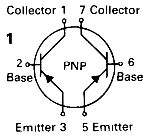
THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD3250,A, MD3251,A		97	70	
MD3250,AF, MD3251,AF		175	87.5	
MQ3251		195	48.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD3250,A, MD3251,A		304	280	
MD3250,AF, MD3251,AF		500	438	
MQ3251		438	292	
		Junction to Ambient	**Junction to Case**	
Coupling Factor				%
MD3250,A, MD3251,A		84	44	
MD3250,AF, MD3251,AF		75	0	
MQ3251 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

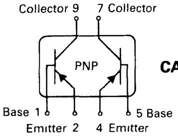
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

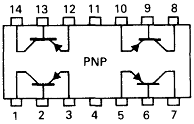
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 40 Vdc, I_E = 0)		—	—	10	nAdc
(V_{CB} = 40 Vdc, I_E = 0, T_A = 150°C)		—	—	10	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	10	nAdc

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

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS(2)						
DC Current Gain		h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)	MD3250,A,AF		25	75	—	
	MD3251,A,AF		50	100	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	MD3250,A,AF		50	82	150	
	MD3251,A,AF		80	170	300	
	MQ3251		80	170	—	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55°C)	MD3250,A,AF		25	35	—	
	MD3251,A,AF		50	75	—	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	MD3250,A,AF		50	87	150	
	MD3251,A,AF		100	180	300	
	MQ3251		100	180	—	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	MD3250,A,AF		50	92	—	
	MD3251,A,AF		100	190	—	
	MQ3251		100	190	300	
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MD3250,A,AF		15	50	—	
	MD3251,A,AF		30	90	—	
	MQ3251		30	90	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			—	0.11	0.25	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.18	0.5	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.6	0.78	0.9	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			—	0.88	1.2	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product		f_T				MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MD3250,A,AF		200	600	—	
	MD3251,A,AF		250	600	—	
	MQ3251		300	600	—	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	2.5	6.0	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	6.0	8.0	pF
MATCHING CHARACTERISTICS (MD3250,A,AF & MD3251,A,AF ONLY)						
DC Current Gain Ratio(3)		h_{FE1}/h_{FE2}				—
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)			0.9	—	1.0	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)			0.9	—	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$				mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc)			—	—	3.0	
(I_C = 10 μAdc, V_{CE} = 5.0 Vdc)			—	—	5.0	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)			—	—	5.0	
Base-Emitter Voltage Differential Change Due to Temperature		$\Delta\lvert V_{BE1}/V_{BE2}\rvert$				mVdc
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = −55 to +25°C)			—	—	0.8	
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, T_A = +25 to +125°C)			—	—	1.0	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

FIGURE 1 – CAPACITANCE

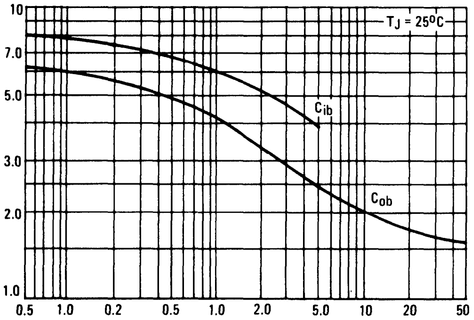
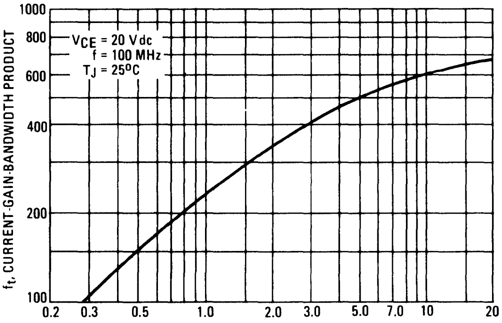


FIGURE 2 – CURRENT-GAIN-BANDWIDTH PRODUCT



NOISE FIGURE VARIATIONS

(V_{CE} = 6.0 V, T_A = 25°C)

FIGURE 3 – EFFECTS OF FREQUENCY

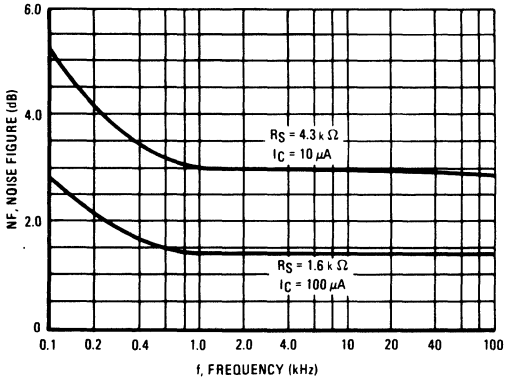


FIGURE 4 – EFFECTS OF SOURCE RESISTANCE

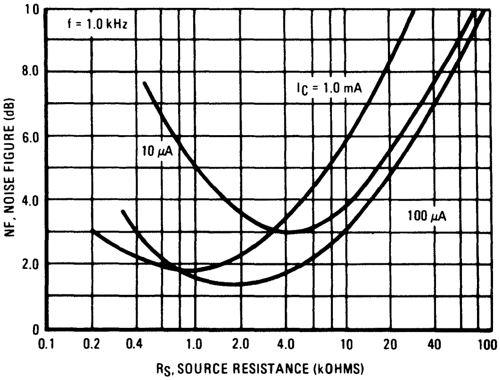


FIGURE 5 – DC CURRENT GAIN

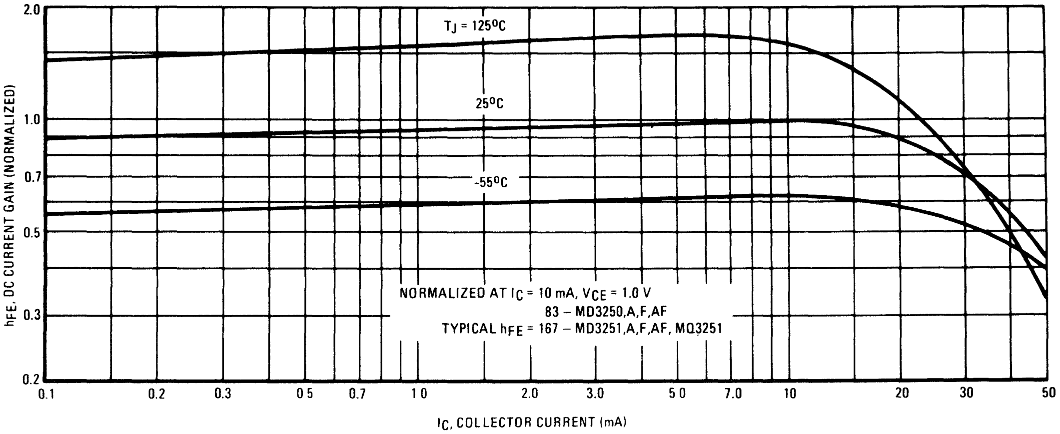


FIGURE 6 – "ON" VOLTAGE

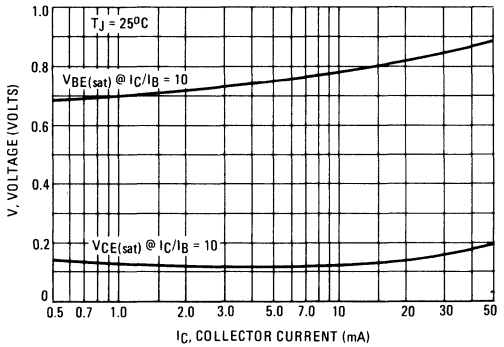


FIGURE 7 – TEMPERATURE COEFFICIENTS

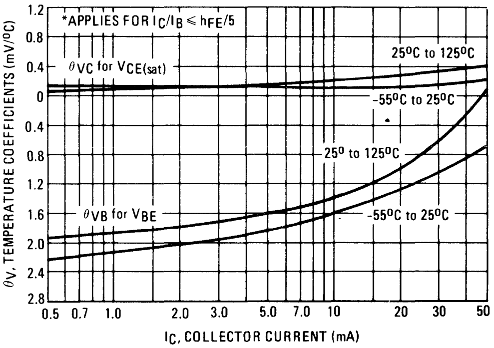
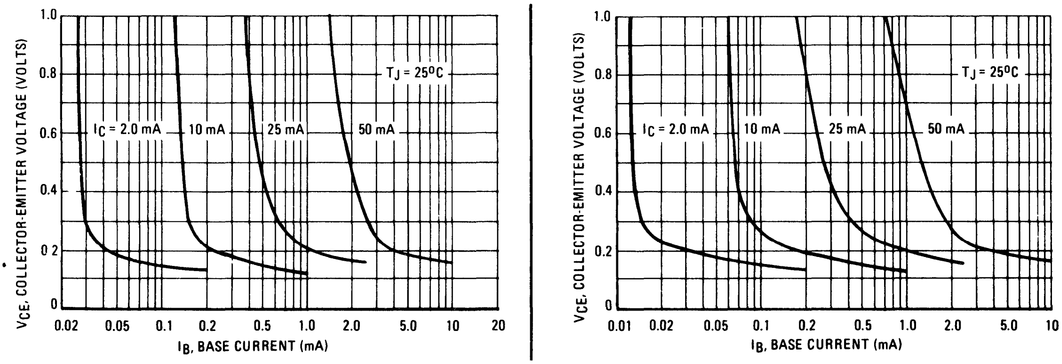


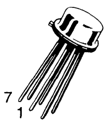
FIGURE 8 – COLLECTOR SATURATION REGION

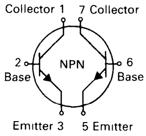

MD3250

MD3251, MQ3251

MD3409
MD3410

CASE 654-07, STYLE 1





DUAL
AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD2218 for graphs.

3

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	575 3.29	625 3.57	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10.3	2.5 14.3	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factors		84	44	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

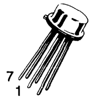
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage ($I_C = 10$ μAdc, $I_B = 0$)		$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$) ($V_{CB} = 50$ Vdc, $I_E = 0$, $T_A = 150°C$)		I_{CBO}	— —	— —	10 10	nAdc μAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)		I_{EBO}	—	—	10	nAdc
ON CHARACTERISTICS						
DC Current Gain(2)		h_{FE}				—
($I_C = 10$ μAdc, $V_{CE} = 10$ Vdc)	MD3410		20	40	100	
($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc)	Both Devices		30	50	120	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	Both Devices		40	60	160	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)	Both Devices		50	65	200	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{CE(sat)}$	—	0.09	0.15	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)		$V_{BE(sat)}$	—	0.7	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	200	250	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)		C_{obo}	—	3.5	8.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)		C_{ibo}	—	15	25	pF
MATCHING CHARACTERISTICS						
Base-Emitter Voltage Differential Change Due to Temperature		$\|V_{BE1}-V_{BE2}\|$				mVdc
($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc,	MD3409		—	—	1.6	
$T_A = -55°C$ to $+25°C$)	MD3410		—	—	0.8	
($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc,	MD3409		—	—	2.0	
$T_A = +25°C$ to $+125°C$)	MD3410		—	—	1.0	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

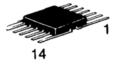
MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD3467		600	650	
MQ3467		400	600	
Derate above 25°C				mW/°C
MD3467		3.42	3.7	
MQ3467		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD3467		2.1	3.0	
MQ3467		1.0	4.0	
Derate above 25°C				mW/°C
MD3467		12	17.2	
MQ3467		5.71	22.8	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

MD3467
MQ3467



MD3467
CASE 654-07, STYLE 1
DUAL



MQ3467
CASE 607-04, STYLE 1
QUAD

AMPLIFIER TRANSISTORS

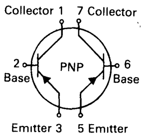
PNP SILICON

THERMAL CHARACTERISTICS

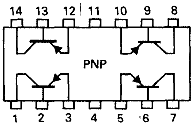
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD3467		83.3	58.3	
MQ3467		175	43.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD3467		292	270	
MQ3467		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD3467		85	40	
MQ3467 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS



CASE 654-07
STYLE 1



CASE 607-04
STYLE 1

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0, T_A = 100°C)	I_{CBO}	—	—	10	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc

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

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	—	—	—
Collector-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	—	0.32	0.5	Vdc
Base-Emitter Saturation Voltage (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	—	0.95	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	150	220	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	8.5	20	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	22	80	pF
SWITCHING CHARACTERISTICS					
Delay Time (V_{CC} = 30 Vdc, V_{BE} = 2.0 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc)	t_d	—	7.0	10	ns
Rise Time	t_r	—	17	30	ns
Storage Time (V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_s	—	58	80	ns
Fall Time	t_f	—	14	30	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 – DC CURRENT GAIN

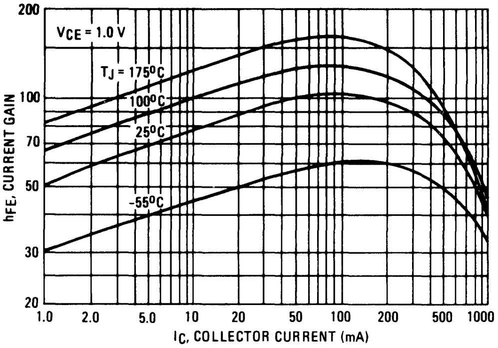


FIGURE 2 – COLLECTOR SATURATION REGION

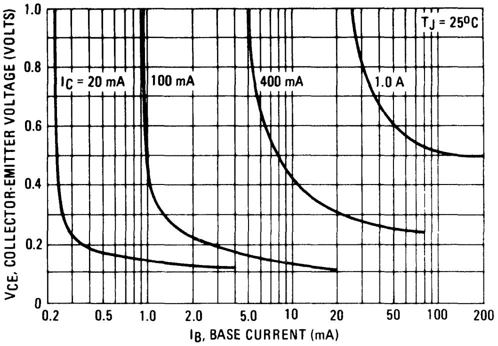


FIGURE 3 – "ON" VOLTAGE

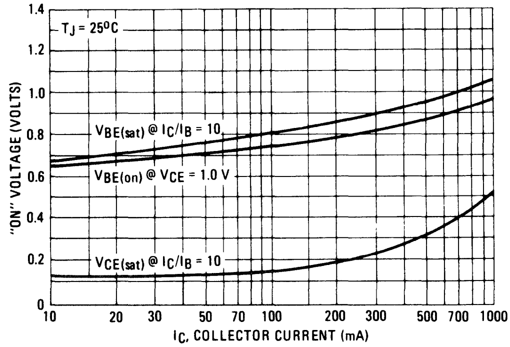


FIGURE 4 – TEMPERATURE COEFFICIENTS

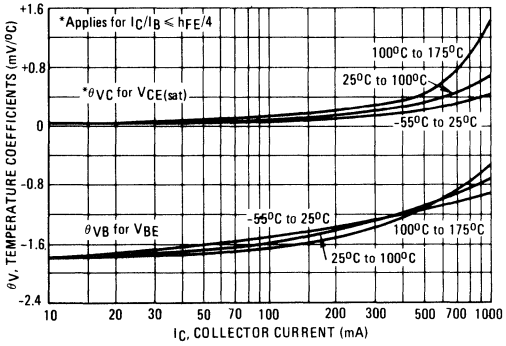


FIGURE 5 – ACTIVE REGION SAFE OPERATING AREA

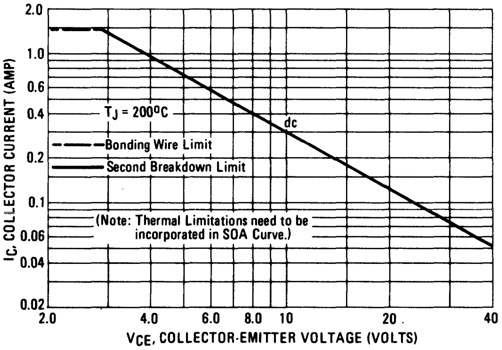


FIGURE 6 – TURN-ON TIME

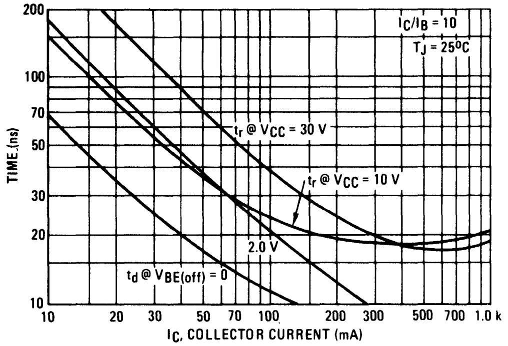


FIGURE 7 – RISE AND FALL TIME

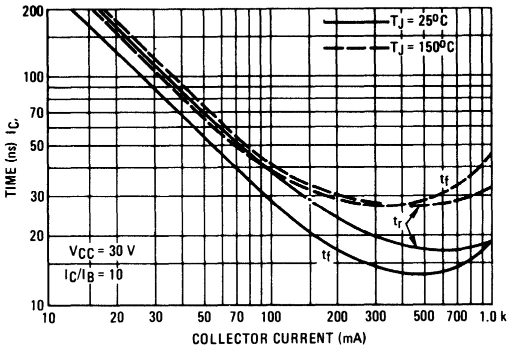


FIGURE 8 – STORAGE TIME

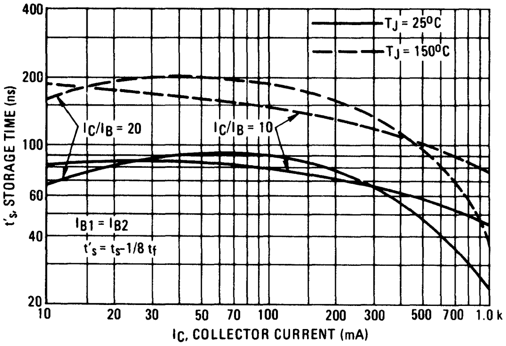


FIGURE 9 – FALL TIME

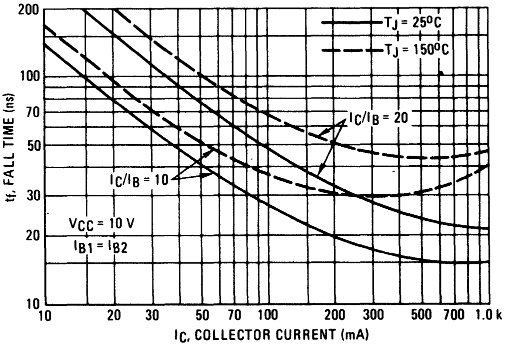


FIGURE 10 – SWITCHING TIME TEST CIRCUIT

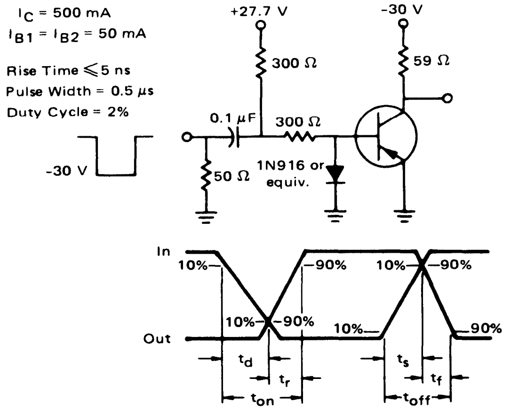
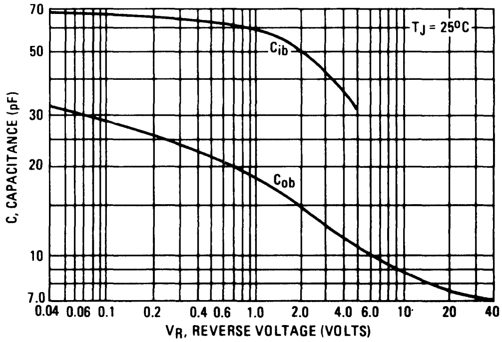
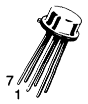


FIGURE 11 – CAPACITANCE

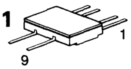


MD3725, F
MQ3725

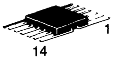
MD3725
CASE 654-07, STYLE 1
DUAL



MD3725F
CASE 610A-04, STYLE 1
DUAL



MQ3725
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	65		Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD3725		600	650	
MD3725F		350	400	
MQ3725		400	600	
Derate above 25°C				mW/°C
MD3725		3.42	3.7	
MD3725F		2.0	2.28	
MQ3725		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD3725		2.1	3.0	
MD3725F		1.25	2.5	
MQ3725		1.0	4.0	
Derate above 25°C				mW/°C
MD3725		12	17.2	
MD3725F		7.15	14.3	
MQ3725		5.71	22.8	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

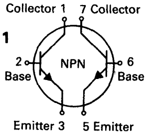
THERMAL CHARACTERISTICS

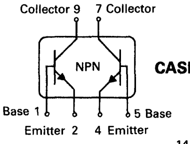
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD3725		83.3	58.3	
MD3725F		140	70	
MQ3725		175	43.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD3725		292	270	
MD3725F		500	438	
MQ3725		433	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD3725		85	40	
MD3725F		75	0	
MQ3725 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

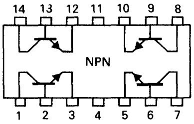
CASE 654-07, STYLE 1





CASE 610A-04, STYLE 1

CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0) MD3725F	$V_{(BR)CES}$	65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 40 Vdc, I_E = 0)		—	0.12	1.7	μAdc
(V_{CB} = 40 Vdc, I_E = 0, T_A = 100°C)		—	—	120	μAdc

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

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS(2)					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	 50 30	 — —	 150 —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	 — —	 0.19 0.30	 0.26 0.45	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	 — 0.80	 — —	 0.86 1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	200	—	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	—	10	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	—	65	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = 50 mAdc, $V_{BE(off)}$ = 3.8 Vdc)	t_{on}	—	20	45	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 500 mAdc, I_{B1} = I_{B2} = 50 mAdc)	t_{off}	—	50	75	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

TYPICAL DC CHARACTERISTICS

FIGURE 1 — DC CURRENT GAIN

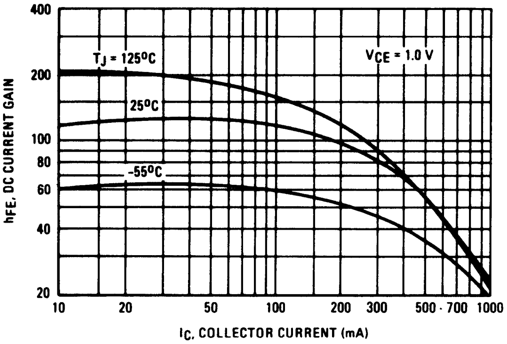


FIGURE 2 — "ON" VOLTAGES

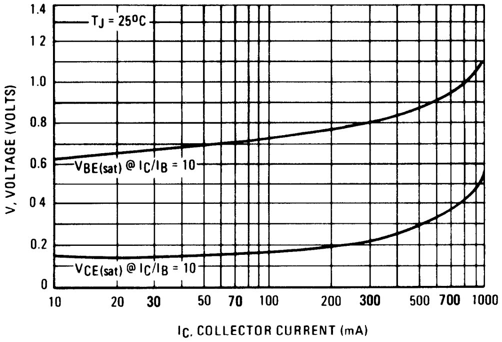


FIGURE 3 — COLLECTOR SATURATION REGION

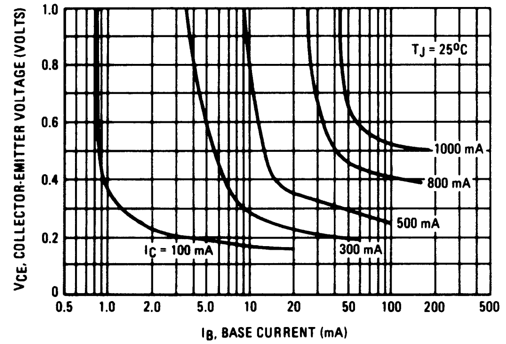
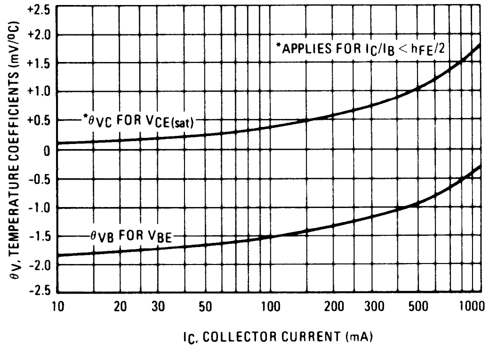


FIGURE 4 — TEMPERATURE COEFFICIENTS



TYPICAL DYNAMIC CHARACTERISTICS

FIGURE 5 — CURRENT-GAIN — BANDWIDTH PRODUCT

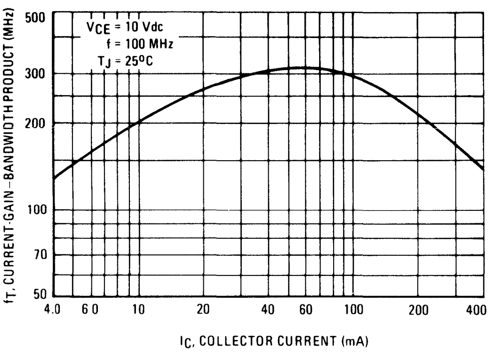


FIGURE 6 — CAPACITANCE

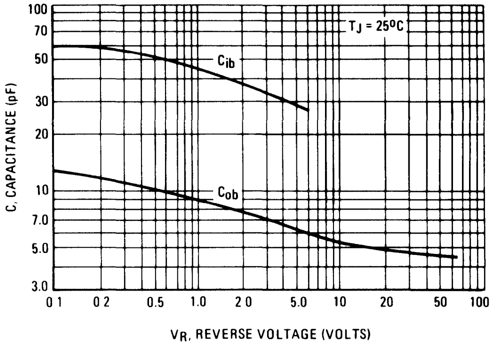


FIGURE 7 — TURN-ON TIME

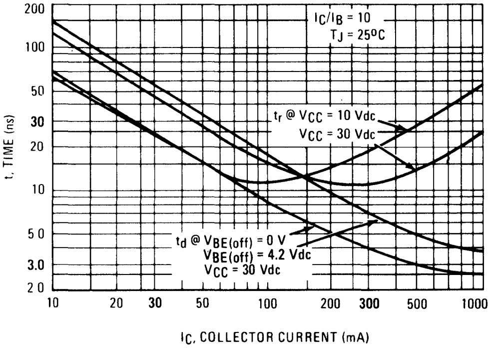


FIGURE 8 — TURN-OFF TIME

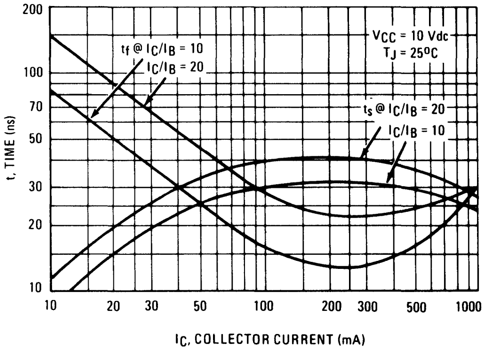


FIGURE 9 — SWITCHING TIME TEST CIRCUIT

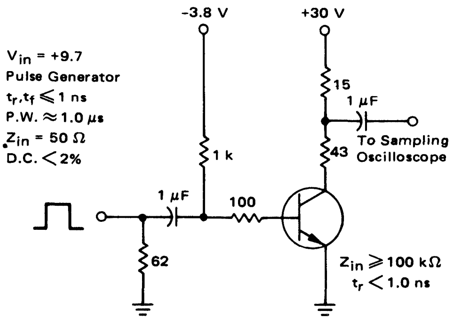
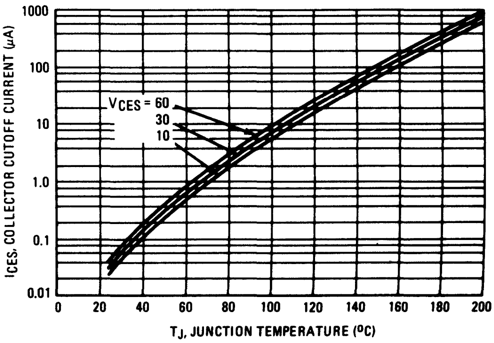
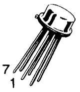


FIGURE 10 — COLLECTOR CUTOFF CURRENT

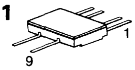


MD3762, F
MQ3762

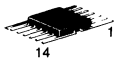
MD3762
CASE 654-07, STYLE 1
DUAL



MD3762F
CASE 610A-04, STYLE 1
DUAL



MQ3762
CASE 607-04, STYLE 1
QUAD

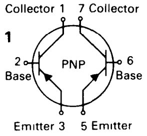


AMPLIFIER TRANSISTORS

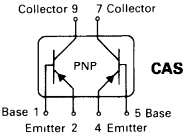
PNP SILICON

PIN CONNECTION DIAGRAMS

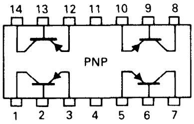
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		One Die	**All Die Equal Power**	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD3762		600	650	
MD3762F		350	400	
MQ3762		400	600	
Derate above 25°C				mW/°C
MD3762		3.42	3.7	
MD3762F		2.0	2.28	
MQ3762		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD3762		2.1	3.0	
MD3762F		1.25	2.5	
MQ3762		1.0	4.0	
Derate above 25°C				mW/°C
MD3762		12	17.2	
MD3762F		7.15	14.3	
MQ3762		5.71	22.8	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD3762		83.3	58.3	
MD3762F		140	70	
MQ3762		175	43.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD3762		292	270	
MD3762F		500	438	
MQ3762		438	292	
		Junction to Ambient	**Junction to Case**	
Coupling Factor				%
MD3762		85	40	
MD3762F		75	0	
MQ3762 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				
(V_{CB} = 30 Vdc, I_E = 0)		—	—	100	nAdc
(V_{CB} = 30 Vdc, I_E = 0, T_A = 100°C)		—	—	10	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	100	nAdc

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

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS(2)						
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 2.0 Vdc)		h_{FE}	20	40	—	—
Collector-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 0.1 Adc)		$V_{CE(sat)}$	—	0.52	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 1.0 Adc, I_B = 0.1 Adc)		$V_{BE(sat)}$	—	1.05	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	150	220	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)		C_{obo}	—	8.5	20	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)		C_{ibo}	—	22	80	pF
SWITCHING CHARACTERISTICS						
Delay Time	(V_{CC} = 30 Vdc, $V_{BE(off)}$ = 2.0 Vdc, I_C = 1.0 Adc, I_{B1} = 100 mAdc)	t_d	—	5.0	10	ns
Rise Time		t_r	—	18	30	ns
Storage Time	(V_{CC} = 30 Vdc, I_C = 1.0 Adc, I_{B1} = I_{B2} = 100 mAdc)	t_s	—	45	80	ns
Fall Time		t_f	—	18	30	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — DC CURRENT GAIN

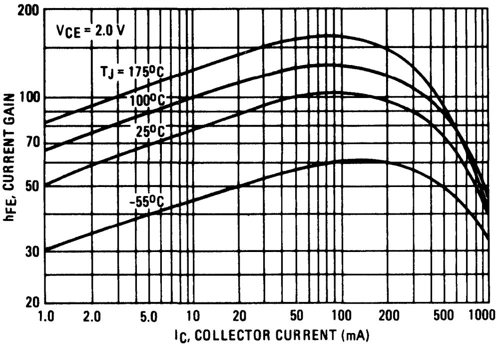


FIGURE 2 — COLLECTOR SATURATION REGION

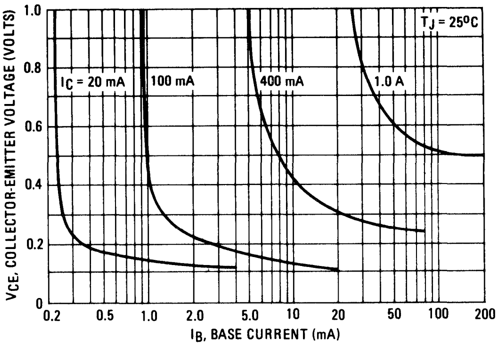


FIGURE 3 — "ON" VOLTAGE

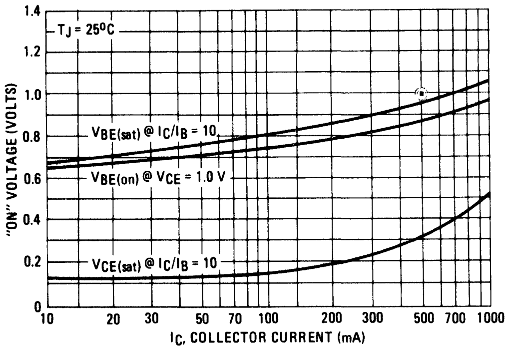


FIGURE 4 — TEMPERATURE COEFFICIENTS

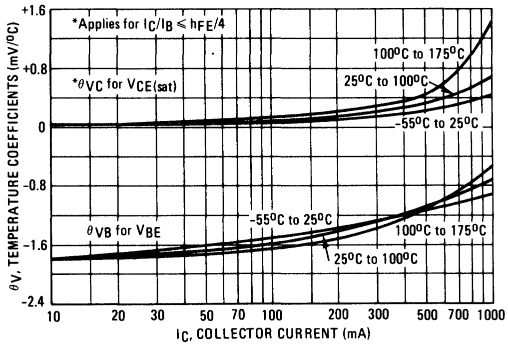


FIGURE 5 – ACTIVE REGION SAFE OPERATING AREA

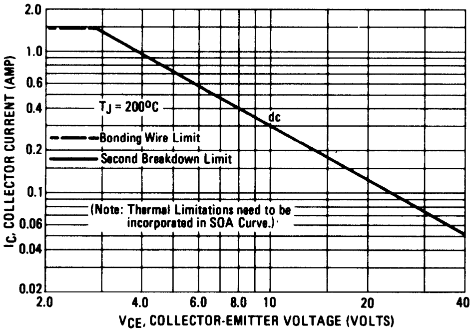


FIGURE 6 – TURN-ON TIME

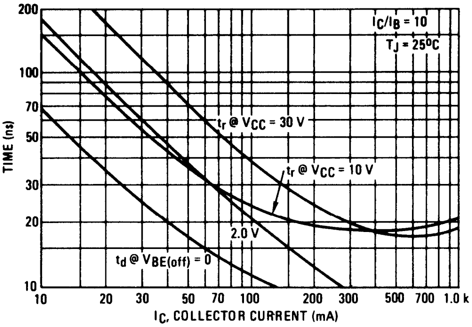


FIGURE 7 – RISE AND FALL TIME

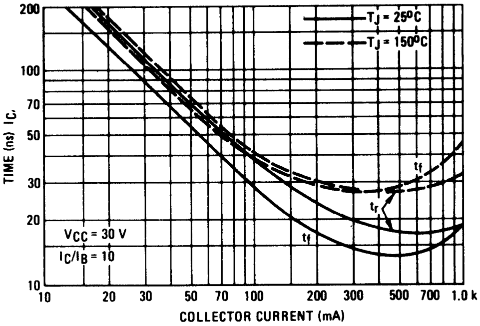


FIGURE 8 – STORAGE TIME

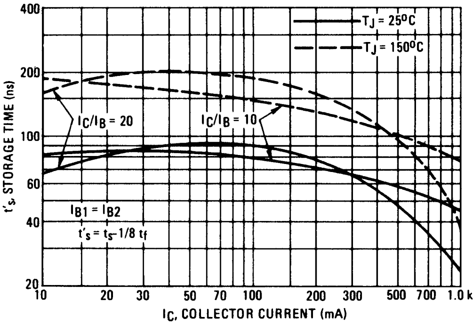


FIGURE 9 – FALL TIME

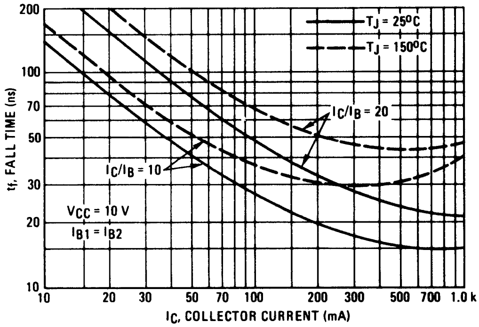


FIGURE 10 – SWITCHING TIME TEST CIRCUIT

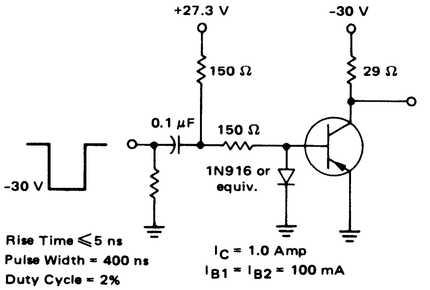
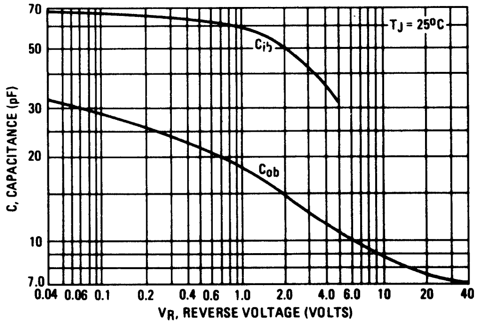
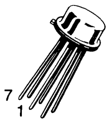


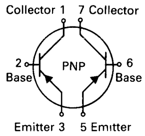
FIGURE 11 – CAPACITANCE



MD4260
MD4261

CASE 654-07, STYLE 1





DUAL RF AMPLIFIERS

PNP SILICON

Refer to 2N4260 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	12		Vdc
Collector-Base Voltage	V_{CBO}	12		Vdc
Emitter-Base Voltage	V_{EBO}	4.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	Both Die	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	550 3.14	600 3.42	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.4 8.0	2.0 11.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Junction to Ambient	Junction to Case	Unit
Thermal Resistance			°C/W
One Die	319	125	
Effective, Both Die	292	87.5	
Coupling Factor	83	40	%

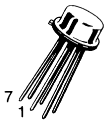
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

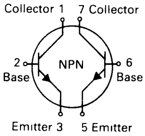
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	12	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current ($V_{CE} = 12$ Vdc, $I_B = 0$)	I_{CEO}	—	1.0	μAdc
Collector Cutoff Current ($V_{CB} = 10$ Vdc, $I_E = 0$)	I_{CBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 30$ mAdc, $V_{CE} = 2.0$ Vdc)	h_{FE}	30 20	200 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{CE(sat)}$	—	0.3	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product ($I_C = 0.5$ mAdc, $V_{CE} = 4.0$ Vdc, f = 100 MHz) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	1.0 1.5	— —	GHz
Output Capacitance ($V_{CB} = 3.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	2.5	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	2.5	pF
Collector Base Time Constant ($I_C = 5.0$ mAdc, $V_{CE} = 4.0$ Vdc, f = 31.8 MHz) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 31.8 MHz)	$r_{b'}C_c$	— —	35 30	ps
MATCHING CHARACTERISTICS (MD4261 only)				
DC Current Gain Ratio(1) ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE1}/h_{FE2}	0.8	1.0	—
Base-Emitter Voltage Differential ($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	$\lvert V_{BE1}-V_{BE2}\rvert$	—	10	mVdc

(1) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD5000, A, B

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N3307 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current Continuous	I_C	50		mAdc
		One Side	**Both Sides**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	400 2.3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

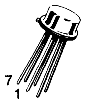
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	— —	— —	0.010 1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	50	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	900	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	—	1.7	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	—	2.0	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 60 MHz, R_S = 400 ohms)	NF	—	3.0	6.0	dB
FUNCTIONAL TEST					
Amplifier Power Gain (I_C = 6.0 mAdc, V_{CB} = 12 Vdc, R_G = R_L = 50 ohms, f = 200 MHz)	G_{pe}	15	20	—	dB
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(1) (I_C = 4.0 mAdc, V_{CE} = 10 Vdc) MD5000 MD5000A MD5000B	h_{FE1}/h_{FE2}	 — 0.9 0.8	 0.7 — —	 — 1.0 1.0	—
Base-Emitter Voltage Differential (I_C = 4.0 mAdc, V_{CE} = 10 Vdc) MD5000 MD5000A MD5000B	$\lvert V_{BE1}-V_{BE2}\rvert$	 — — —	 5.0 — —	 — 5.0 10	mVdc
Base-Emitter Voltage Differential Gradient (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, T_A = −55 to +125°C) MD5000 MD5000A MD5000B	$\frac{\Delta(V_{BE1}-V_{BE2})}{\Delta T_A}$	 — — —	 10 — —	 — 10 20	μV/°C

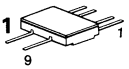
(1) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD6001, F MD6002, F MD6003, MQ6001

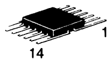
MD6001, MD6002, MD6003
CASE 654-07, STYLE 5
DUAL



MD6001F, MD6002F
CASE 610A-04, STYLE 1
DUAL



MQ6001
CASE 607-04, STYLE 1
QUAD



COMPLEMENTARY GENERAL PURPOSE TRANSISTORS
NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MD6003 MD6003F	MD6001,F MD6002,F MQ6001,2	Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	50	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD6001,2,3		575	625	
MD6001F,2F		350	400	
MQ6001		400	600	
Derate above 25°C				mW/°C
MD6001,2,3		3.29	3.57	
MD6001F,2F		2.0	2.28	
MQ6001		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD6001,2,3		1.8	2.5	
MD6001F,2F		1.0	2.0	
MQ6001		0.9	3.6	
Derate above 25°C				mW/°C
MD6001,2,3		10.3	14.3	
MD6001F,2F		5.71	11.4	
MQ6001		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

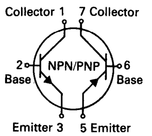
THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD6001,2,3		97	70	
MD6001F,2F		175	87.5	
MQ6001		195	48.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C
MD6001,2,3		304	280	
MD6001F,2F		500	438	
MQ6001		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD6001,2,3		84	44	
MD6001F,2F		75	0	
MQ6001 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

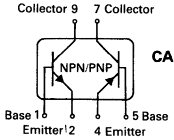
(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

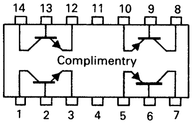
CASE 654-07, STYLE 5



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage	$V_{(BR)CBO}$				Vdc
(I_C = 10 μAdc, I_E = 0) MD6003		50	—	—	
MD6001,F, MD6002,F, MQ6001, MQ6002		60	—	—	
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Base Cutoff Current	I_{BEV}				nAdc
(V_{CE} = 30 Vdc, V_{BE} = 3.0 Vdc) MD6003		—	—	50	
(V_{CE} = 50 Vdc, V_{EB} = 3.0 Vdc) MD6001,F,2,F,		—	—	30	

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

Characteristic		Symbol	Min	Typ	Max	Unit
Collector Cutoff Current		I_{CEV}				
(V_{CE} = 30 Vdc, $V_{BE(off)}$ = 3.0 Vdc)	MD6003		—	—	30	nAdc
(V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	MD6001,F,2,F, MQ6001		—	—	20	nAdc
(V_{CE} = 50 Vdc, $V_{EB(off)}$ = 3.0 Vdc, T_A = 150°C)	MD6001,F,2,F, MQ6001		—	—	30	μAdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	MD6003,F	I_{CBO}	—	—	100	nA

ON CHARACTERISTICS(2)

Characteristic		Symbol	Min	Typ	Max	Unit
DC Current Gain		h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		20	80	—	
	MD6002,F		35	70	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		25	90	—	
	MD6003		40	70	—	
	MQ6002,F		50	100	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		35	70	—	
	MD6002,F		75	110	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		40	—	120	
	MD6003		70	110	—	
	MD6002,F		100	200	300	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		20	—	—	
	All Other Devices		30	90	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MD6001,F, MQ6001		20	80	—	
	MD6002,F		50	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	All Devices		—	0.3	0.4	
(I_C = 300 mAdc, I_B = 30 mAdc)	MD6001, MD6002,F, MQ6001		—	0.59	1.4	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)	All Devices		—	1.02	1.3	
(I_C = 300 mAdc, I_B = 30 mAdc)	MD6001, MD6002,F, MQ6001		—	1.25	2.0	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — DC CURRENT GAIN

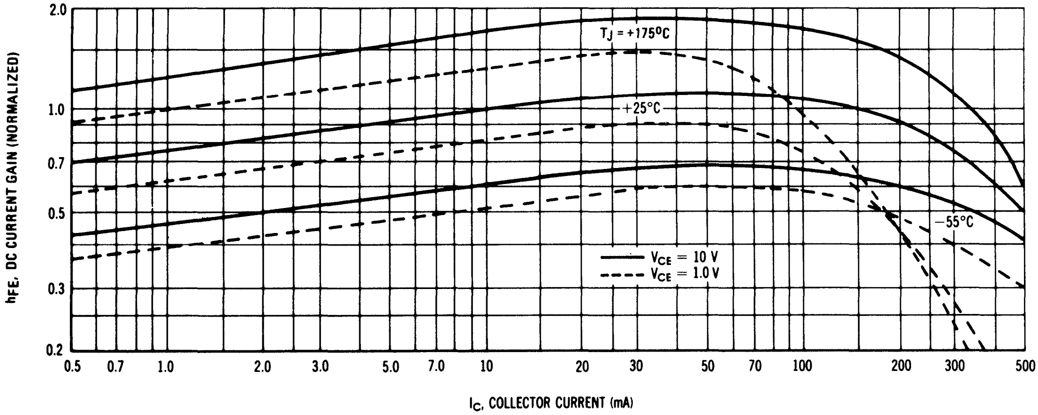


FIGURE 2 – "ON" VOLTAGES

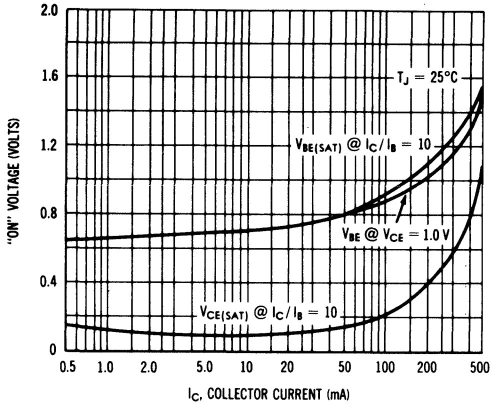
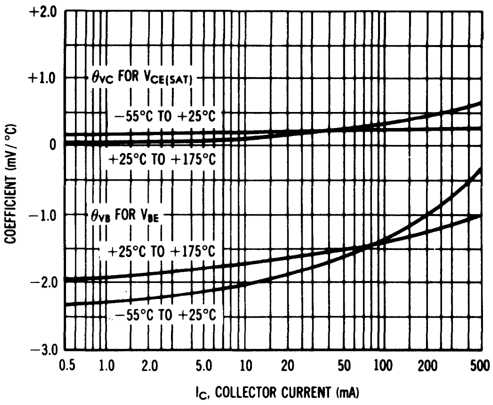


FIGURE 3 – TEMPERATURE COEFFICIENTS



NOISE FIGURE

V_{CE} = 10 V, T_A = 25°C

FIGURE 4 – FREQUENCY EFFECTS

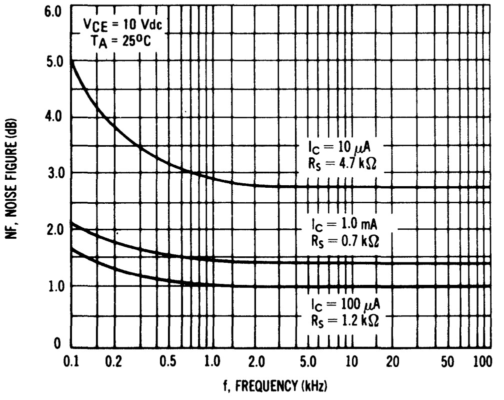


FIGURE 5 – SOURCE RESISTANCE EFFECTS

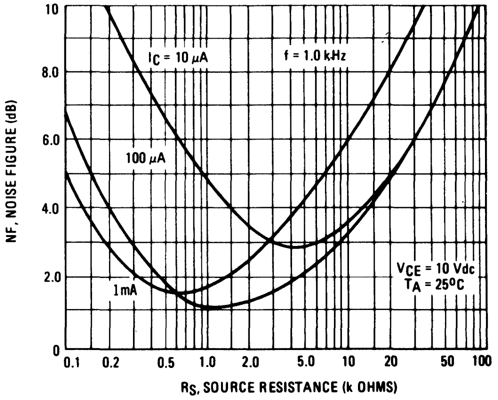


FIGURE 6 – CURRENT-GAIN BANDWIDTH PRODUCT

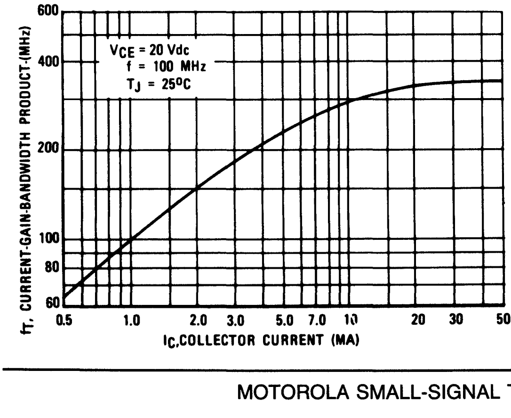


FIGURE 7 – CAPACITANCE

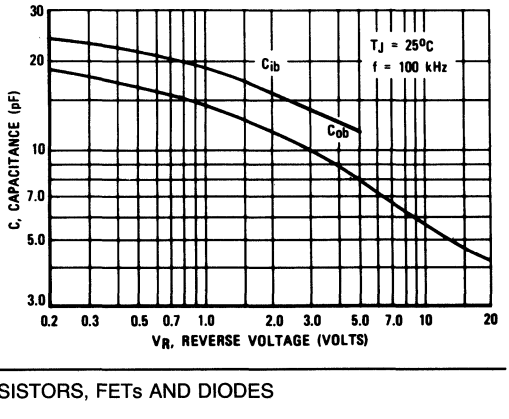


FIGURE 8 — TURN ON TIME

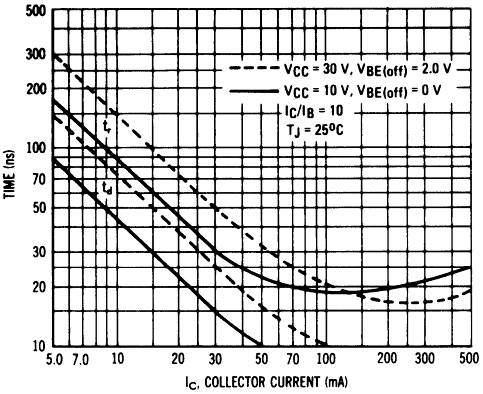


FIGURE 9 — CHARGE DATA

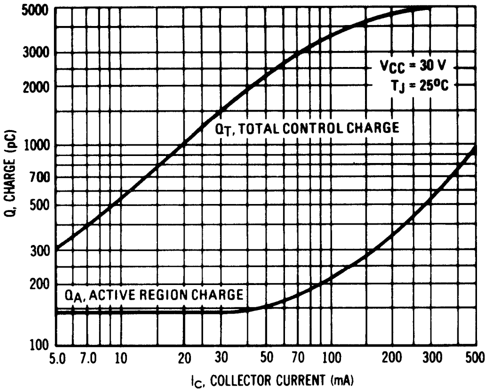


FIGURE 10 — STORAGE TIME

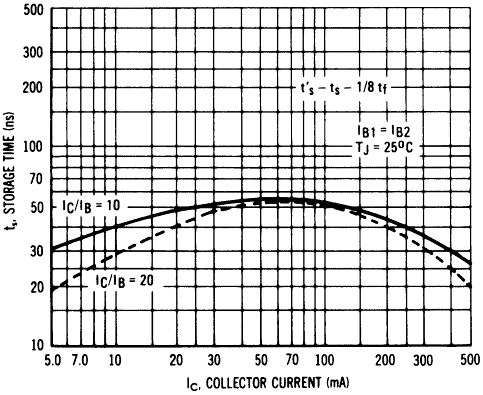


FIGURE 11 — FALL TIME

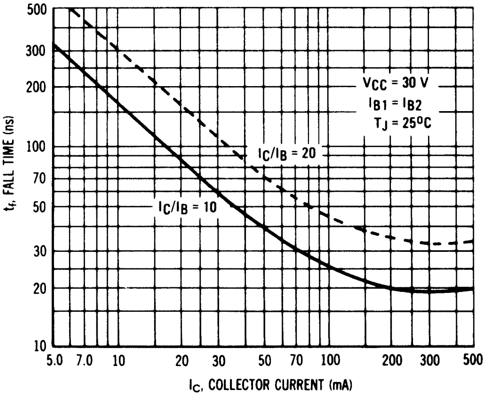


FIGURE 12 — DELAY AND RISE TIME TEST CIRCUIT

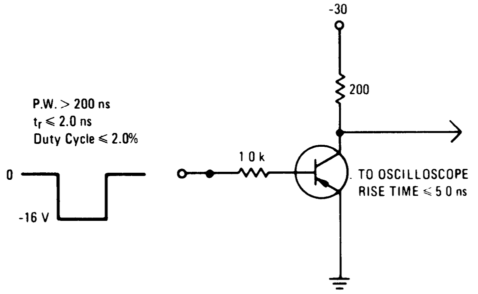
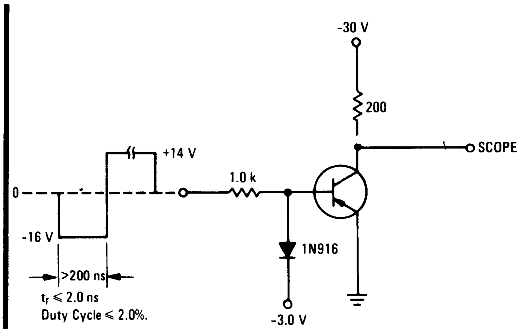


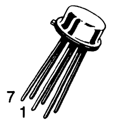
FIGURE 13 — STORAGE AND FALL TIME TEST CIRCUIT

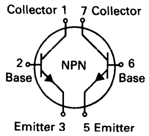


For NPN Test Circuits, Reverse Diode and all Voltage Polarities.

MD7000

CASE 654-07, STYLE 1





DUAL GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	**Both Die**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 575 3.29	 625 3.57	 mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.8 10.3	 2.5 14.3	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factor		84	44	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

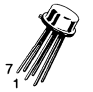
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 40$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) ($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc) ($I_C = 300$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	 40 70 30	 60 80 50	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.2	0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.95	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 20$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	3.5	8.0	pF
Input Capacitance ($V_{EB} = 2.0$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	15	30	pF

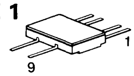
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD7001, F
MQ7001

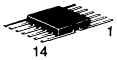
MD7001
CASE 654-07, STYLE 1
DUAL



MD7001F
CASE 610A-04, STYLE 1
DUAL



MQ7001
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS

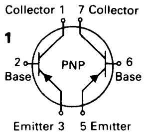
PNP SILICON

MAXIMUM RATINGS

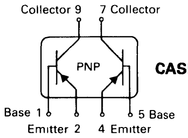
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		One Die	All Die	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD7001		600	650	
MD7001F		350	400	
MQ7001		400	600	
Derate above 25°C				mW/°C
MD7001		3.42	3.7	
MD7001F		2.0	2.28	
MQ7001		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD7001		2.1	3.8	
MD7001F		1.25	2.5	
MQ7001		1.0	4.0	
Derate above 25°C				mW/°C
MD7001		12	17.2	
MD7001F		7.15	14.3	
MQ7001		5.71	22.8	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

PIN CONNECTION DIAGRAMS

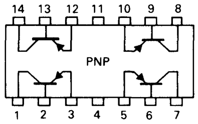
CASE 654-07, STYLE 1



CASE 610A-04, STYLE 1



CASE 607-04, STYLE 1



THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD7001		83.3	58.3	
MD7001F		140	70	
MQ7001		175	43.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD7001		292	270	
MD7001F		500	438	
MQ7001		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD7001		85	40	
MD7001F		75	0	
MQ7001 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}				—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		40	50	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)		70	90	—	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)		30	60	—	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{CE(sat)}$	—	0.25	0.4	Vdc

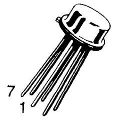
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

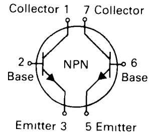
Characteristic	Symbol	Min	Typ	Max	Unit
Base-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)	$V_{BE(sat)}$	—	0.88	1.3	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	320	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	5.8	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	16	30	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD7002, A, B

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2919 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	30		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 575 3.29	 625 3.57	 mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.8 10.3	 2.5 14.3	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	Both Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factors		84	44	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

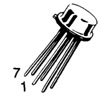
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(2) (I_C = 100 μAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40 50	130 170	— —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.2	0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.8	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 5.0 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	260	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	2.6	6.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	2.3	8.0	pF
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3) (I_C = 100 μAdc, V_{CE} = 10 Vdc) MD7002A MD7002B	h_{FE1}/h_{FE2}	 0.75 0.85	 — —	 1.0 1.0	—
Base-Emitter Voltage Differential (I_C = 100 μAdc, V_{CE} = 10 Vdc) MD7002A MD7002B	$\lvert V_{BE1}-V_{BE2}\rvert$	 — —	 — —	 25 15	 mVdc

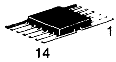
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD7003, A, B
MQ7003



MD7003, A, B
CASE 654-07, STYLE 1
DUAL



MQ7003
CASE 607-04, STYLE 1
QUAD

AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N3810 for curves.

MAXIMUM RATINGS

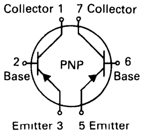
Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	**All Die Equal Power**	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD7003,A,B		550	600	
MD7003,AF		350	400	
MQ7003		400	600	
Derate above 25°C				mW/°C
MD7003,A,B		3.14	3.42	
MD7003,AF		2.0	2.28	
MQ7003		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD7003,A,B		1.4	2.0	
MD7003,AF		0.7	1.4	
MQ7003		0.7	2.8	
Derate above 25°C				mW/°C
MD7003,A,B		8.0	11.4	
MD7003,AF		4.0	8.0	
MQ7003		4.0	16	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

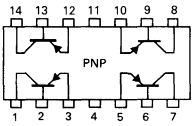
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD7003,A,B		125	87.5	
MD7003		250	125	
MQ7003		250	62.6	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD7003,A,B		319	292	
MD7003		500	438	
MQ7003		438	292	
		Junction to Ambient	**Junction to Case**	
Coupling Factor				%
MD7003,A,B		83	40	
MD7003		75	0	
MQ7003 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS



CASE 654-07
STYLE 1



CASE 607-04
STYLE 1

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain(2)	h_{FE}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		40	350	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		50	350	—	

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

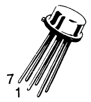
Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	—	0.25	0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{BE(sat)}$	—	0.6	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	300	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	3.0	6.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	2.0	8.0	pF
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 3.0 kohms, f = 10 Hz to 15.7 kHz)		NF	—	2.0	—	dB
MATCHING CHARACTERISTICS						
DC Current Gain Ratio(3)		h_{FE1}/h_{FE2}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MD7003A,AF		0.75	—	1.0	
	MD7003B		0.85	—	1.0	
Base-Emitter Voltage Differential		$\lvert V_{BE1}-V_{BE2}\rvert$				mV
(I_C = 100 μAdc, V_{CE} = 10 Vdc)	MD7003A,AF		—	—	25	
	MD7003B		—	—	15	

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

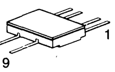
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD7007, A, B, BF
MQ7007

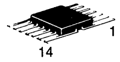
MD7007,A,B
CASE 654-07, STYLE 1
DUAL



MD7007BF
CASE 610A-04, STYLE 1
DUAL



MQ7007
CASE 607-04, STYLE 1
QUAD



AMPLIFIER TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	200		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD7007,A,B		575	625	
MD7007BF		350	400	
MQ7007		400	600	
Derate above 25°C				mW/°C
MD7007,A,B		3.29	3.57	
MD7007BF		2.0	2.28	
MQ7007		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD7007,A,B		1.8	2.5	
MD7007BF		1.0	2.0	
MQ7007		0.9	3.6	
Derate above 25°C				mW/°C
MD7007,A,B		10.3	14.3	
MD7007BF		5.71	11.4	
MQ7007		5.13	20.5	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

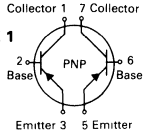
THERMAL CHARACTERISTICS

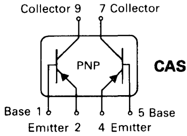
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD7007,A,B		97	70	
MD7007BF		175	87.5	
MQ7007		195	48.8	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD7007,A,B		304	280	
MD7007BF		500	438	
MQ7007		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD7007,A,B		84	44	
MD7007BF		75	0	
MQ7007 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

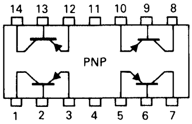
CASE 654-07, STYLE 1





CASE 610A-04, STYLE 1

CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain	h_{FE}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		30	110	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		30	130	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		30	75	—	
(I_C = 50 mAdc, V_{CE} = 10 Vdc)		15	25	—	

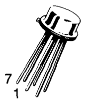
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	—	0.38	1.0	Vdc
Base-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	—	0.9	1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	300	600	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	4.0	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	3.8	10	pF
MATCHING CHARACTERISTICS					
DC Current Gain Ratio(3) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) MD7007A MD7007B	h_{FE1}/h_{FE2}	 0.75 0.85	 — —	 1.0 1.0	—
Base-Emitter Voltage Differential (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) MD7007A MD7007B	$\lvert V_{BE1}-V_{BE2}\rvert$	 — —	 — —	 20 10	mVdc

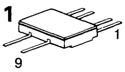
(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

MD7021, F
MQ7021

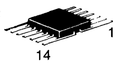
MD7021
CASE 654-07, STYLE 5
DUAL



MD7021F
CASE 610A-04, STYLE 1
DUAL



MQ7021
CASE 607-04, STYLE 1
QUAD



COMPLEMENTARY GENERAL PURPOSE TRANSISTORS

NPN/PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	50		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		One Die	All Die Equal Power	
Total Device Dissipation @ T_A = 25°C	P_D			mW
MD7021		550	600	
MD7021F		350	400	
MQ7021		400	600	
Derate above 25°C				mW/°C
MD7021		3.14	3.42	
MD7021F		2.0	2.28	
MQ7021		2.28	3.42	
Total Device Dissipation @ T_C = 25°C	P_D			Watts
MD7021		1.4	2.0	
MD7021F		0.7	1.4	
MQ7021		0.7	2.8	
Derate above 25°C				mW/°C
MD7021		8.0	11.4	
MD7021F		4.0	8.0	
MQ7021		4.0	16	
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

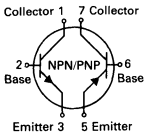
THERMAL CHARACTERISTICS

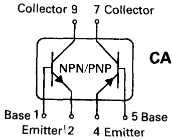
Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$			°C/W
MD7021		125	87.5	
MD7021F		250	125	
MQ7021		250	62.6	
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)			°C/W
MD7021		319	292	
MD7021F		500	438	
MQ7021		438	292	
		Junction to Ambient	Junction to Case	
Coupling Factor				%
MD7021		83	40	
MD7021F		75	0	
MQ7021 (Q1-Q2)		57	0	
(Q1-Q3 or Q1-Q4)		55	0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

PIN CONNECTION DIAGRAMS

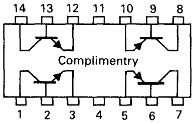
CASE 654-07, STYLE 5





CASE 610A-04, STYLE 1

CASE 607-04, STYLE 1



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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		40	65	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		50	70	—	

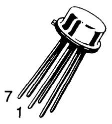
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

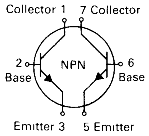
Characteristic	Symbol	Min	Typ	Max	Unit
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)(2)	$V_{CE(sat)}$	—	—	0.35	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	200	320	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	—	6.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)	C_{ibo}	—	—	8.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 Adc)	t_{on}	—	28	—	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	72	—	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MD8001
thru
MD8003

CASE 654-07, STYLE 1





DUAL AMPLIFIER TRANSISTORS

NPN SILICON

Refer to 2N2920 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage MD8001 MD8002 MD8003	V_{CEO}	 40 50 60		Vdc
Collector Current — Continuous	I_C	30		mAdc
		One Die	**Both Die Equal Power**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 575 3.29	 625 3.57	 mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.8 10.3	 2.5 14.3	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die Max	Both Die Equal Power Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	97	70	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	304	280	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factor		84	44	%

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

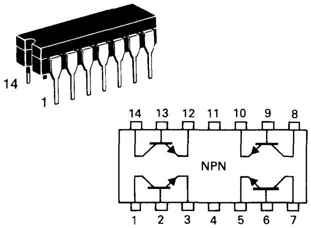
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	 MD8001 MD8002 MD8003	$V_{(BR)CEO}$	 40 50 60	 — — —	 — — —	Vdc
Collector Cutoff Current (V_{CB} = 40 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		h_{FE}	100	200	—	—
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(2) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)		f_T	—	260	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	2.6	—	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	2.3	—	pF
MATCHING CHARACTERISTICS						
Base-Emitter Voltage Differential (I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		$\lvert V_{BE1}-V_{BE2}\rvert$	—	—	15	mVdc

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MHQ918

CASE 632-08, STYLE 1
TO-116



QUAD AMPLIFIER TRANSISTORS

NPN SILICON

Refer to MD918 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	30		Vdc
Emitter-Base Voltage	V_{EBO}	3.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.65 3.72	 1.9 10.88	 Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.3 7.43	 4.6 26.3	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

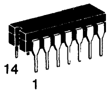
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain	h_{FE}				—
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)		—	110	—	
(I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)		20	80	—	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		—	50	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.11	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.84	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 4.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	850	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 140 kHz)	C_{obo}	—	0.75	2.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 140 kHz)	C_{ibo}	—	1.4	2.5	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, R_S = 400 Ohms, f = 60 MHz)	NF	—	4.0	6.0	dB

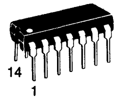
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

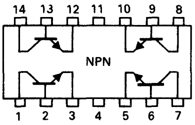
MHQ2222
MPQ2221*, MPQ2222*

MHQ2222
CASE 632-08, STYLE 1
TO-116



MPQ2221
MPQ2222
CASE 646-06, STYLE 1
TO-116





QUAD GENERAL PURPOSE TRANSISTORS

NPN SILICON

Refer to MD2218 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ T_A = 25°C	P_D	0.65	1.9	Watts
Derate above 25°C MHQ2222		3.72	10.88	mW/°C
MPQ2221, MPQ2222		5.2	15.2	
Operating and Storage Junction Temperature Range MHQ2222	T_J, T_{stg}	−65 to +200		°C
MPQ2221,22		−55 to +150		

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MPQ2221		35	—	—	
	MHQ2222, MPQ2222		75	—	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MPQ2221		40	—	—	
	MHQ2222, MPQ2222		100	—	—	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)	MPQ2221		20	—	—	
	MHQ2222, MPQ2222		30	—	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	0.4	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.6	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	1.3	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	2.6	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(1) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	350	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)		C_{obo}	—	4.5	8.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1 MHz)		C_{ibo}	—	17	30	pF
SWITCHING CHARACTERISTICS						
Turn-On Time (V_{CC} = 30 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)		t_{on}	—	25	—	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)		t_{off}	—	250	—	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*MPQ2221A and MPQ2222A also available.

FIGURE 1 – DELAY AND RISE TIME EQUIVALENT TEST CIRCUIT

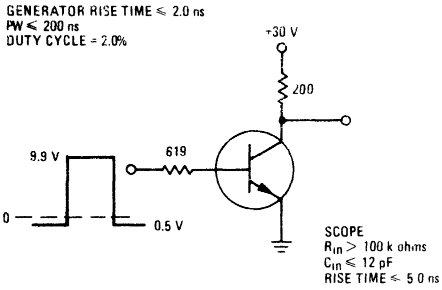
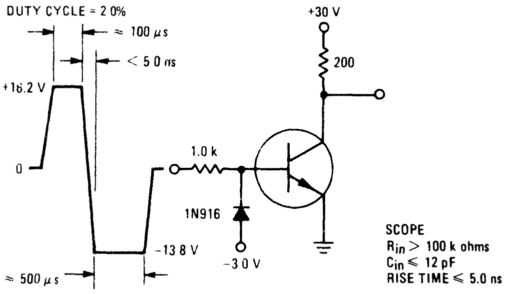
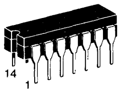


FIGURE 2 – STORAGE TIME AND FALL TIME EQUIVALENT TEST CIRCUIT

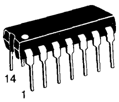


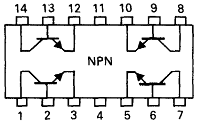
MHQ2369
MPQ2369

MHQ2369
CASE 632-08, STYLE 1
TO-116



MPQ2369
CASE 646-06, STYLE 1
TO-116





QUAD SWITCHING TRANSISTORS

NPN SILICON

Refer to MD2369 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C MHQ2369 MPQ2369	P_D	 0.5 2.86 5.0	 1.5 8.58 15	 Watts mW/°C
Operating and Storage Junction Temperature Range MHQ2369 MPQ2369	T_J, T_{stg}	 −65 to +200 −55 to +125		°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	0.4	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	0.5	μAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 2.0 Vdc)	h_{FE}	40 20	— —	— —	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	450	550	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1 MHz)	C_{obo}	—	2.5	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1 MHz)	C_{ibo}	—	3.0	5.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 3.0 Vdc, V_{BE} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc)	t_{on}	—	9.0	—	ns
Turn-Off Time (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = 3.0 mAdc, I_{B2} = 1.5 mAdc)	t_{off}	—	15	—	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

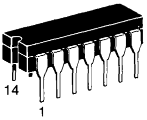
QUAD DUAL IN-LINE NPN HERMETIC SILICON AMPLIFIER TRANSISTORS

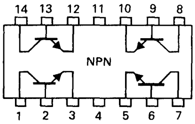
... designed for low-level, high-gain amplifier applications.

- Low Noise Figure — NF = 2.0 dB (Typ) @ I_C = 10 μAdc
- Transistors Similar to 2N2484
- TO-116 Ceramic Package — Compact Size Compatible with IC Automatic Insertion Equipment
- "H" Series for Hi-Rel Applications (See Tables 1 thru 3)

MHQ2484, H, HX, HXV

CASE 632-08, STYLE 1
TO-116





QUAD AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CB}	60		Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	**Total Device**	
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 3.42	1.8 10.3	Watts mW/°C
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.85	4.2 24	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 45 Vdc, I_E = 0)	I_{CBO}	—	—	20	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain (1) (I_C = 0.1 mAdc, V_{CE} = 5.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 200 300 300	 — — —	 — — —	—
Collector-Emitter Saturation Voltage (1) (I_C = 1.0 mAdc, I_B = 0.1 mAdc) (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	 — —	 0.13 0.15	 0.35 0.5	Vdc
Base-Emitter On Voltage (I_C = 100 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	$V_{BE(on)}$	 — —	 0.58 0.7	 0.7 0.8	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)	f_T	50	100	—	MHz
Collector-Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	—	1.8	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	—	4.0	8.0	pF
Noise Figure (I_C = 10 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 kΩ, f = 10 Hz to 15.7 kHz, BW = 10 kHz)	NF	—	2.0	—	dB

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

TABLE 1 — PRODUCT CLASSIFICATIONS

H — Controlled Lot with Sample Environmental and Life Testing
HX — 100% Processing Plus Sample Environmental and Life Testing
HXV — Same as HX Plus 100% Internal Visual Inspection

TABLE 2 — HX/HXV 100% PROCESSING STEPS

	HX	HXV
Internal Visual (Mil-Std-750, Method 2072)	—	100%
High Temperature Storage (Mil-Std-750, Method 1032)	100%	100%
Thermal Shock (Mil-Std-202, Method 107 Cond. F*)	100%	100%
Constant Acceleration (Mil-Std-750, Method 2006, 20 KG^{s}, Y_1)	100%	100%
Hermetic Seal (Fine + Gross Leak) (Mil-Std-750, Method 1071, Cond. G +G1**)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
High Temperature Reverse Bias (Mil-Std-750, Method 1039, Cond. A)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
Power Burn-In (Mil-Std-750, Method 1039, Cond. B)	100%	100%
READ Electrical Parameters (Group A)	100%	100%

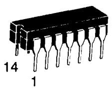
* $T_{(LOW)} = -55°C$
** Cond. G, Fine Leak = 1×10^{7} ATM. CC/sec.

TABLE 3 — SIMPLIFIED HI-REL PRODUCT FLOW

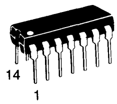
H	HX	HXV
Commercial Product ↓ Group A, B, C Sample Test ↓ Ship	Commercial Product ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship	100% Pre Cap Visual ↓ 100% Test ↓ Group A, B, C Sample Test ↓ Ship

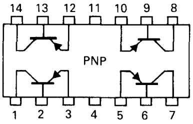
MHQ2906
MPQ2906* MPQ2907*

MHQ2906
CASE 632-08, STYLE 1
TO-116



MPQ2906
MPQ2907
CASE 646-06, STYLE 1
TO-116





QUAD GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to MD2904 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	600		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ $T_A = 25°C$	P_D	0.65	1.9	Watts
Derate above 25°C MHQ2906		3.72	10.88	mW/°C
MPQ2906, MPQ2907		6.5	19	
Operating and Storage Junction Temperature Range MHQ2906	T_J, T_{stg}	−65 to +200		°C
MPQ2906,07		−55 to +125		

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)		I_{CBO}	—	—	50	nAdc
Emitter Cutoff Current (V_{CB} = 3.0 Vdc, I_E = 0)		I_{EBO}	—	—	50	nAdc
ON CHARACTERISTICS						
DC Current Gain(1)		h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	MHQ2906, MPQ2906		35	—	—	
	MPQ2907		75	—	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	MHQ2906, MPQ2906		40	—	—	
	MPQ2907		100	—	—	
(I_C = 300 mAdc, V_{CE} = 10 Vdc)	MHQ2906, MPQ2906		30	—	—	
	MPQ2907		50	—	—	
Collector-Emitter Saturation Voltage(1)		$V_{CE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	0.4	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	1.6	
Base-Emitter Saturation Voltage(1)		$V_{BE(sat)}$				Vdc
(I_C = 150 mAdc, I_B = 15 mAdc)			—	—	1.3	
(I_C = 300 mAdc, I_B = 30 mAdc)			—	—	2.6	
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)		f_T	200	350	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)		C_{obo}	—	6.0	8.0	pF
Input Capacitance (V_{BE} = 2.0 Vdc, I_C = 0, f = 1 MHz)		C_{ibo}	—	20	30	pF
SWITCHING CHARACTERISTICS						
Turn-On Time (V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)		t_{on}	—	30	—	ns
Turn-Off Time (V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)		t_{off}	—	170	—	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.
*MPQ2906A and MPQ2907A also available.

FIGURE 1 – DELAY AND RISE TIME TEST CIRCUIT

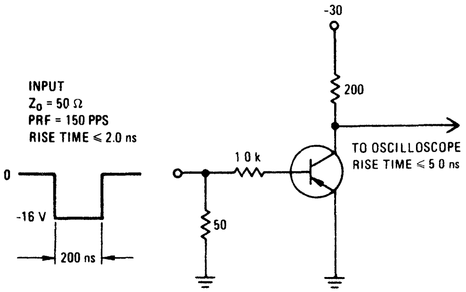
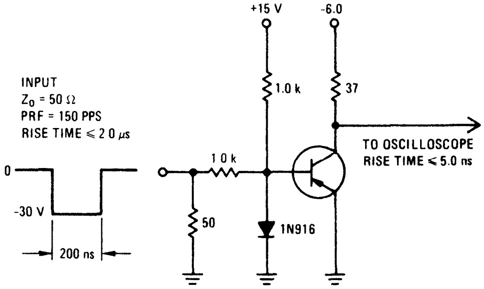
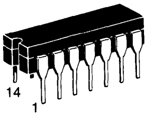


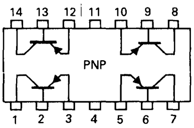
FIGURE 2 – STORAGE AND FALL TIME TEST CIRCUIT



MHQ3467

CASE 632-08, STYLE 1
TO-116





QUAD MEMORY DRIVER TRANSISTORS

PNP SILICON

Refer to MD3467 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	40		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	1.0		Adc
		Each Transistor	**Total Device**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 0.9 5.14	 2.7 15.4	 Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.8 10.3	 6.3 36	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +200		°C

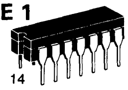
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	—	200	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	200	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	20	—	—	—
Collector-Emitter Saturation Voltage(1) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{CE(sat)}$	—	0.23	0.5	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 500$ mAdc, $I_B = 50$ mAdc)	$V_{BE(sat)}$	—	0.9	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	125	190	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1 MHz)	C_{obo}	—	10	25	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1 MHz)	C_{ibo}	—	55	80	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_C = 500$ mAdc, $I_{B1} = 50$ mAdc)	t_{on}	—	—	40	ns
Turn-Off Time ($I_C = 500$ mAdc, $I_{B1} = I_{B2} = 50$ mAdc)	t_{off}	—	—	90	ns

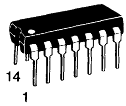
(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

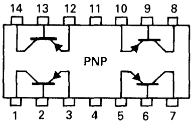
MHQ3546
MPQ3546

MHQ3546
CASE 632-08, STYLE 1
TO-116



MPQ3546
CASE 646-06, STYLE 1
TO-116





QUAD SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	12		Vdc
Collector-Base Voltage	V_{CBO}	15		Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	200		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ T_A = 25°C	P_D	0.5	1.5	Watts
Derate above 25°C MHQ3546		2.86	8.58	mW/°C
MPQ3546		4.0	12	
Operating and Storage Junction Temperature Range MHQ3546	T_J, T_{stg}	−65 to +200		°C
MPQ3546		−55 to +150		

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain(1)	h_{FE}				—
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)		30	—	—	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		15	—	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	—	0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	—	0.9	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	600	1000	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	2.0	6.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	3.5	8.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 2.0 Vdc, $V_{BE(off)}$ = 3.0 Vdc, I_C = 30 mAdc, I_{B1} = 1.5 mAdc)	t_{on}	—	15	—	ns
Turn-Off Time (V_{CC} = 2.0 Vdc, I_C = 30 mAdc, I_{B1} = I_{B2} = 1.5 mAdc)	t_{off}	—	25	—	ns

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

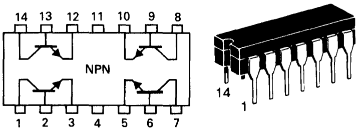
QUAD DUAL-IN LINE NPN HERMETIC SILICON MEMORY DRIVER TRANSISTORS

MHQ3724, H, HX, HXV
MHQ3725, H, HX, HXV

... designed for high-current, high-speed switching, ferrite core and plated wire memory drivers, and MOS translator applications.

- Fast Switching Times —
  t_{on} = 35 ns (Max)
  t_{off} = 60 ns (Max)
- Low Collector-Emitter Saturation Voltage — $V_{CE(sat)}$ = 0.95 Vdc (Max) @ I_C = 1.0 Adc
- DC Current Gain Specified — 100 mAdc to 1.0 Adc
- Transistors Similar to 2N3724, 2N3725
- TO-116 Ceramic Package — Compact Size Compatible with IC Automatic Insertion Equipment
- "H" Series for Hi-Rel Applications (See Tables 1 thru 3)

CASE 632-08, STYLE 1
TO-116



QUAD MEMORY DRIVER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MHQ3724	MHQ3725	Unit
Collector-Emitter Voltage	V_{CEO}	30	45	Vdc
Collector-Emitter Voltage	V_{CES}	50	70	Vdc
Collector-Base Voltage	V_{CB}	50	70	Vdc
Emitter-Base Voltage	V_{EB}	6.0		Vdc
Collector Current — Continuous	I_C	1.5		Adc
		Each Transistor	**Four Transistors Equal Power**	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	750 4.3	2000 11.4	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 6.86	4.0 22.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +200		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mAdc, I_B = 0)	MHQ3725 MHQ3724	$V_{(BR)CEO}$	45 30	— —	— —	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 μAdc, V_{BE} = 0)	MHQ3725 MHQ3724	$V_{(BR)CES}$	70 50	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	MHQ3725 MHQ3724	$V_{(BR)CBO}$	70 50	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 10 μAdc)		$V_{(BR)EBO}$	6.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 40 Vdc, I_E = 0)	MHQ3725 MHQ3724	I_{CBO}	—	—	500	nAdc
ON CHARACTERISTICS (1)						
DC Current Gain (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)		h_{FE}	60	100	250	—
(I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	MHQ3724 MHQ3725		25 35	40 50	— —	
(I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)			25	50	—	
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 Adc, I_B = 100 mAdc)		$V_{CE(sat)}$	— — —	0.14 0.23 0.36	0.26 0.52 0.95	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc) (I_C = 1.0 mAdc, I_B = 100 mAdc)		$V_{BE(sat)}$	— 0.8 —	0.75 0.88 1.0	0.86 1.1 1.7	Vdc

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

(continued)

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

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	200	275	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	5.0	10	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{ib}	—	50	70	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (V_{CC} = 30 Vdc, I_C = 0.5 Adc, $V_{BE(off)}$ = 3.8 Vdc, I_{B1} = 50 mAdc)	t_{on}	—	20	35	ns
Turn-Off Time (V_{CC} = 30 Vdc, I_C = 0.5 Adc, I_{B1} = I_{B2} = 50 mAdc)	t_{off}	—	50	60	ns

Figure 1. Turn-On and Turn-Off Switching Times Test Circuit

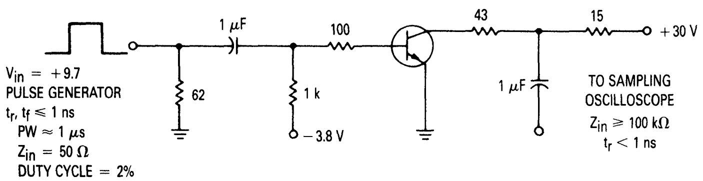


Table 1. Product Classifications

H — Controlled Lot with Sample Environmental and Life Testing
HX — 100% Processing Plus Sample Environmental and Life Testing
HXV — Same as HX Plus 100% Internal Visual Inspection

Table 2. HX/HXV 100% Processing Steps

	HX	HXV
Internal Visual (Mil-Std-750, Method 2072)	—	100%
High Temperature Storage (Mil-Std-750, Method 1032)	100%	100%
Thermal Shock (Mil-Std-202, Method 107, Cond. F*)	100%	100%
Constant Acceleration (Mil-Std-750, Method 2006, 20 KG^S, Y_1)	100%	100%
Hermetic Seal (Fine + Gross Leak) (Mil-Std-750, Method 1071, Cond. G + G1**)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
High Temperature Reverse Bias (Mil-Std-750, Method 1039, Cond. A)	100%	100%
READ Electrical Parameters (Group A)	100%	100%
Power Burn-In (Mil-Std-750, Method 1039, Cond. B)	100%	100%
READ Electrical Parameters (Group A)	100%	100%

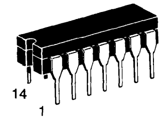
*$T_{(LOW)}$ = −55°C
**Cond. G, Fine Leak = 1 x 10^{-7} ATM. CC/sec.

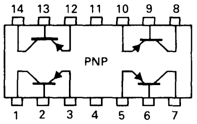
Table 3. Simplified Hi-Rel Product Flow

H	HX	HXV
Commercial Product	Commercial Product	100% Pre Cap Visual
Group A, B, C Sample Test	100% Test	100% Test
Ship	Group A, B, C Sample Test	Group A, B, C Sample Test
	Ship	Ship

MHQ3798

CASE 632-08, STYLE 1
TO-116





QUAD
AMPLIFIER TRANSISTORS

PNP SILICON

Refer to 2N3810 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	40		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	50		mAdc
		Each Transistor	Total Device	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.5 2.86	 1.5 8.58	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.0 5.71	 3.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

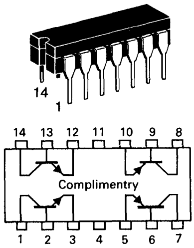
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	10	nAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	20	nAdc
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 10 μAdc, V_{CE} = 5.0 Vdc) (I_C = 100 μAdc, V_{CE} = 5.0 Vdc) (I_C = 500 μAdc, V_{CE} = 5.0 Vdc) (I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 100 150 150 125	 — — — —	 — — — —	—
Collector-Emitter Saturation Voltage (I_C = 100 μAdc, I_B = 10 μAdc) (I_C = 1.0 mAdc, I_B = 100 μAdc)	$V_{CE(sat)}$	 — —	 — —	 0.2 0.25	Vdc
Base-Emitter Saturation Voltage (I_C = 100 μAdc, I_B = 10 μAdc) (I_C = 1.0 mAdc, I_B = 100 μAdc)	$V_{BE(sat)}$	 — —	 — —	 0.7 0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 100 MHz)	f_T	—	130	—	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	2.3	—	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	5.5	—	pF
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 3.0 kohms, f = 10 Hz to 15.7 kHz)	NF	—	2.5	—	dB

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

MHQ6002

CASE 632-08, STYLE 1
TO-116



QUAD COMPLEMENTARY TRANSISTORS

NPN/PNP SILICON

Refer to MHQ2222 for NPN graphs.*

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 0.65 3.72	 1.9 10.88	 Watts mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 1.3 7.43	 4.6 26.3	 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

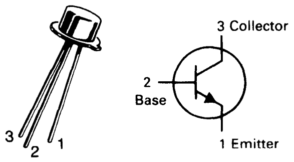
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10\ \mu$Adc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10\ \mu$Adc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$)	I_{CBO}	—	—	20	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	30	nAdc
ON CHARACTERISTICS					
DC Current Gain(1)	h_{FE}				—
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)		25	— —	— —	
($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)		35	— —	— —	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)		40	— —	— —	
($I_C = 300$ mAdc, $V_{CE} = 10$ Vdc)		20	— —		
Collector-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{CE(sat)}$	— —	— —	0.4 1.4	Vdc
Base-Emitter Saturation Voltage(1) ($I_C = 150$ mAdc, $I_B = 15$ mAdc) ($I_C = 300$ mAdc, $I_B = 30$ mAdc)	$V_{BE(sat)}$	— —	— —	1.3 2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) ($I_C = 50$ mAdc, $V_{CE} = 20$ Vdc, f = 100 kHz)	f_T	—	400	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1 MHz) NPN PNP	C_{obo}	— —	6.0 4.5	— —	pF
Input Capacitance ($V_{BE} = 2.0$ Vdc, $I_C = 0$, f = 1 MHz) NPN PNP	C_{ibo}	— —	20 17	— —	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($V_{CC} = 30$ Vdc, $V_{BE} = 0.5$ Vdc, $I_C = 150$ mAdc, $I_{B1} = 15$ mAdc)	t_{on}	—	30	—	ns
Turn-Off Time ($V_{CC} = 30$ Vdc, $I_C = 150$ mAdc, $I_{B1} = I_{B2} = 15$ mAdc)	t_{off}	— —	225 —	— —	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Refer to MHQ2907 for PNP graphs.

MM1748A

CASE 27-02, STYLE 1
TO-52 (TO-206AC)



SWITCHING TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	$V_{CEO(sus)}$	6.0	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	583	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

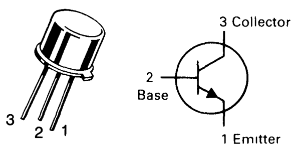
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	6.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0$ Vdc, $I_E = 0$) ($V_{CB} = 5.0$ Vdc, $I_E = 0$, $T_A = 150°C$)	I_{CBO}	 — —	 — —	 5.0 5.0	 nAdc μAdc
ON CHARACTERISTICS(2)					
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 0.5$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 0.5$ Vdc, $T_A = -55°C$) ($I_C = 30$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 30 10 15	 55 20 20	 90 — —	—
Collector-Emitter Saturation Voltage ($I_C = 3.0$ mAdc, $I_B = 0.15$ mAdc)	$V_{CE(sat)}$	—	0.2	0.3	Vdc
Base-Emitter Saturation Voltage ($I_C = 3.0$ mAdc, $I_B = 0.15$ mAdc)	$V_{BE(sat)}$	0.7	0.78	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 5.0$ mAdc, $V_{CE} = 4.0$ Vdc, f = 100 MHz)	f_T	800	850	—	MHz
Output Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 140 kHz)	C_{obo}	—	2.0	3.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 140 kHz)	C_{ibo}	—	1.8	2.0	pF
SWITCHING CHARACTERISTICS					
Storage Time ($V_{CC} = 3.0$ Vdc, $I_C = 5.0$ mAdc, $I_{B1} = I_{B2} = 5.0$ mAdc)	t_s	—	4.0	6.0	ns
Turn-On Time ($V_{CC} = 1.0$ Vdc, $V_{BE(off)} = 1.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = 2.0$ mAdc, $I_{B2} = 1.0$ mAdc)	t_{on}	—	12	15	ns
Turn-Off Time ($V_{CC} = 1.0$ Vdc, $I_C = 10$ mAdc, $I_{B1} = I_{B2} = 1.0$ mAdc)	t_{off}	—	12	15	ns

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

MM3001
thru
MM3003

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MM3001	MM3002	MM3003	Unit
Collector-Emitter Voltage	V_{CEO}	150	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous	I_C	200	50	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71			Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	5.0 28.6			Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

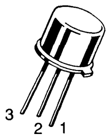
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

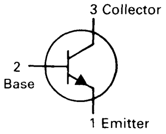
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 10$ mAdc, $I_B = 0$)	MM3001 MM3002 MM3003	$V_{(BR)CEO}$	150 200 150	— — —	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current ($V_{CB} = 75$ Vdc, $I_E = 0$) ($V_{CB} = 100$ Vdc, $I_E = 0$)	MM3001 MM3002, MM3003	I_{CBO}	— —	1.0 5.0	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc)		h_{FE}	20	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)		f_T	150	—	MHz
Output Capacitance ($V_{CB} = 20$ Vdc, $I_E = 0$, f = 100 kHz)	MM3001 MM3002, MM3003	C_{obo}	— —	7.0 15	pF

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

MM3005
thru
MM3007

CASE 79-04, STYLE 1
TO-39 (TO-205AD)





AUDIO TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MM3005	MM3006	MM3007	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	80	100	120	Vdc
Emitter-Base Voltage	V_{EBO}		5.0		Vdc
Collector Current — Continuous	I_C		2.5		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D		1.0 5.71		Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D		8.0 45.6		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}		−65 to +200		°C

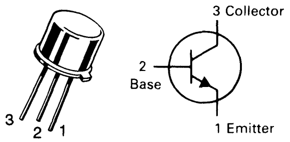
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
($I_C = 10$ mAdc, $I_B = 0$)	MM3005		60	—	
	MM3006		80	—	
	MM3007		100	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
($I_C = 100$ μAdc, $I_E = 0$)	MM3005		80	—	
	MM3006		100	—	
	MM3007		120	—	
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
($V_{CB} = 60$ Vdc, $I_E = 0$)	MM3005		—	100	
($V_{CB} = 80$ Vdc, $I_E = 0$)	MM3006		—	100	
($V_{CB} = 100$ Vdc, $I_E = 0$)	MM3007		—	100	
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	All Types		40	—	
($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3005		50	250	
($I_C = 200$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3006		50	250	
($I_C = 250$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3007		50	250	
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{CE(sat)}$	—	0.35	Vdc
Base-Emitter On Voltage ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)		$V_{BE(on)}$	0.60	0.75	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)		f_T	50	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)		C_{obo}	—	15	pF

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

MM3009

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	MM3009	Unit
Collector-Emitter Voltage	V_{CEO}	180	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	4.0 22.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

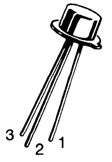
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

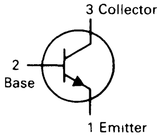
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	180	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CB} = 180 Vdc, I_E = 0)	I_{CEO}	—	0.1	μAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)	I_{EBO}	—	0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain	h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		30	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		40	—	
(I_C = 30 mAdc, V_{CE} = 10 Vdc)		30	—	
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 20 MHz)	f_T	50	—	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	—	20	pF

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.

MM3903
MM3904

CASE 27-02, STYLE 1
TO-52 (TO-206AC)





GENERAL PURPOSE TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	6.0	Vdc
Collector Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	200 2.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	500 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +125	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	490	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	60	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	6.0	—	Vdc
Base Cutoff Current ($V_{CE} = 30$ Vdc, $V_{EB(off)} = 3.0$ Vdc)		I_{BEV}	—	50	nAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{EB(off)} = 3.0$ Vdc)		I_{CEX}	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3903		20	—	
	MM3904		40	—	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3903		35	—	
	MM3904		70	—	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3903		50	150	
	MM3904		100	300	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3903		30	—	
	MM3904		60	—	
($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3903		10	—	
	MM3904		15	—	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			—	0.2	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)			—	0.3	
Base-Emitter Saturation Voltage		$V_{BE(sat)}$			Vdc
($I_C = 10$ mAdc, $I_B = 1.0$ mAdc)			0.65	0.85	
($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)			—	0.95	

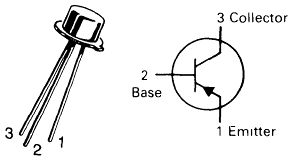
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	MM3903 MM3904	f_T	250 300	— —	MHz
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	8.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3903 MM3904	h_{fe}	50 100	200 400	—
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	—	35	ns
Rise Time		t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc) MM3903 MM3904	t_s	— —	175 200	ns
Fall Time		t_f	—	50	ns

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

MM3905
MM3906

CASE 27-02, STYLE 1
TO-52 (TO-206AC)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N3250 for graphs.

MAXIMUM RATINGS

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

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	490	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)		$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)		$V_{(BR)EBO}$	5.0	—	Vdc
Base Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 3.0$ Vdc)		I_{BEV}	—	50	nAdc
Collector Cutoff Current ($V_{CE} = 30$ Vdc, $V_{BE} = 3.0$ Vdc)		I_{CEV}	—	50	nAdc
ON CHARACTERISTICS(1)					
DC Current Gain		h_{FE}			—
($I_C = 0.1$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3905 MM3906		30 60	— —	
($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3905 MM3906		40 80	— —	
($I_C = 10$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3905 MM3906		50 100	150 300	
($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3905 MM3906		30 60	— —	
($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc)	MM3905 MM3906		10 15	— —	
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{CE(sat)}$	 — —	 0.25 0.4	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)		$V_{BE(sat)}$	 0.65 —	 0.85 0.95	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1)		f_T			MHz
($I_C = 10$ mAdc, $V_{CE} = 20$ Vdc, f = 100 MHz)	MM3905 MM3906		200 250	— —	

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

Characteristic		Symbol	Min	Max	Unit
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	5.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	10	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	h_{ie}	0.5 2.0	8.0 12	k ohms
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	h_{re}	0.1×10^{-4} 1×10^{-4}	5×10^{-4} 10×10^{-4}	—
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	h_{fe}	50 100	200 400	—
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	MM3905 MM3906	h_{oe}	1.0 3.0	40 60	μmhos
Noise Figure (I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k ohm, f = 10 Hz to 15.7 kHz)	MM3905 MM3906	NF	— —	5.0 4.0	dB

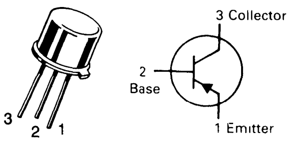
SWITCHING CHARACTERISTICS

			Symbol	Min	Max	Unit
Delay Time	(V_{CC} = 3.0 Vdc, $V_{BE(off)}$ = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	—	35	ns
Rise Time			t_r	—	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	MM3905 MM3906	t_s	— —	200 225	ns
Fall Time		MM3905 MM3906	t_f	— —	60 75	ns

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 2.0%.

MM4000
thru
MM4003

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTORS

PNP SILICON

Refer to 2N3494 for graphs for MM4000.*

MAXIMUM RATINGS

Rating	Symbol	MM4000	MM4001	MM4002	MM4003	Unit
Collector-Emitter Voltage	V_{CEO}	100	150	200	250	Vdc
Collector-Base Voltage	V_{CBO}	100	150	200	250	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	4.0	4.0	4.0	Vdc
Collector Current — Continuous	I_C	100	500	500	500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 3.42	1.0 5.71	1.0 5.71	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.0 17.2	5.0 28.6	5.0 28.6	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200				°C

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

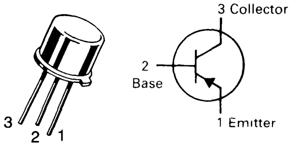
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	MM4000	$V_{(BR)CEO}$	100	—	Vdc
	MM4001		150	—	
	MM4002		200	—	
	MM4003		250	—	
Collector-Base Breakdown Voltage (I_E = 0, I_C = 100 μAdc)	MM4000	$V_{(BR)CBO}$	100	—	Vdc
	MM4001		150	—	
	MM4002		200	—	
	MM4003		250	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	Vdc
Collector Cutoff Current		I_{CBO}			μAdc
(V_{CB} = 50 Vdc, I_E = 0)	MM4000		—	1.0	
(V_{CB} = 75 Vdc, I_E = 0)	MM4001		—	1.0	
(V_{CB} = 150 Vdc, I_E = 0)	MM4002, MM4003		—	5.0	
ON CHARACTERISTICS					
DC Current Gain(1) (I_C = 10 mAdc, V_{CE} = 10 Vdc)		h_{FE}	20	—	—
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc)	MM4000, MM4001	$V_{CE(sat)}$	—	0.6	Vdc
	MM4002, MM4003		—	5.0	
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 100 kHz)	MM4000	C_{obo}	—	6.0	pF
	MM4001		—	10	
	MM4002, MM4003		—	20	

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

*Refer to 2N3634 for graphs for MM4001.
Refer to 2N4930 for graphs for MM4002 and MM4003.

MM4005

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AMPLIFIER TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	175	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

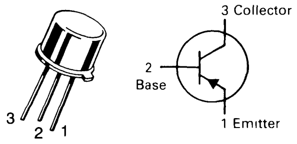
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 50$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_E = 0$)	I_{EBO}	—	—	100	nAdc
ON CHARACTERISTICS(2)					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 150$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 40 50	 90 150	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{CE(sat)}$	—	0.1	—	Vdc
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)	$V_{BE(sat)}$	—	0.7	—	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 20 MHz)	f_T	50	250	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	10	—	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	100	—	pF

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MM4036
MM4037

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



SWITCHING TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Emitter Voltage		V_{CEO}		Vdc
	MM4036		65	
	MM4037		40	
Collector-Base Voltage		V_{CBO}		Vdc
	MM4036		90	
	MM4037		60	
Emitter-Base Voltage		V_{EBO}	5.0	Vdc
Base Current		I_B	500	mAdc
Collector Current — Continuous		I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C		P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C		P_D	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range		T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}(1)$	175	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage(2)		$V_{(BR)CEO}$				Vdc
($I_C = 10$ mAdc, $I_B = 0$)	MM4036		65	—	—	
	MM4037		40			
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
($I_C = 100$ μAdc, $I_E = 0$)	MM4036		90	—	—	
($I_C = 10$ μAdc, $I_E = 0$)	MM4037		60	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
($I_E = 100$ μAdc, $I_C = 0$)	MM4036		5.0	—	—	
($I_E = 1.0$ μAdc, $I_C = 0$)	MM4037		5.0	—	—	
Collector Cutoff Current(1)		I_{CEV}				
($V_{CE} = 60$ Vdc, $V_{BE(off)} = 1.5$ Vdc)	MM4036		—	—	250	nAdc
($V_{CE} = 30$ Vdc, $V_{BE(off)} = 1.5$ Vdc, $T_C = 150°C$)	MM4036		—	—	100	μAdc
Collector Cutoff Current		I_{CBO}	—	—	250	
($V_{CB} = 60$ Vdc, $I_E = 0$)	MM4036, MM4037					nAdc
Emitter Cutoff Current		I_{EBO}				μAdc
($V_{BE} = 3.0$ Vdc, $I_C = 0$)	MM4036		—	—	250	
($V_{BE} = 5.0$ Vdc, $I_C = 0$)	MM4037		—	—	1.0	
ON CHARACTERISTICS(2)						
DC Current Gain		h_{FE}				—
($I_C = 100$ μAdc, $V_{CE} = 10$ Vdc)	MM4036		20	50	—	
($I_C = 150$ mAdc, $V_{CE} = 2.0$ Vdc)	MM4036		20	60	200	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	MM4036		40	90	140	
($I_C = 500$ mAdc, $V_{CE} = 10$ Vdc)	MM4036		20	40	—	
($I_C = 1.0$ mAdc, $V_{CE} = 10$ Vdc)	MM4037		15	50	—	
($I_C = 150$ mAdc, $V_{CE} = 10$ Vdc)	MM4037		50	75	250	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$				Vdc
($I_C = 150$ mAdc, $I_B = 15$ mAdc)	MM4036		—	0.3	0.65	
	MM4037			0.3	1.4	
Base-Emitter Saturation Voltage ($I_C = 150$ mAdc, $I_B = 15$ mAdc)		$V_{BE(sat)}$	—	1.0	1.4	Vdc

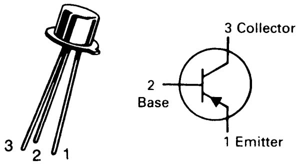
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain — Bandwidth Product(2) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	60	100	—	MHz
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	MM4036, MM4037	C_{ibo}	—	60	—	pF
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	MM4036 MM4037	C_{cb}	— —	20 20	— 30	pF
SWITCHING CHARACTERISTICS						
Turn-On Time	(V_{CC} = 30 Vdc, I_C = 150 mAdc, I_{B1} = 15 mAdc)	t_{on}	—	40	75	ns
Turn-Off Time	(V_{CC} = 6.0 Vdc, I_C = 150 mAdc, I_{B1} = I_{B2} = 15 mAdc)	t_{off}	—	110	175	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MM4258

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



SWITCHING TRANSISTOR

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MM4257	MM4258	Unit
Collector-Emitter Voltage	V_{CEO}	6.0	12	Vdc
Collector-Base Voltage	V_{CBO}	6.0	12	Vdc
Emitter-Base Voltage	V_{EBO}	4.5		Vdc
Collector Current — Continuous	I_C	200		mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.06		mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.2 6.86		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) ($I_C = 100\ \mu Adc$, $V_{BE} = 0$)	$V_{(BR)CES}$	12	—	—	Vdc
Collector-Emitter Sustaining Voltage(1) ($I_C = 3.0$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	12	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	12	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	4.5	—	—	Vdc
Collector Cutoff Current ($V_{CE} = 6.0$ Vdc, $V_{BE} = 0$) ($V_{CE} = 3.0$ Vdc, $V_{BE} = 0$, $T_A = +65°C$)	I_{CES}	 — —	 — —	 0.01 5.0	μAdc
ON CHARACTERISTICS(1)					
DC Current Gain ($I_C = 1.0$ mAdc, $V_{CE} = 0.5$ Vdc) ($I_C = 10$ mAdc, $V_{CE} = 0.3$ Vdc) ($I_C = 50$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 15 30 30	 — — —	 — 120 —	—
Collector-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{CE(sat)}$	 — —	 — —	 0.15 0.5	Vdc
Base-Emitter Saturation Voltage ($I_C = 10$ mAdc, $I_B = 1.0$ mAdc) ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	$V_{BE(sat)}$	 0.75 —	 — —	 0.95 1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz) ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	700	—	—	MHz
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	—	3.5	pF
Collector-Base Capacitance ($V_{CB} = 5.0$ Vdc, $I_E = 0$, f = 100 kHz)	C_{cb}	—	—	3.0	pF

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

Characteristic		Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS						
Turn-On Time	(V_{CC} = 1.5 Vdc, V_{BE} = 0, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_{on}	—	10	15	ns
Delay Time		t_d	—	5.0	10	
Rise Time		t_r	—	5.0	15	
Turn-Off Time	(V_{CC} = 1.5 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_{off}	—	16	20	ns
Storage Time		t_s	—	8.0	20	
Fall Time		t_f	—	8.0	10	
Storage Time (I_C ≈ 10 mAdc, I_{B1} ≈ 10 mAdc, I_{B2} ≈ 10 mAdc)		t_s	—	—	20	ns

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
(2) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

TYPICAL TRANSIENT CHARACTERISTICS

FIGURE 1 — CURRENT-GAIN — BANDWIDTH PRODUCT

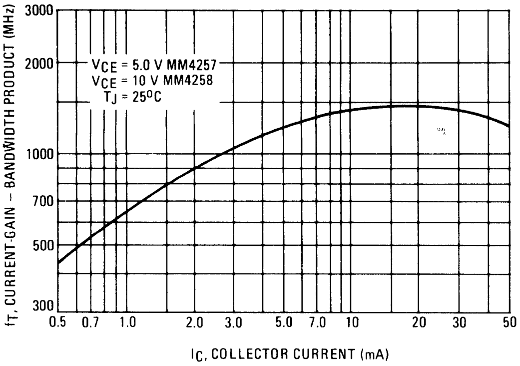


FIGURE 2 — CAPACITANCE

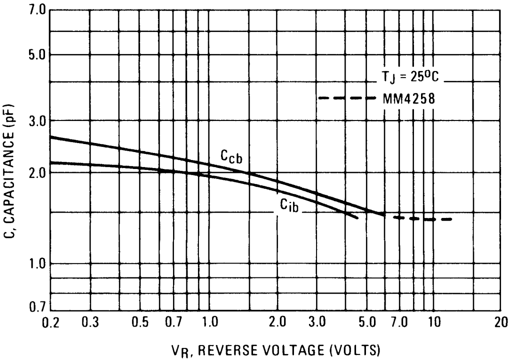


FIGURE 3 — TURN-ON TIME

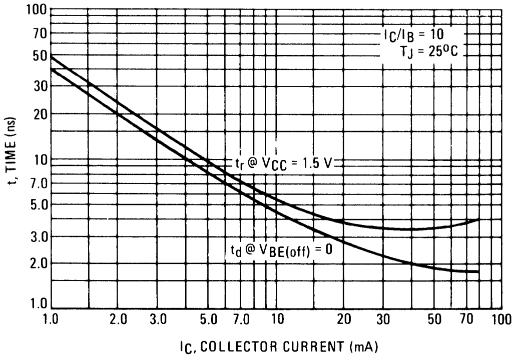


FIGURE 4 — TURN-OFF TIME

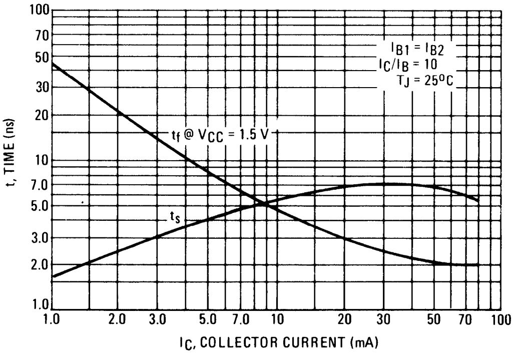
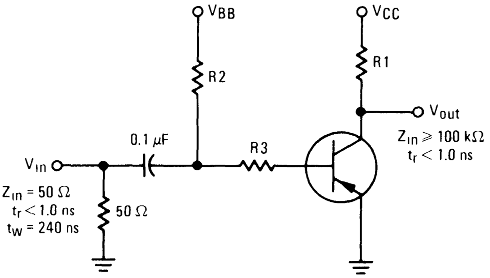


FIGURE 5 — SWITCHING TIME TEST CIRCUIT



	V_{in} Volts	V_{BB} Volts	V_{CC} Volts	R1 Ohms	R2 Ohms	R3 Ohms	I_C mA	I_{B1} mA	I_{B2} mA
t_{on}	-5.8	GND	-1.5	130	2.2 k	5 k	10	1.0	–
t_{off}	+9.8	-8.0	-1.5	130	2.2 k	5 k	10	1.0	1.0
t_s	+9.0	-10	-3.0	270	510	390	10	10	10

FIGURE 6 — DC CURRENT GAIN

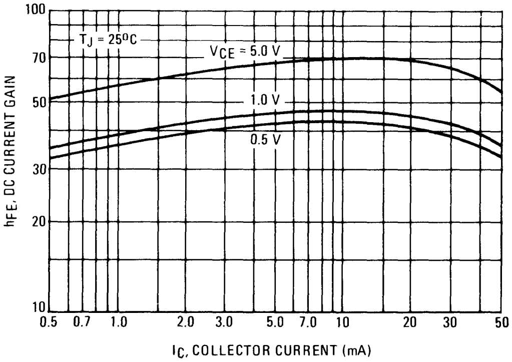
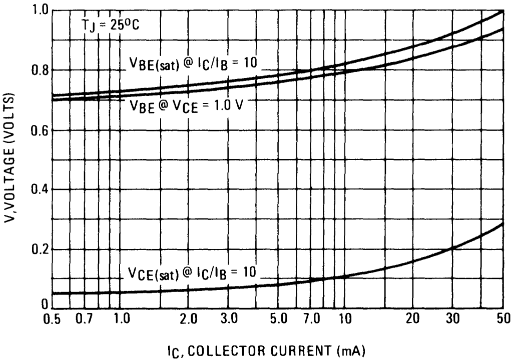
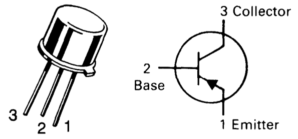


FIGURE 7 — "ON" VOLTAGES



MM5005
thru
MM5007

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



AUDIO TRANSISTORS

PNP SILICON

MAXIMUM RATINGS

Rating	Symbol	MM5005	MM5006	MM5007	Unit
Collector-Emitter Voltage	V_{CEO}	60	80	100	Vdc
Collector-Base Voltage	V_{CBO}	80	100	120	Vdc
Emitter-Base Voltage	V_{EBO}	5.0			Vdc
Collector Current — Continuous	I_C	2.0			Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 1.5 8.57			 Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 8.0 45.7			 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200			°C

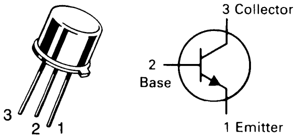
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1)		$V_{(BR)CEO}$			Vdc
(I_C = 10 mAdc, I_B = 0)	MM5005		60	—	
	MM5006		80	—	
	MM5007		100	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$			Vdc
(I_C = 100 μAdc, I_E = 0)	MM5005		80	—	
	MM5006		100	—	
	MM5007		120	—	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	5.0	—	Vdc
Collector Cutoff Current		I_{CBO}			nAdc
(V_{CB} = 60 Vdc, I_E = 0)	MM5005		—	200	
(V_{CB} = 80 Vdc, I_E = 0)	MM5006		—	200	
(V_{CB} = 100 Vdc, I_E = 0)	MM5007		—	200	
Emitter Cutoff Current (V_{EB} = 4.0 Vdc, I_C = 0)		I_{EBO}	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain		h_{FE}			—
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	All Types		40	—	
(I_C = 150 mAdc, V_{CE} = 2.5 Vdc)	MM5005		50	250	
(I_C = 200 mAdc, V_{CE} = 2.5 Vdc)	MM5006		50	250	
(I_C = 250 mAdc, V_{CE} = 2.5 Vdc)	MM5007		50	250	
Collector-Emitter Saturation Voltage (I_C = 150 mAdc, I_B = 15 mAdc)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter On Voltage (I_C = 150 mAdc, V_{CE} = 2.5 Vdc)		$V_{BE(on)}$	0.65	0.8	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(1) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 20 MHz)		f_T	30	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	20	pF

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

MM5262

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



GENERAL PURPOSE TRANSISTOR

NPN SILICON

Refer to 2N3724 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Emitter Voltage	V_{CES}	60	Vdc
Collector-Base Voltage	V_{CBO}	75	Vdc
Emitter-Base Voltage	V_{EBO}	5.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	4.0 22.8	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	44	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	175	°C/W

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

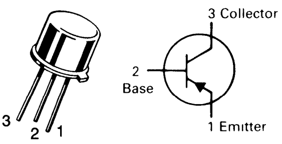
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	75	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 75$ Vdc, $I_E = 0$)	I_{CBO}	—	—	100	μAdc
Collector Cutoff Current ($V_{CE} = 60$ Vdc, $V_{BE} = 0$)	I_{CES}	—	—	10	μAdc
Emitter Cutoff Current ($V_{BE} = 5.0$ Vdc, $I_C = 0$)	I_{EBO}	—	—	100	μAdc
ON CHARACTERISTICS(2)					
DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 500$ mAdc, $V_{CE} = 1.0$ Vdc) ($I_C = 1.0$ Adc, $V_{CE} = 1.0$ Vdc)	h_{FE}	 35 40 25	 100 65 35	 — — —	—
Collector-Emitter Saturation Voltage ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	$V_{CE(sat)}$	—	0.29	0.8	Vdc
Base-Emitter Saturation Voltage ($I_C = 1.0$ Adc, $I_B = 100$ mAdc)	$V_{BE(sat)}$	—	0.94	1.4	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	—	350	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{obo}	—	7.3	—	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 1.0 MHz)	C_{ibo}	—	72	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time	t_{on}	—	16	30	ns
Turn-Off Time	t_{off}	—	28	60	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MM5415
MM5416

CASE 79-04, STYLE 1
TO-39 (TO-205AD)



TRANSISTORS

PNP SILICON

Refer to 2N5415 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MM5415	MM5416	Unit
Collector-Emitter Voltage	V_{CEO}	200	300	Vdc
Collector-Base Voltage	V_{CBO}	200	350	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	7.0	Vdc
Base Current	I_B	0.5		Adc
Collector Current — Continuous	I_C	1.0		Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 6.7		Watt W/°C
Total Power Dissipation @ $T_C = 50°C$ Linear Derating Factor	P_D	10 0.057		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

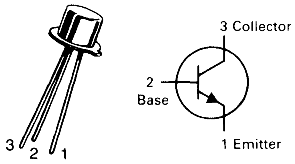
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	150	°C/W

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage ($I_C = 10$ mA, $I_B = 0$)	MM5415 MM5416	$V_{CEO(sus)}$	200 300	— —	Vdc
Collector Cutoff Current ($V_{CE} = 150$ Vdc, $I_B = 0$)	MM5415, MM5416	I_{CEO}	—	50	μAdc
Collector Cutoff Current ($V_{CE} = 175$ Vdc, $I_E = 0$) ($V_{CE} = 280$ Vdc, $I_E = 0$)	MM5415 MM5416	I_{CBO}	— —	50 50	μAdc μAdc
Emitter Cutoff Current ($V_{BE} = 4.0$ Vdc, $I_C = 0$) ($V_{BE} = 7.0$ Vdc, $I_C = 0$)	MM5415 MM5416	I_{EBO}	— —	20 20	μAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 50$ mAdc, $V_{CE} = 10$ Vdc)	MM5415 MM5416	h_{FE}	30 30	150 120	—
Collector-Emitter Saturation Voltage ($I_C = 50$ mAdc, $I_B = 5.0$ mAdc)	MM5415, MM5416	$V_{CE(sat)}$	—	2.5	Vdc
Base-Emitter On Voltage ($I_C = 50$ mAdc, $V_{CE} = 10$ V)	MM5415, MM5416	$V_{BE(on)}$	—	1.5	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product ($I_C = 10$ mAdc, $V_{CE} = 10$ Vdc, f = 5.0 MHz)		f_T	15	—	MHz
Output Capacitance ($V_{CB} = 10$ Vdc, f = 1.0 MHz)		C_{obo}	—	25	pF
Current Gain — High Frequency ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 kHz)		$\|h_{fe}\|$	25	—	—
Real Part of Input Impedance ($I_C = 5.0$ mAdc, $V_{CE} = 10$ Vdc, f = 1.0 MHz)		$Re(h_{ie})$	—	300	Ohms

MM6427

CASE 22-03, STYLE 1
TO-18 (TO-206AA)



DARLINGTON TRANSISTOR

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	12	Vdc
Collector Current — Continuous	I_C	300	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	375 2.14	mW W/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.25 7.15	Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	140	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	467	°C/W

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage(1) ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	40	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	50	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	12	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ Vdc, $I_E = 0$)	I_{CBO}	—	100	nAdc
Emitter Cutoff Current ($V_{BE} = 10$ Vdc, $I_C = 0$)	I_{EBO}	—	100	nAdc
ON CHARACTERISTICS(1)				
DC Current Gain ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc) ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	 5000 10,000	 — —	—
Collector-Emitter Saturation Voltage ($I_C = 100$ mAdc, $I_B = 0.1$ mAdc)	$V_{CE(sat)}$	—	1.5	Vdc
Base-Emitter On Voltage ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	$V_{BE(on)}$	—	2.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 100 kHz)	C_{obo}	—	8.0	pF
Input Capacitance ($V_{BE} = 0.5$ Vdc, $I_C = 0$, f = 100 kHz)	C_{ibo}	—	15	pF
Small-Signal Current Gain(1) ($I_C = 10$ mAdc, $V_{CE} = 5.0$ Vdc, f = 100 MHz)	h_{fe}	1.25	—	—

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

MQ982 For Specifications, See MD982,F Data.

MQ1120 For Specifications, See MD1121 Data.

MQ2218,A/MQ2219,A For Specifications, See MD2218,A,AF Data.

MQ2369 For Specifications, See MD2369,A,B Data.

MQ2904/MQ2905A For Specifications, See MD2904,A,AF Data.

MQ3251 For Specifications, See MD3250,A,F,AF Data.

MQ3467 For Specifications, See MD3467 Data.

MQ3725 For Specifications, See MD3725,F Data.

MQ3762 For Specifications, See MD3762,F Data.

MQ6001 For Specifications, See MD6001,F Data.

MQ7001 For Specifications, See MD7001,F Data.

MQ7003 For Specifications, See MD7003,A,B Data.

MQ7007 For Specifications, See MD7007,A,B,BF Data.

MQ7021 For Specifications, See MD7021,F Data.

MPQ2221/MPQ2222 For Specifications, See MHQ2222 Data.

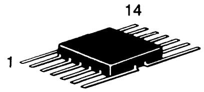
MPQ2369 For Specifications, See MHQ2369 Data.

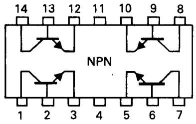
MPQ2906/MPQ2907 For Specifications, See MHQ2906 Data.

MPQ3546 For Specifications, See MHQ3546 Data.

MQ1129

CASE 607-04, STYLE 1





QUAD
AMPLIFIER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CBO}	60		Vdc
Emitter-Base Voltage	V_{EBO}	5.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		One Die	**All Die Equal Power**	
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	 400 2.28	 600 3.42	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	 0.9 5.13	 3.6 20.5	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	One Die	All Die Equal Power	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	195	48.8	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$(1)	438	292	°C/W
		Junction to Ambient	**Junction to Case**	
Coupling Factors MQ1129 (Q1-Q2) (Q1-Q3 or Q1-Q4)		 57 55	 0 0	%

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(2) (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0) (V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	 — —	 — —	 10 10	 nAdc μAdc
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)	I_{EBO}	—	—	10	nAdc

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

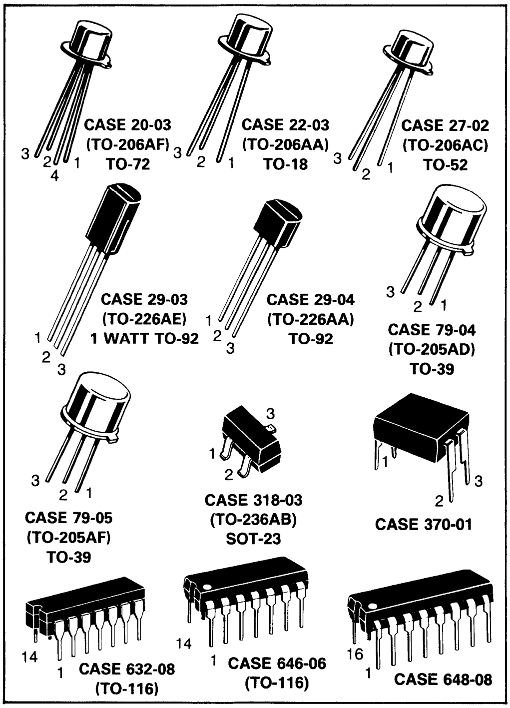
Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain(2)	h_{FE}				—
(I_C = 10 μAdc, V_{CE} = 10 Vdc)		60	—	—	
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		100	—	300	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		100	120	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)		100	140	—	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.09	0.1	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	0.7	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product(2) (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	200	250	—	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{obo}	—	3.5	8.0	pF
MATCHING CHARACTERISTICS (MD1129, MD1129F)					
DC Current Gain Ratio(3)	h_{FE1}/h_{FE2}				—
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		0.9	—	1.0	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		0.9	—	1.0	
Base-Emitter Voltage Differential	$\lvert V_{BE1}-V_{BE2}\rvert$				mVdc
(I_C = 100 μAdc, V_{CE} = 10 Vdc)		—	—	5.0	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)		—	—	5.0	
Base-Emitter Voltage Differential Change Due to Temperature	$\Delta(V_{BE1}-V_{BE2})$				mVdc
(I_C = 100 μAdc, V_{CE} = 10 Vdc, T_A = −55 to +25°C)		—	—	0.8	
(I_C = 100 μAdc, V_{CE} = 10 Vdc, T_A = +25 to +125°C)		—	—	1.0	

(1) $R_{\theta JA}$ is measured with the device soldered into a typical printed circuit board.

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

(3) The lowest h_{FE} reading is taken as h_{FE1} for this ratio.

Field-Effect Transistors



The data sheets on the following pages are designed to emphasize those FET's that by virtue of widespread industry use, ease of manufacture, and consequently low relative cost, merit first consideration for new equipment design. Package options from low-cost plastic to metal packages are available.

This section contains both single and multiple field-effect transistors.

CAUTION:

Static electricity is a surface phenomenon which most commonly occurs when two dissimilar materials come into contact and then separate. Electro Static Discharge (ESD) damage of semiconductor components by operating personnel is quickly becoming a very prominent and significant problem. From simple bipolar designs to sensitive MOSFET structures, ESD has its unforgiving effect of degradation or destruction.

Motorola believes it is important to extend an emphasizing note of cautiousness when handling and testing *ANY* FET product. Precautions include, but are not limited to, the implementation of static safe workstations and proper handling techniques (see below). Additionally, it is very important to keep FET devices in their antistatic shipping containers and away from any static-generating materials.

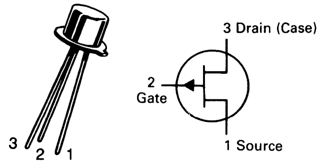
HANDLING CONSIDERATIONS:

MOS Field-Effect Transistors, due to their extremely high input resistance, are subject to potential damage by the accumulation of excess static charge. To avoid possible damage to the devices while handling, testing, or in actual operation, the following procedure should be followed:

1. The leads of the devices should remain wrapped in the shorting spring except when being tested or in actual operaiton to avoid the build-up of static charge.
2. Avoid unnecessary handling; when handled, the devices should be picked up by the *can* instead of the leads.
3. The devices should not be inserted or removed from circuits with the power on as transient voltages may cause permanent damage to the devices.

2N2843
2N2844

CASE 22-03, STYLE 12
TO-18 (TO-206AA)



JFETs
GENERAL PURPOSE

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Drain Current	I_D	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.7	mW mW/°C
Storage Temperature Range	T_{stg}	−60 to +200	°C

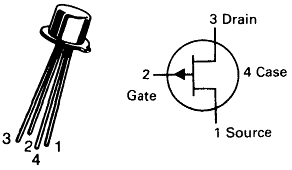
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current ($V_{GS} = 5.0$ V)		I_{GSS}	—	10	nA
Gate Source Cutoff Voltage ($V_{DS} = -5.0$ V, $I_D = -1.0\ \mu A$)		$V_{GS(off)}$	—	1.7	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = -5.0$ V)	 2N2843 2N2844	I_{DSS}*	 −200 −440	 −1000 −2200	μA
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = -5.0$ V, f = 1.0 kHz)	 2N2843 2N2844	$\lvert y_{fs}\rvert$*	 540 1400	 — —	μmhos
Input Capacitance ($V_{DS} = -5.0$ V, $V_{GS} = 1.0$ V, f = 140 kHz)	 2N2843 2N2844	C_{iss}	 — —	 17 30	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = -5.0$ V, f = 1.0 kHz, $R_G = 1.0$ meg)		NF	—	3.0	dB

*Pulse Width ≤ 630 ms, Duty Cycle = 10%.

2N3330

CASE 20-03, STYLE 5
TO-72 (TO-206AF)



JFET
AMPLIFIER
JAN AND JTX AVAILABLE

P-CHANNEL — DEPLETION

Refer to 2N5460 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	20	Vdc
Reverse Gate-Source Voltage	V_{GSR}	20	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.7	mWatts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

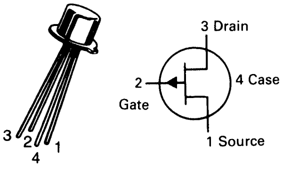
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

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

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

2N3331

CASE 20-03, STYLE 5
TO-72 (TO-206AF)



JFET
LOW FREQUENCY

P-CHANNEL — DEPLETION

Refer to 2N5460 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	20	Vdc
Drain-Gate Voltage	V_{DG}	20	Vdc
Gate-Source Voltage	V_{GS}	20	Vdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

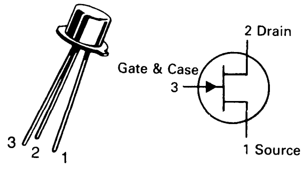
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = 10 μA)	$V_{(BR)GSS}$	20	—	Vdc
Gate Reverse Current (V_{GS} = 10 V, V_{DS} = 0)	I_{GSS}	—	10	nA
Gate Source Cutoff Voltage (V_{DS} = −15 V, I_D = −10 μA)	$V_{GS(off)}$	—	8.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current (V_{DS} = −10 V, V_{GS} = 0 V)	I_{DSS}*	−5.0	−15.0	mA
Drain-Source Resistance (I_D = −100 μA, V_{GS} = 0)	r_{DS}	—	800	ohms
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = −10 V, I_D = −5.0 mA, f = 1.0 kHz)	$\|y_{fs}\|$*	2000	4000	μmhos
Output Admittance (V_{DS} = −10 V, I_D = −2.0 mA, f = 1.0 kHz)	$\|y_{os}\|$*	—	100	μmhos
Forward Transfer Admittance (V_{DS} = −10 V, I_D = −2.0 mA, f = 10 MHz)	y_{fs}*	1350	—	μmhos
Input Capacitance (V_{DS} = −10 V, V_{GS} = 1.0 V, f = 1.0 MHz)	C_{iss}	—	20	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DS} = −5.0 V, I_D = −1.0 mA, R_G = 1.0 MΩ, f = 1.0 kHz)	NF	—	4.0	dB

*Pulse Width ≤ 300 μs, Duty Cycle ≤ 10%.

2N3437
2N3438

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFETs
LOW FREQUENCY

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	50	Vdc
Gate-Source Voltage	V_{GS}	50	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.7	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

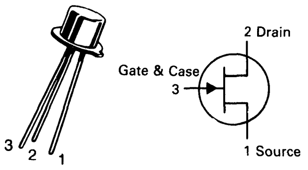
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$)		$V_{(BR)GSS}$	50	—	Vdc
Gate Reverse Current ($V_{GS} = -30$ V)		I_{GSS}	—	0.5	nA
Gate Source Cutoff Voltage ($V_{DS} = 20$ V, $I_D = 1.0$ nA)	2N3437	$V_{GS(off)}$	—	−5.0	Vdc
	2N3438		—	−2.5	
Gate Source Voltage ($V_{DS} = 20$ V, $I_D = 1.0\ \mu A$)	2N3437	V_{GS}	—	−4.8	Vdc
	2N3438		—	−2.3	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 20$ V)	2N3437	I_{DSS}*	0.8	4.0	mA
	2N3438		0.2	1.0	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 20$ V, f = 1.0 kHz)	2N3437	$\lvert y_{fs} \rvert$	1500	6000	μmhos
	2N3438		800	4500	
Output Admittance ($V_{DS} = 30$ V, f = 1.0 kHz)	2N3437	$\lvert y_{os} \rvert$	—	20	μmhos
	2N3438		—	5.0	
Input Capacitance ($V_{DS} = 10$ V) ($V_{DS} = 6.0$ V) ($V_{DS} = 4.0$ V, f = 1.0 MHz)		C_{iss}	—	18	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 10$ V, $R_G = 1.0$ mΩ, f = 1.0 kHz)		NF	—	2.0	dB

*Pulse Width ≤ 630 ms, Duty Cycle ≤ 10%.

2N3459
2N3460

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFETs
LOW FREQUENCY/
LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	50	Vdc
Gate-Source Voltage	V_{GS}	50	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.7	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

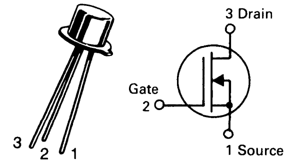
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$)	$V_{(BR)GSS}$	−50	—	Vdc
Gate Reverse Current ($V_{GS} = -30$ V)	I_{GSS}	—	−0.25	nA
Gate Source Cutoff Voltage ($V_{DS} = 20$ V, $I_D = 1.0\ \mu A$) 2N3459 2N3460	$V_{GS(off)}$	 — —	 −3.4 −1.8	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current ($V_{DS} = 20$ Volts) 2N3459 2N3460	I_{DSS}*	 0.8 0.2	 4.0 1.0	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = 20$ Volts, f = 1.0 kHz) 2N3459 2N3460	$\|y_{fs}\|$*	 1500 800	 6000 4500	μmhos
Output Admittance ($V_{DS} = 30$ Volts, f = 1.0 kHz) 2N3459 2N3460	$\|y_{os}\|$	 — —	 20 5.0	μmhos
Input Capacitance ($V_{DS} = 10$ V)	C_{iss}	—	18	pF
Output Capacitance ($V_{DS} = 30$ V)	C_{oss}	—	5.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure ($V_{DS} = 10$ V, f = 20 Hz, $R_G = 1.0$ MΩ) 2N3459 2N3460	NF	 — —	 4.0 4.0	dB

*Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

2N3796
2N3797

CASE 22-03, STYLE 2
TO-18 (TO-206AA)



MOSFETs
LOW POWER AUDIO

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}		Vdc
2N3796		25	
2N3797		20	
Gate-Source Voltage	V_{GS}	±10	Vdc
Drain Current	I_D	20	mAdc
Total Device Dissipation @ T_A = 25°C	P_D	200	mW
Derate above 25°C		1.14	mW/°C
Junction Temperature Range	T_J	+175	°C
Storage Channel Temperature Range	T_{stg}	−65 to +200	°C

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage	$V_{(BR)DSX}$				Vdc
(V_{GS} = −4.0 V, I_D = 5.0 μA) 2N3796		25	30	—	
(V_{GS} = −7.0 V, I_D = 5.0 μA) 2N3797		20	25	—	
Gate Reverse Current(1)	I_{GSS}				pAdc
(V_{GS} = −10 V, V_{DS} = 0)		—	—	1.0	
(V_{GS} = −10 V, V_{DS} = 0, T_A = 150°C)		—	—	200	
Gate Source Cutoff Voltage	$V_{GS(off)}$				Vdc
(I_D = 0.5 μA, V_{DS} = 10 V) 2N3796		—	−3.0	−4.0	
(I_D = 2.0 μA, V_{DS} = 10 V) 2N3797		—	−5.0	−7.0	
Drain-Gate Reverse Current(1) (V_{DG} = 10 V, I_S = 0)	I_{DGO}	—	—	1.0	pAdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current	I_{DSS}				mAdc
(V_{DS} = 10 V, V_{GS} = 0) 2N3796		0.5	1.5	3.0	
2N3797		2.0	2.9	6.0	
On-State Drain Current	$I_{D(on)}$				mAdc
(V_{DS} = 10 V, V_{GS} = +3.5 V) 2N3796		7.0	8.3	14	
2N3797		9.0	14	18	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance	$\|y_{fs}\|$				μmhos
(V_{DS} = 10 V, V_{GS} = 0, f = 1.0 kHz) 2N3796		900	1200	1800	
2N3797		1500	2300	3000	
(V_{DS} = 10 V, V_{GS} = 0, f = 1.0 MHz) 2N3796		900	—	—	
2N3797		1500	—	—	
Output Admittance	$\|y_{os}\|$				μmhos
(V_{DS} = 10 V, V_{GS} = 0, f = 1.0 kHz) 2N3796		—	12	25	
2N3797		—	27	60	
Input Capacitance	C_{iss}				pF
(V_{DS} = 10 V, V_{GS} = 0, f = 1.0 MHz) 2N3796		—	5.0	7.0	
2N3797		—	6.0	8.0	
Reverse Transfer Capacitance (V_{DS} = 10 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	0.5	0.8	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 10 V, V_{GS} = 0, f = 1.0 kHz, R_S = 3 megohms)	NF	—	3.8	—	dB

(1) This value of current includes both the FET leakage current as well as the leakage current associated with the test socket and fixture when measured under best attainable conditions.

TYPICAL DRAIN CHARACTERISTICS

FIGURE 1 — 2N3796

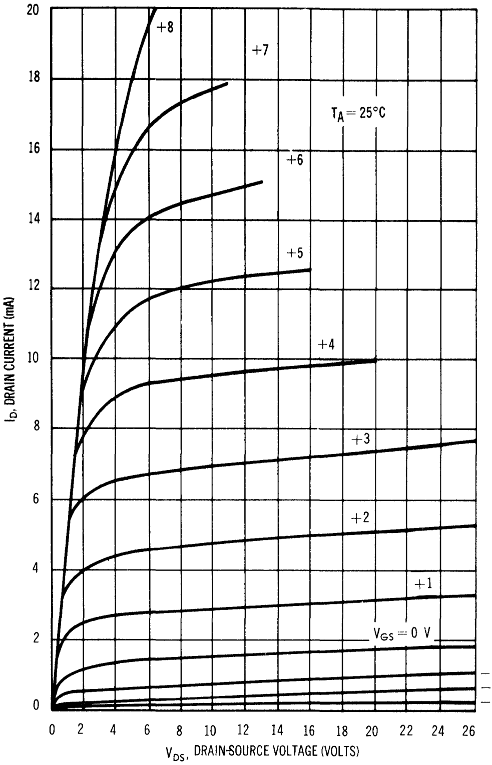
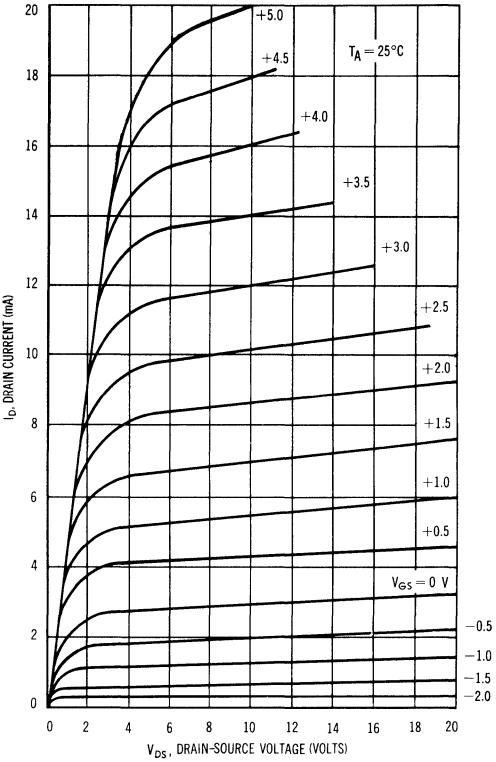


FIGURE 2 — 2N3797



COMMON SOURCE TRANSFER CHARACTERISTICS

FIGURE 3 — 2N3796

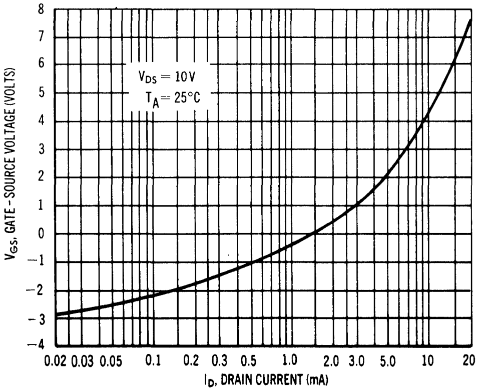


FIGURE 4 — 2N3797

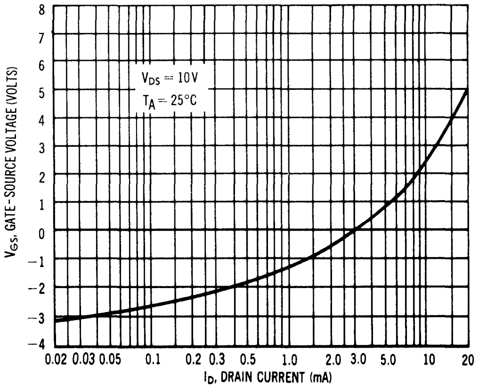


FIGURE 5 — FORWARD TRANSFER ADMITTANCE

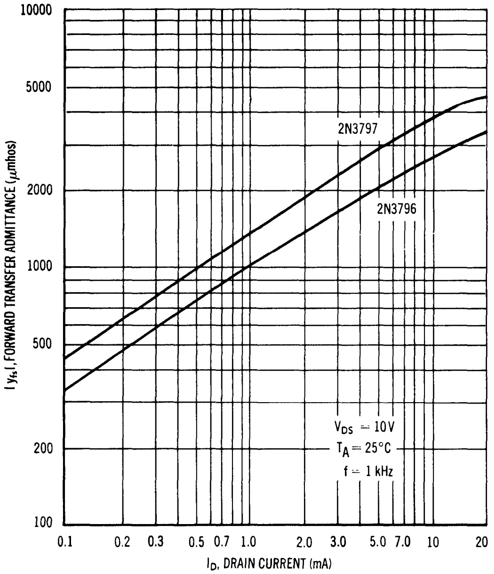


FIGURE 6 — OUTPUT ADMITTANCE

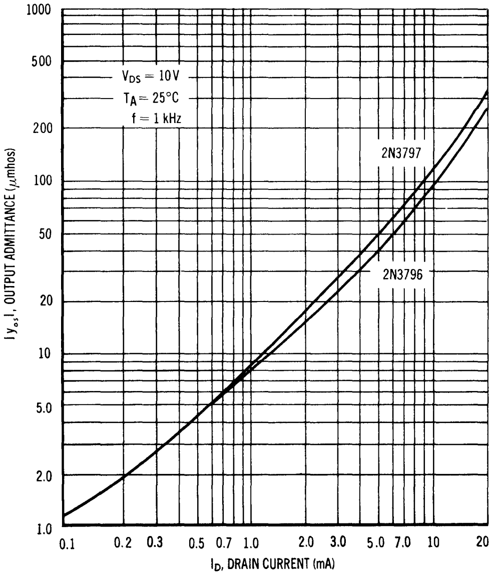


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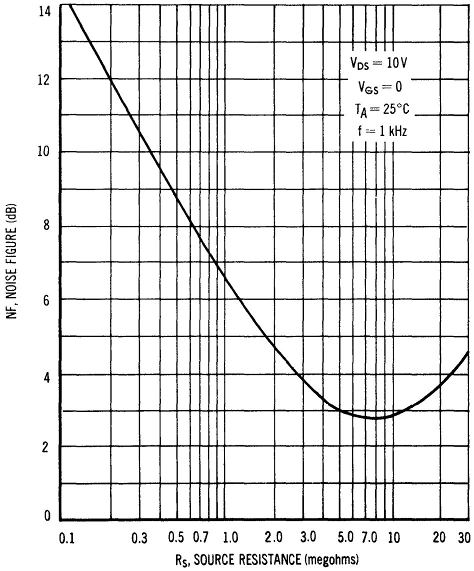
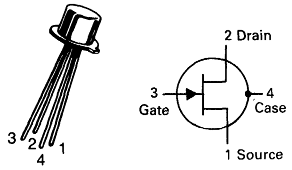
FIGURE 7 — NOISE FIGURE



2N3821
2N3822
2N3824

CASE 20-03, STYLE 1
TO-72 (TO-206AF)



JFETs
LOW FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION
JAN, JTX 2N3821 AND JAN, JTX 2N3822
AVAILABLE

Refer to 2N4220 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	50	Vdc
Drain-Gate Voltage	V_{DG}	50	Vdc
Gate-Source Voltage	V_{GS}	−50	Vdc
Drain Current	I_D	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.0	mW mW/°C
Junction Temperature Range	T_J	175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = −1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	−50	—	Vdc
Gate Reverse Current		I_{GSS}			nAdc
(V_{GS} = −30 Vdc, V_{DS} = 0)			—	−0.1	
(V_{GS} = −30 Vdc, V_{DS} = 0, T_A = 150°C)			—	−100	
Gate Source Cutoff Voltage		$V_{GS(off)}$			Vdc
(I_D = 0.5 nAdc, V_{DS} = 15 Vdc)	2N3821		—	−4.0	
	2N3822		—	−6.0	
Gate Source Voltage		V_{GS}			Vdc
(I_D = 50 μAdc, V_{DS} = 15 Vdc)	2N3821		−0.5	−2.0	
(I_D = 200 μAdc, V_{DS} = 15 Vdc)	2N3822		−1.0	−4.0	
Drain Cutoff Current		$I_{D(off)}$			nAdc
(V_{DS} = 15 Vdc, V_{GS} = −8.0 Vdc)	2N3824		—	0.1	
(V_{DS} = 15 Vdc, V_{GS} = −8.0 Vdc, T_A = 150°C)	2N3824		—	100	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1)		I_{DSS}			mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	2N3821		0.5	2.5	
	2N3822		2.0	10	
Static Drain-Source On Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N3824	$r_{DS(on)}$	—	250	Ohms
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance		$\|y_{fs}\|$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)(1)	2N3821		1500	4500	
	2N3822		3000	6500	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N3821		1500	—	
	2N3822		3000	—	
Output Admittance(1)		$\|y_{os}\|$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N3821		—	10	
	2N3822		—	20	
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	6.0	pF
Reverse Transfer Capacitance		C_{rss}			pF
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	2N3821		—	3.0	
	2N3822		—	3.0	
(V_{GS} = −8.0 Vdc, V_{DS} = 0, f = 1.0 MHz)	2N3824		—	3.0	

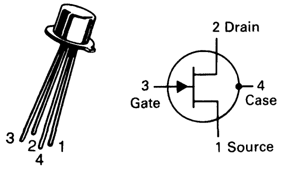
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0, R_S = 1.0 megohm, f = 10 Hz, Noise Bandwidth = 5.0 Hz)	2N3821, 2N3822	NF	—	5.0	dB
Equivalent Input Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, f = 10 Hz, Noise Bandwidth = 5.0 Hz)	2N3821, 2N3822	e_n	—	200	nv/Hz$^{1/2}$

(1) Pulse Test: Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

2N3823

JAN, JTX, JTXV AVAILABLE
CASE 20-03, STYLE 1
TO-72 (TO-206AF)



JFET VHF AMPLIFIER

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	−30	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 2.0	mW mW/°C
Junction Temperature Range	T_J	175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

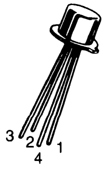
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

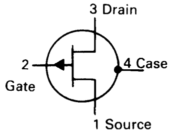
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = −1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	−30	—	Vdc
Gate Reverse Current (V_{GS} = −20 Vdc, V_{DS} = 0) (V_{GS} = −20 Vdc, V_{DS} = 0, T_A = 150°C)	I_{GSS}	 — —	 −0.5 −500	nAdc
Gate Source Cutoff Voltage (I_D = 0.5 nAdc, V_{DS} = 15 Vdc)	$V_{GS(off)}$	—	−8.0	Vdc
Gate Source Voltage (I_D = 0.4 mAdc, V_{DS} = 15 Vdc)	V_{GS}	−1.0	−7.5	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current(1) (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	4.0	20	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)(1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)	$\|y_{fs}\|$	 3500 3200	 6500 —	μmhos
Input Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)	$Re(y_{is})$	—	800	μmhos
Output Conductance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)(1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)	 $\|y_{os}\|$ $Re(y_{os})$	 — —	 35 200	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	6.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0, R_S = 1000 ohms, f = 100 MHz)	NF	—	2.5	dB

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

2N3909, A

CASE 20-03, STYLE 5
TO-72 (TO-206AF)





JFET AMPLIFIERS

P-CHANNEL — DEPLETION

Refer to 2N5460 for graphs.

MAXIMUM RATINGS

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

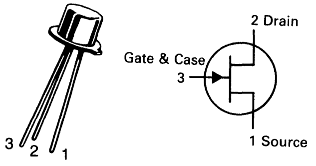
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.) (1)

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

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

2N3970
thru
2N3972

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	40	Vdc
Drain-Gate Voltage	V_{DG}	40	Vdc
Reverse Gate-Source Voltage	V_{GSR}	40	Vdc
Forward Gate Current	I_{GF}	50	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{GS} = 0)		$V_{(BR)GSS}$	40	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSS}	—	250	pAdc
Drain Reverse Current (V_{DG} = 20 Vdc, I_S = 0)		I_{DGO}	—	250	pAdc
(V_{DG} = 20 Vdc, I_S = 0, T_A = 150°C)			—	500	nAdc
Drain Cutoff Current (V_{DS} = 20 Vdc, V_{GS} = −12 Vdc)		$I_{D(off)}$	—	250	pAdc
(V_{DS} = 20 Vdc, V_{GS} = −12 Vdc, T_A = 150°C)			—	500	nAdc
Gate Source Voltage (V_{DS} = 20 Vdc, I_D = 1.0 nAdc)	2N3970	V_{GS}	−4.0	−10	Vdc
	2N3971		−2.0	−5.0	
	2N3972		−0.5	−3.0	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1) (V_{DS} = 20 Vdc, V_{GS} = 0)	2N3970	I_{DSS}	50	150	mAdc
	2N3971		25	75	
	2N3972		5.0	30	
Drain-Source On-Voltage (I_D = 20 mAdc, V_{GS} = 0)	2N3970	$V_{DS(on)}$	—	1.0	Vdc
(I_D = 10 mAdc, V_{GS} = 0)	2N3971		—	1.5	
(I_D = 5.0 mAdc, V_{GS} = 0)	2N3972		—	2.0	
Static Drain-Source On Resistance (I_D = 1.0 mAdc, V_{GS} = 0)	2N3970	$r_{DS(on)}$	—	30	Ohms
	2N3971		—	60	
	2N3972		—	100	
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N3970	$r_{ds(on)}$	—	30	Ohms
	2N3971		—	60	
	2N3972		—	100	
Input Capacitance (V_{DS} = 20 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	25	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = −12 Vdc, f = 1.0 MHz)		C_{rss}	—	6.0	pF

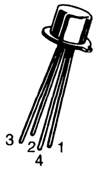
SWITCHING CHARACTERISTICS

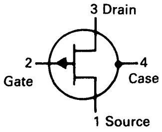
Turn-On Delay Time	Test Condition for 2N3970: (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $I_{D(on)}$ = 20 mAdc, $V_{GS(off)}$ = 10 Vdc)	2N3970	$t_{d(on)}$	—	10	ns
		2N3971		—	15	
		2N3972		—	40	
Rise Time	Test Condition for 2N3971: (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $I_{D(on)}$ = 10 mAdc, $V_{GS(on)}$ = 5.0 Vdc)	2N3970	t_r	—	10	ns
		2N3971		—	15	
		2N3972		—	40	
Turn-Off Time	Test Condition for 2N3972: (V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $I_{D(on)}$ = 5.0 mAdc, $V_{GS(off)}$ = 3.0 Vdc)	2N3970	t_{off}	—	30	ns
		2N3971		—	60	
		2N3972		—	100	

(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle = 3.0%.

2N3993
2N3994

CASE 20-03, STYLE 5
TO-72 (TO-206AF)





JFETs SWITCHING

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

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

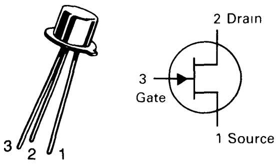
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu Adc$, $V_{DS} = 0$)		$V_{(BR)GSS}$	25	—	Vdc
Drain Reverse Current		I_{DGO}			
($V_{DG} = -15$ Vdc, $I_S = 0$)			—	1.2	nAdc
($V_{DG} = -15$ Vdc, $I_S = 0$, $T_A = 150°C$)			—	1.2	μAdc
Drain Cutoff Current		$I_{D(off)}$			
($V_{DS} = -10$ Vdc, $V_{GS} = 10$ Vdc)	2N3993		—	1.2	nAdc
($V_{DS} = -10$ Vdc, $V_{GS} = 6.0$ Vdc)	2N3994		—	1.2	
($V_{DS} = -10$ Vdc, $V_{GS} = 10$ Vdc, $T_A = 150°C$)	2N3993		—	1.0	μAdc
($V_{DS} = -10$ Vdc, $V_{GS} = 6.0$ Vdc, $T_A = 150°C$)	2N3994		—	1.0	
Gate Source Voltage		V_{GS}			Vdc
($V_{DS} = -10$ Vdc, $I_D = -1.0\ \mu Adc$)	2N3993		4.0	9.5	
	2N3994		1.0	5.5	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1)		I_{DSS}			mAdc
($V_{DS} = -10$ Vdc, $V_{GS} = 0$)	2N3993		−10	—	
	2N3994		−2.0	—	
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
($V_{GS} = 0$, $I_D = 0$, f = 1.0 kHz)	2N3993		—	150	
	2N3994		—	300	
Forward Transfer Admittance(1)		$\lvert y_{fs} \rvert$			mmhos
($V_{DS} = -10$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	2N3993		6.0	12	
	2N3994		4.0	10	
Input Capacitance ($V_{DS} = -10$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	16	pF
Reverse Transfer Capacitance		C_{rss}			pF
($V_{DS} = 0$, $V_{GS} = 10$ Vdc, f = 1.0 MHz)	2N3993		—	4.5	
($V_{DS} = 0$, $V_{GS} = 6.0$ Vdc, f = 1.0 MHz)	2N3994		—	5.0	

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

2N4091
thru
2N4093

CASE 22-03, STYLE 3
TO-18 (TO-206AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	40	Vdc
Drain-Gate Voltage	V_{DG}	40	Vdc
Gate-Source Voltage	V_{GS}	40	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 10	Watts mW/°C
Junction Temperature Range	T_J	−65 to +175	°C
Storage Temperature Range	T_{stg}	−65 to +175	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu Adc$, $V_{DS} = 0$)		$V_{(BR)GSS}$	40	—	Vdc
Drain-Gate Breakdown Voltage ($I_D = 1.0\ \mu Adc$, $I_S = 0$)		$V_{(BR)DGO}$	40	—	Vdc
Gate Source Cutoff Voltage		$V_{GS(off)}$			Vdc
($V_{DS} = 20$ Vdc, $I_D = 1.0$ nAdc)	2N4091		−5.0	−10	
	2N4092		−2.0	−7.0	
	2N4093		−1.0	−5.0	
Source Reverse Current ($V_{SG} = 20$ Vdc, $I_D = 0$)		I_{SGO}	—	0.2	nAdc
Drain Reverse Current		I_{DGO}			nAdc
($V_{DG} = 20$ Vdc, $I_S = 0$)			—	0.2	
($V_{DG} = 20$ Vdc, $I_D = 0$, $T_A = 150°C$)			—	0.4	µAdc
Drain-Cutoff Current		$I_{D(off)}$			
($V_{DS} = 20$ Vdc, $V_{GS} = 12$ Vdc)	2N4091		—	0.2	nAdc
($V_{DS} = 20$ Vdc, $V_{GS} = 8.0$ Vdc)	2N4092		—	0.2	
($V_{DS} = 20$ Vdc, $V_{GS} = 6.0$ Vdc)	2N4093		—	0.2	
($V_{DS} = 20$ Vdc, $V_{GS} = 12$ Vdc, $T_A = 150°C$)	2N4091		—	0.4	µAdc
($V_{DS} = 20$ Vdc, $V_{GS} = 8.0$ Vdc, $T_A = 150°C$)	2N4092		—	0.4	
($V_{DS} = 20$ Vdc, $V_{GS} = 6.0$ Vdc, $T_A = 150°C$)	2N4093		—	0.4	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current*		I_{DSS}*			mAdc
($V_{DS} = 20$ Vdc, $V_{GS} = 0$)	2N4091		30	—	
	2N4092		15	—	
	2N4093		8.0	—	
Drain-Source On-Voltage		$V_{DS(on)}$			Vdc
($I_D = 6.6$ mAdc, $V_{GS} = 0$)	2N4091		—	0.2	
($I_D = 4.0$ mAdc, $V_{GS} = 0$)	2N4092		—	0.2	
($I_D = 2.5$ mAdc, $V_{GS} = 0$)	2N4093		—	0.2	
Static Drain-Source On Resistance		$r_{DS(on)}$			Ohms
($I_D = 1.0$ mAdc, $V_{GS} = 0$)	2N4091		—	30	
	2N4092		—	50	
	2N4093		—	80	

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

Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N4091		—	30	
	2N4092		—	50	
	2N4093		—	80	
Input Capacitance (V_{DS} = 20 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	16	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 20 Vdc, f = 1.0 MHz)		C_{rss}	—	5.0	pF
SWITCHING CHARACTERISTICS					
Delay Time (See Figure 1)		t_d			ns
($I_{D(on)}$ = 6.6 mAdc)	2N4091		—	15	
($I_{D(on)}$ = 4.0 mAdc)	2N4092		—	15	
($I_{D(on)}$ = 2.5 mAdc)	2N4093		—	20	
Rise Time (See Figure 1)		t_r			ns
($I_{D(on)}$ = 6.6 mAdc)	2N4091		—	10	
($I_{D(on)}$ = 4.0 mAdc)	2N4092		—	20	
($I_{D(on)}$ = 2.5 mAdc)	2N4093		—	40	
Turn-Off Time (See Figure 1)		t_{off}			ns
($V_{GS(off)}$ = 12 Vdc)	2N4091		—	40	
($V_{GS(off)}$ = 8.0 Vdc)	2N4092		—	60	
($V_{GS(off)}$ = 6.0 Vdc)	2N4093		—	80	

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

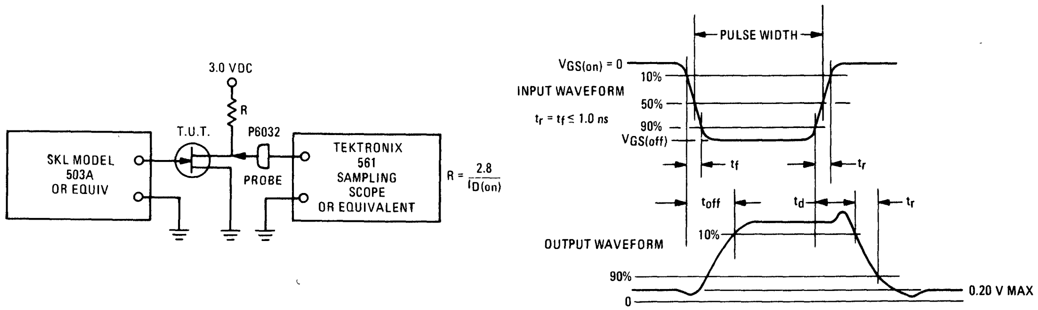
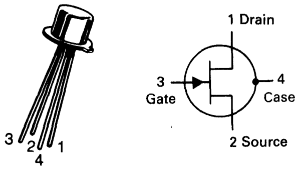


FIGURE 1 – SWITCHING TIMES TEST CIRCUIT

2N4220, A
thru
2N4222, A

CASE 20-03, STYLE 3
TO-72 (TO-206AF)



JFETs
LOW FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	−30	Vdc
Drain Current	I_D	15	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2	mW mW/°C
Junction Temperature Range	T_J	175	°C
Storage Channel Temperature Range	T_{stg}	−65 to +200	°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage ($I_G = -10\ \mu Adc$, $V_{DS} = 0$)		$V_{(BR)GSS}$	−30	—	—	Vdc
Gate Reverse Current		I_{GSS}				nAdc
($V_{GS} = -15$ Vdc, $V_{DS} = 0$)			—	—	−0.1	
($V_{GS} = -15$ Vdc, $V_{DS} = 0$, $T_A = 150°C$)			—	—	−100	
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
($I_D = 0.1$ nAdc, $V_{DS} = 15$ Vdc)	2N4220,A		—	—	−4	
	2N4221,A		—	—	−6	
	2N4222,A		—	—	−8	
Gate Source Voltage		V_{GS}				Vdc
($I_D = 50\ \mu Adc$, $V_{DS} = 15$ Vdc)	2N4220,A		−0.5	—	−2.5	
($I_D = 200\ \mu Adc$, $V_{DS} = 15$ Vdc)	2N4221,A		−1.0	—	−5.0	
($I_D = 500\ \mu Adc$, $V_{DS} = 15$ Vdc)	2N4222,A		−2.0	—	−6.0	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current*		I_{DSS}				mAdc
($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	2N4220,A		0.5	—	3.0	
	2N4221,A		2.0	—	6.0	
	2N4222,A		5.0	—	15	
Static Drain-Source On Resistance		$r_{DS(on)}$				Ohms
($V_{DS} = 0$, $V_{GS} = 0$)	2N4220,A		—	500	—	
	2N4221,A		—	400	—	
	2N4222,A		—	300	—	
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance Common Source*		$\|y_{fs}\|$				µmhos
($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	2N4220,A		1000	—	4000	
	2N4221,A		2000	—	5000	
	2N4222,A		2500	—	6000	
Output Admittance Common Source		$\|y_{os}\|$				µmhos
($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	2N4220,A		—	—	10	
	2N4221,A		—	—	20	
	2N4222,A		—	—	40	
Input Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	4.5	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{rss}	—	1.2	2.0	pF
Common-Source Output Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 30 MHz)		C_{osp}	—	1.5	—	pF

*Pulse Test: Pulse Width = 630 ms, Duty Cycle = 10%.

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

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Noise Figure	NF				dB
(V_{DS} = 15 Vdc, V_{GS} = 0, R_S = 1.0 megohm, 2N4220A		—	—	2.5	
f = 100 Hz) 2N4221A		—	—	2.5	
2N4222A		—	—	2.5	

FIGURE 1 — NOISE FIGURE versus FREQUENCY

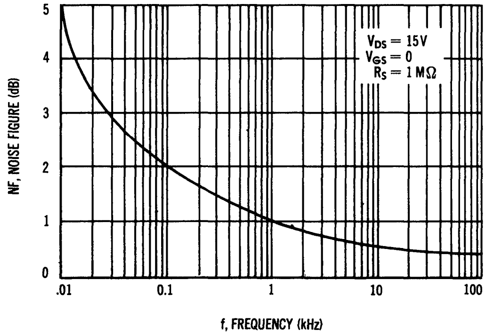


FIGURE 2 — NOISE FIGURE versus SOURCE RESISTANCE

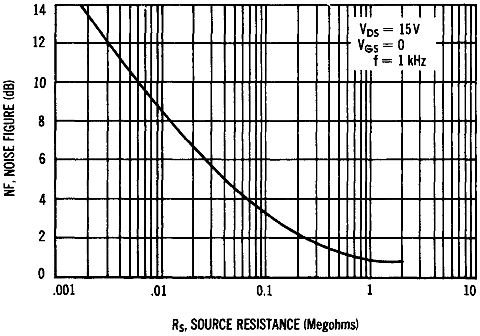


FIGURE 3 — TYPICAL DRAIN CHARACTERISTICS
$V_{GS(off)} \cong -1.2$ VOLTS

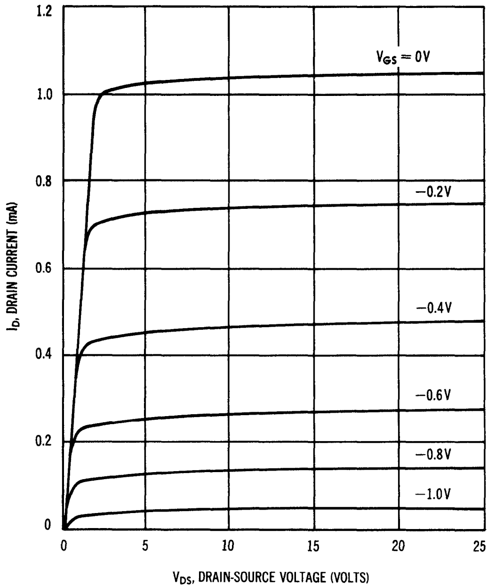


FIGURE 4 — COMMON SOURCE TRANSFER CHARACTERISTICS
$V_{GS(off)} \cong -1.2$ VOLTS

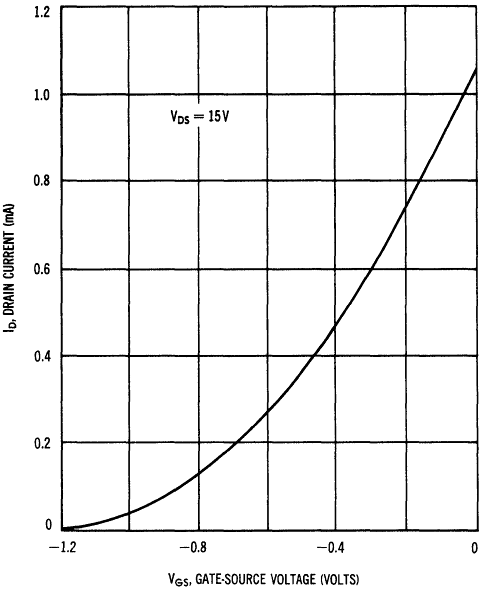


FIGURE 5 — TYPICAL DRAIN CHARACTERISTICS
$V_{GS(off)} \cong -3.5$ VOLTS

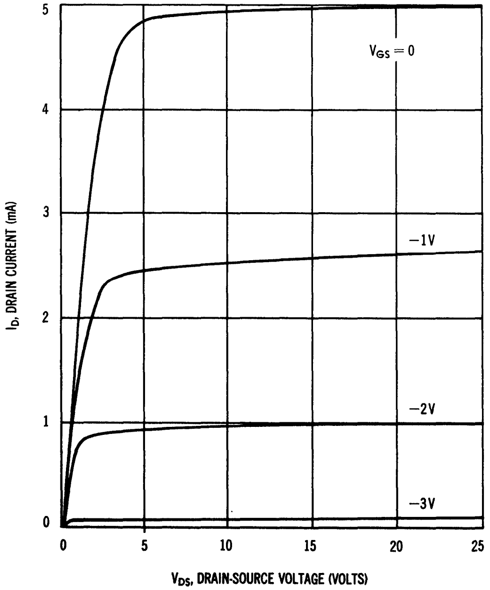


FIGURE 6 — COMMON SOURCE TRANSFER CHARACTERISTICS
$V_{GS(off)} \cong -3.5$ VOLTS

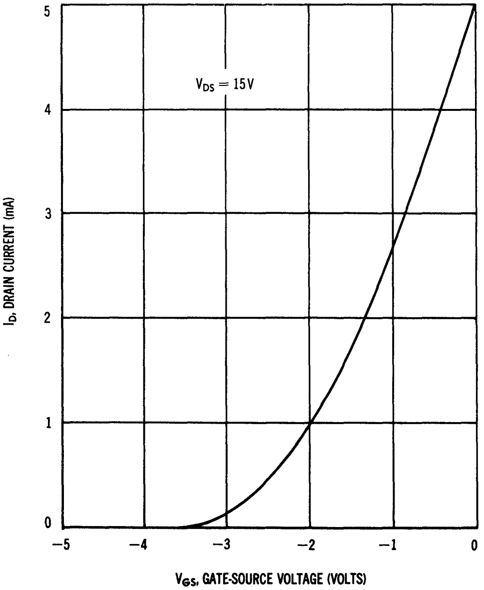


FIGURE 7 — TYPICAL DRAIN CHARACTERISTICS
$V_{GS(off)} \cong -5.8$ VOLTS

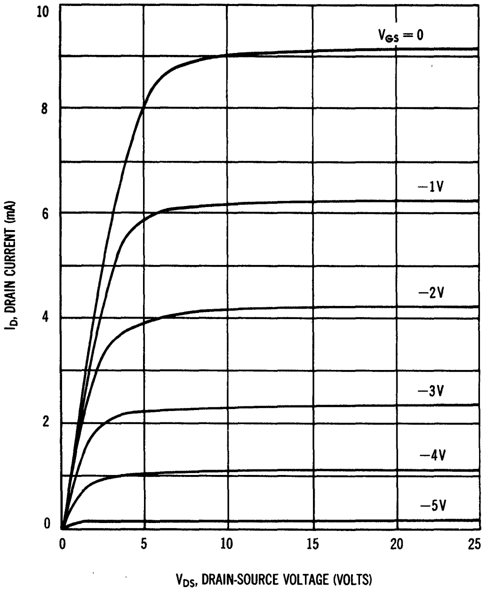
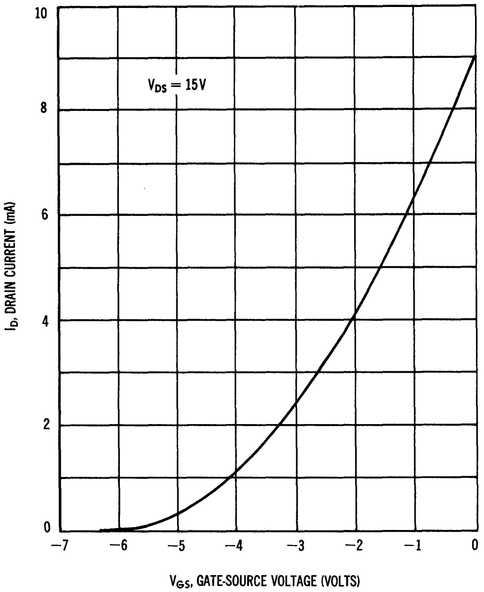


FIGURE 8 — COMMON SOURCE TRANSFER CHARACTERISTICS
$V_{GS(off)} \cong -5.8$ VOLTS

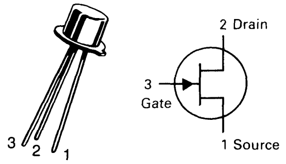


NOTES:

1. Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%). Under dc conditions, self heating in higher I_{DSS} units reduces I_{DSS} (See Figure 10).
2. Figures 8, 9, 10: Data taken in a standard printed circuit with a TO-18 type socket mounting and 1/4" lead length.

2N4338
thru
2N4341

CASE 22-03, STYLE 3
TO-18 (TO-206AA)



JFETs
LOW FREQUENCY, LOW NOISE

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	50	Vdc
Drain-Gate Voltage	V_{DG}	50	Vdc
Gate-Source Voltage	V_{GS}	50	Vdc
Reverse Gate-Source Voltage	V_{GSR}	50	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

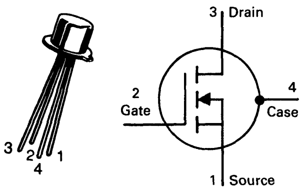
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu A$)		$V_{(BR)GSS}$	50	—	Vdc
Gate Reverse Current ($V_{GS} = -30$ V)		I_{GSS}	—	0.1	nA
Gate Source Cutoff Voltage ($V_{DS} = 15$ V, $I_D = 0.1\ \mu A$)	2N4338	$V_{GS(off)}$	−0.3	−1.0	Vdc
	2N4339		−0.6	−1.8	
	2N4340		−1.0	−3.0	
	2N4341		−2.0	−6.0	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 15$ V)	2N4338	I_{DSS}*	0.2	0.6	mA
	2N4339		0.5	1.5	
	2N4340		1.2	3.6	
	2N4341		3.0	9.0	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 15$ V, f = 1.0 kHz)	2N4338	$\|y_{fs}\|$*	600	1800	μmhos
	2N4339		800	2400	
	2N4340		1300	3000	
	2N4341		2000	4000	
Output Admittance ($V_{DS} = 15$ V, f = 1.0 kHz)	2N4338	$\|y_{os}\|$	—	5.0	μmhos
	2N4339		—	15	
	2N4340		—	30	
	2N4341		—	60	
Input Capacitance ($V_{DS} = 15$ V, f = 1.0 MHz)		C_{iss}	—	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ V, f = 1.0 MHz)		C_{rss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 15$ Volts, f = 1.0 kHz, $R_G = 1.0\ M\Omega$)		NF	—	1.0	dB

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

2N4351

CASE 20-03, STYLE 2
TO-72 (TO-206AF)



MOSFET SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

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

*Transient potentials of ±75 Volt will not cause gate-oxide failure.

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage ($I_D = 10\ \mu A$, $V_{GS} = 0$)	$V_{(BR)DSX}$	25	—	Vdc
Zero-Gate-Voltage Drain Current ($V_{DS} = 10$ V, $V_{GS} = 0$) $T_A = 25°C$ $T_A = 150°C$	I_{DSS}	 — —	 10 10	 nAdc μAdc
Gate Reverse Current ($V_{GS} = \pm 15$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	±10	pAdc
ON CHARACTERISTICS				
Gate Threshold Voltage ($V_{DS} = 10$ V, $I_D = 10\ \mu A$)	$V_{GS(Th)}$	1.0	5	Vdc
Drain-Source On-Voltage ($I_D = 2.0$ mA, $V_{GS} = 10$ V)	$V_{DS(on)}$	—	1.0	V
On-State Drain Current ($V_{GS} = 10$ V, $V_{DS} = 10$ V)	$I_{D(on)}$	3.0	—	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = 10$ V, $I_D = 2.0$ mA, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	1000	—	μmho
Input Capacitance ($V_{DS} = 10$ V, $V_{GS} = 0$, f = 140 kHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 0$, f = 140 kHz)	C_{rss}	—	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)} = 10$ V, f = 140 kHz)	$C_{d(sub)}$	—	5.0	pF
Drain-Source Resistance ($V_{GS} = 10$ V, $I_D = 0$, f = 1.0 kHz)	$r_{ds(on}$	—	300	ohms

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn-On Delay (Fig. 5)	$I_D = 2.0$ mAdc, $V_{DS} = 10$ Vdc, $V_{GS} = 10$ Vdc) (See Figure 9; Times Circuit Determined)	t_{d1}	—	45	ns
Rise Time (Fig. 6)		t_r	—	65	ns
Turn-Off Delay (Fig. 7)		t_{d2}	—	60	ns
Fall Time (Fig. 8)		t_f	—	100	ns

FIGURE 1 — FORWARD TRANSFER ADMITTANCE

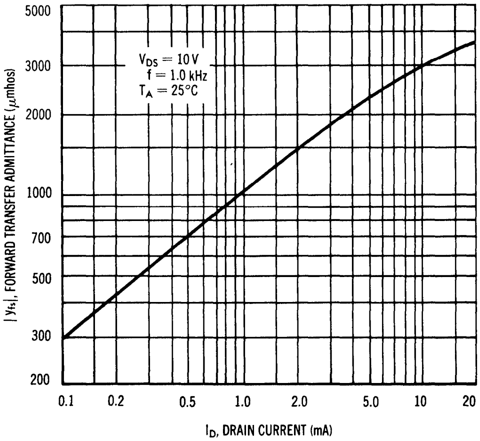


FIGURE 2 — TRANSFER CHARACTERISTICS

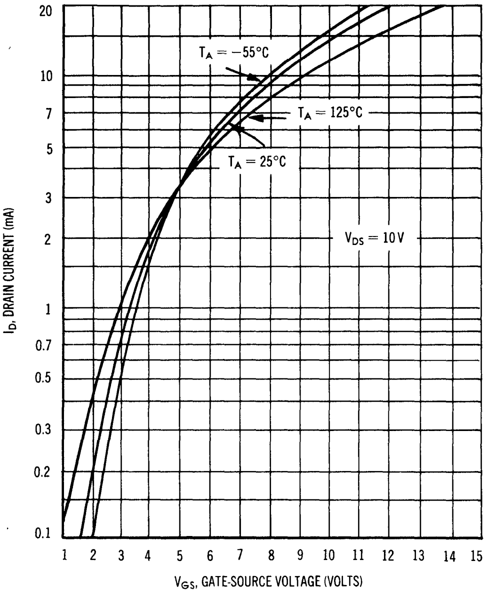


FIGURE 3 — DRAIN-SOURCE "ON" RESISTANCE

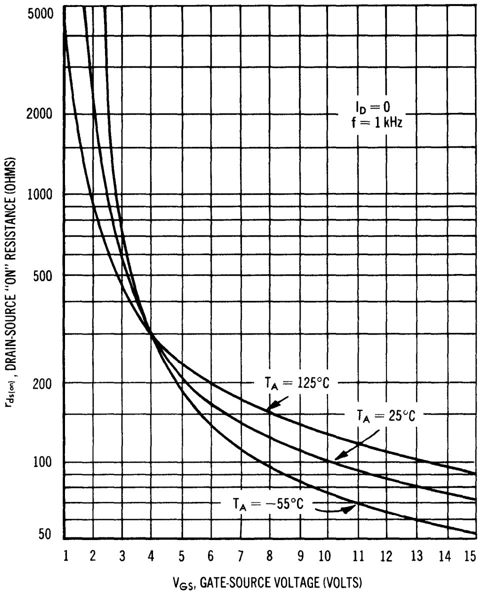
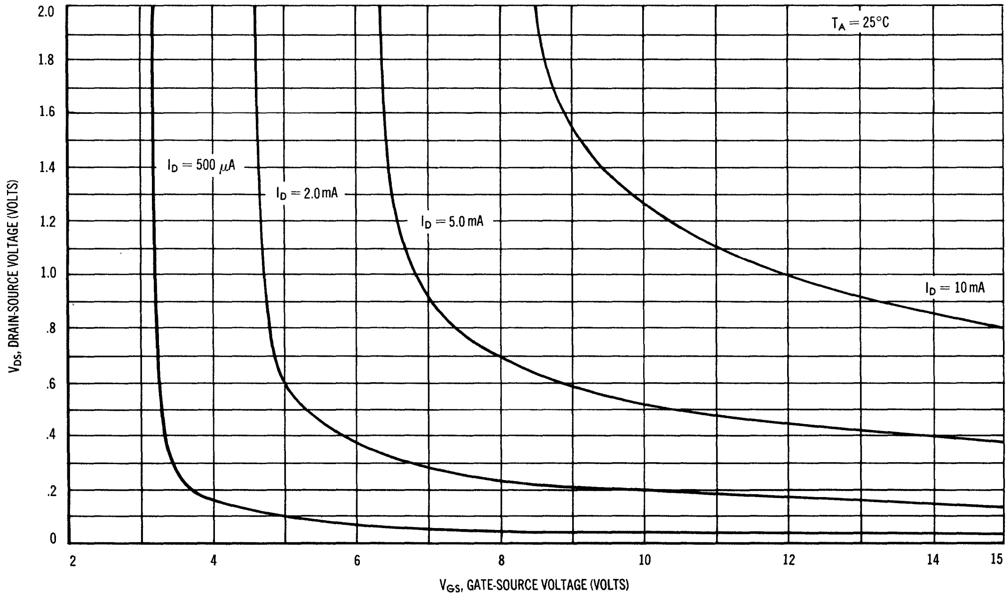


FIGURE 4 — "ON" DRAIN-SOURCE VOLTAGE



SWITCHING CHARACTERISTICS

($T_A = 25°C$)

FIGURE 5 — TURN-ON DELAY TIME

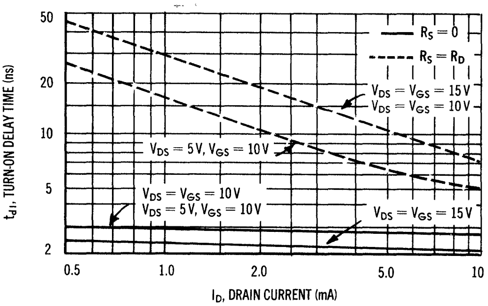


FIGURE 6 — RISE TIME

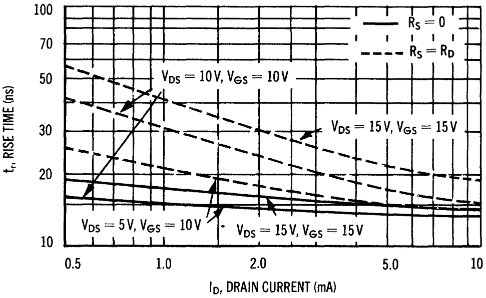


FIGURE 7 — TURN-OFF DELAY TIME

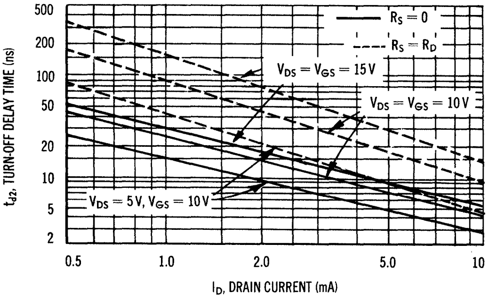


FIGURE 8 — FALL TIME

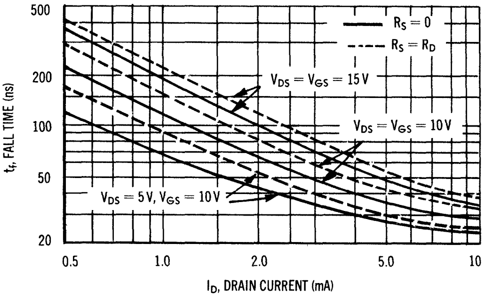
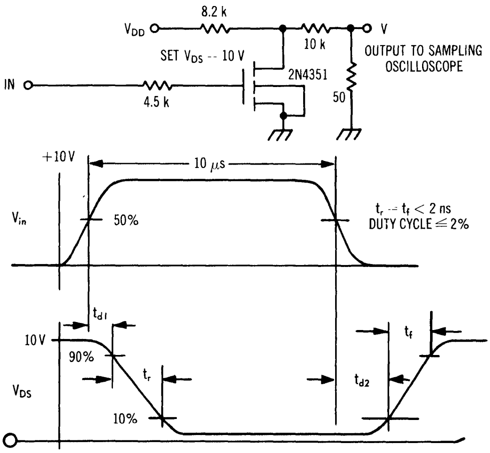


FIGURE 9 — SWITCHING CIRCUIT and WAVEFORMS



The switching characteristics shown above were measured in a test circuit similar to Figure 10. At the beginning of the switching interval, the gate voltage is at ground and the gate-source capacitance ($C_{gs} = C_{iss} - C_{rss}$) has no charge. The drain voltage is at V_{DD}, and thus the feedback capacitance (C_{rss}) is charged to V_{DD}. Similarly, the drain-substrate capacitance ($C_{d(sub)}$) is charged to V_{DD} since the substrate and source are connected to ground.

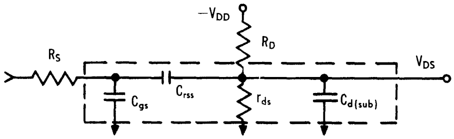
During the turn-on interval, C_{gs} is charged to V_{GS} (the input voltage) through R_S (generator impedance). C_{rss} must be discharged to $V_{GS} - V_{D(on)}$ through R_S and the parallel combination of the load resistor (R_D) and the channel resistance (r_{ds}). In addition, $C_{d(sub)}$ is discharged to a low value ($V_{D(on)}$) through R_D in parallel with r_{ds}. During turn-off this charge flow is reversed.

Predicting turn-on time proves to be somewhat difficult since the channel resistance (r_{ds}) is a function of the gate-source voltage (V_{GS}). As C_{gs} becomes charged, V_{GS} is approaching V_{in} and r_{ds} decreases (see Figure 4) and since C_{rss} and $C_{d(sub)}$ are charged through r_{ds}, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and $C_{d(sub)}$, then r_{ds} (which is in parallel with R_D) will be low compared to R_D during the switching interval and will largely determine the turn-on time. On the other hand, during turn-off r_{ds} will be almost an open circuit requiring C_{rss} and $C_{d(sub)}$ to be charged through R_D and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where $R_S = 0$ and C_{gs} is charged through the pulse generator impedance only.

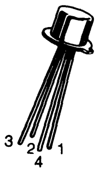
The switching curves shown with $R_S = R_D$ simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with $R_S = 0$ simulates a low source impedance drive such as might occur in complementary logic circuits.

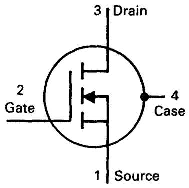
FIGURE 10 — SWITCHING CIRCUIT MOSFET EQUIVALENT MODEL



2N4352

CASE 20-03, STYLE 2
TO-72 (TO-206AF)





MOSFET SWITCHING

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

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

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage ($I_D = -10\ \mu A$, $V_{GS} = 0$)	$V_{(BR)DSX}$	−25	—	Vdc
Zero-Gate-Voltage Drain Current ($V_{DS} = -10$ V, $V_{GS} = 0$) $T_A = 25°C$ $T_A = 150°C$	I_{DSS}	— —	−10 −10	nAdc μAdc
Gate Reverse Current ($V_{GS} = \pm 30$ V, $V_{DS} = 0$)	I_{GSS}	—	±10	pAdc
ON CHARACTERISTICS				
Gate Threshold Voltage ($V_{DS} = -10$ V, $I_D = -10\ \mu A$)	$V_{GS(Th)}$	−1.0	−5.0	Vdc
Drain-Source On-Voltage ($I_D = -2.0$ mA, $V_{GS} = -10$ V)	$V_{DS(on)}$	—	−1.0	V
On-State Drain Current ($V_{GS} = -10$ $V_{DS} = -10$ V)	$I_{D(on)}$	−3.0	—	mA
SMALL-SIGNAL CHARACTERISTICS				
Drain-Source Resistance ($V_{GS} = -10$ V, $I_D = 0$, f = 1.0 kHz)	$r_{ds(on)}$	—	600	ohms
Forward Transfer Admittance ($V_{DS} = -10$ V, $I_D = 2.0$ mA, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	1000	—	μmho
Input Capacitance ($V_{DS} = -10$ V, $V_{GS} = 0$, f = 140 kHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 0$, f = 140 kHz)	C_{rss}	—	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)} = -10$ V, f = 140 kHz)	$C_{d(sub)}$	—	4.0	pF

SWITCHING CHARACTERISTICS

Turn-On Delay (Figures 5)	$I_D = -2.0$ mAdc, $V_{DS} = -10$ Vdc, $V_{GS} = -10$ V) (See Figure 9, Times Circuit Determined)	t_{d1}	—	45	ns
Rise Time (Figures 6)		t_r	—	65	ns
Turn-Off Delay (Figures 7)		t_{d2}	—	60	ns
Fall Time (Figures 8)		t_f	—	100	ns

FIGURE 1 — FOWARD TRANSFER ADMITTANCE

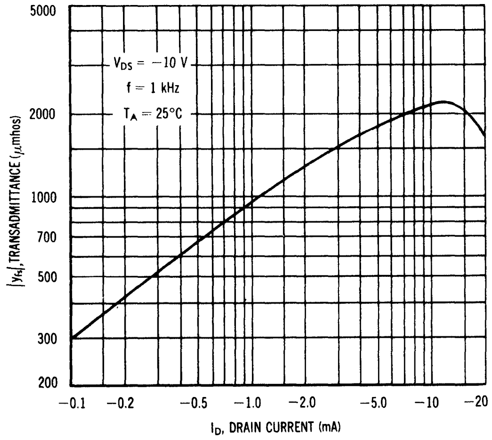


FIGURE 2 — TRANSFER CHARACTERISTICS

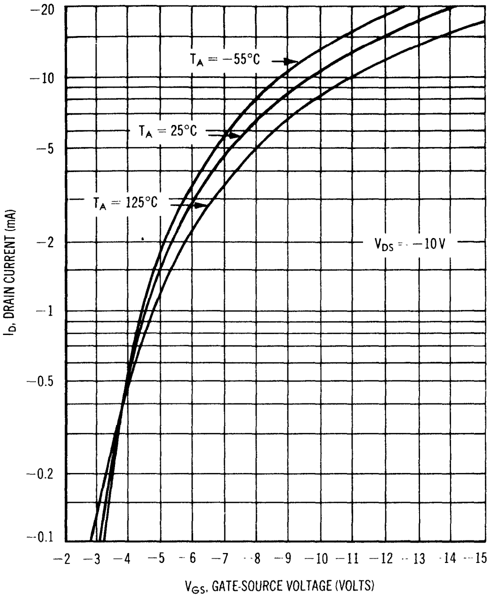


FIGURE 3 — DRAIN-SOURCE "ON" RESISTANCE

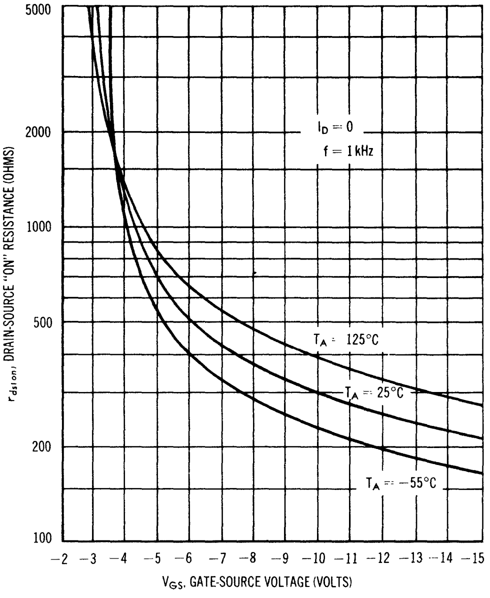
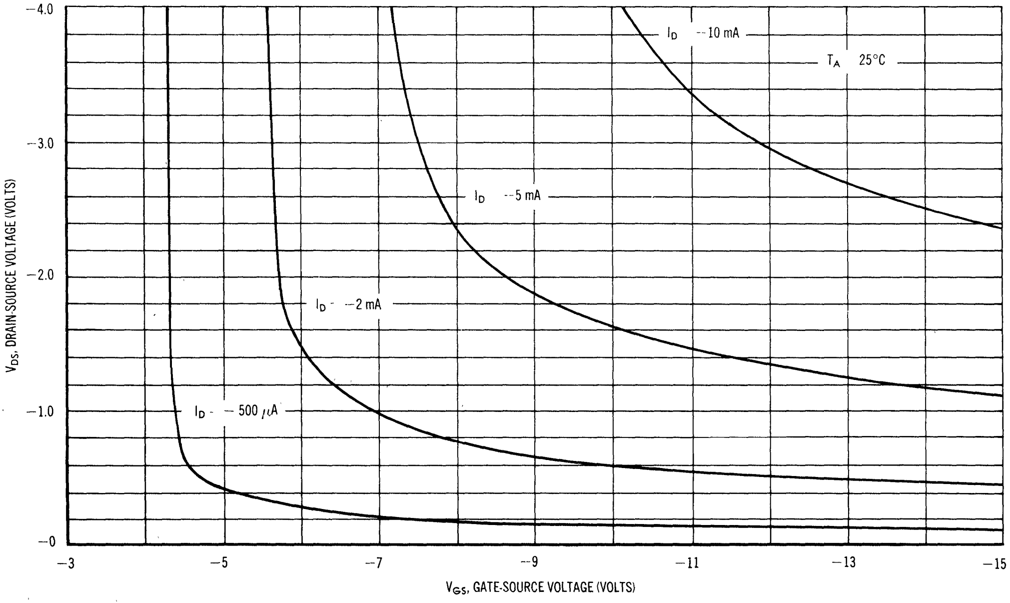


FIGURE 4 — "ON" DRAIN-SOURCE VOLTAGE



SWITCHING CHARACTERISTICS

(T_A = 25°C)

FIGURE 5 — TURN-ON DELAY TIME

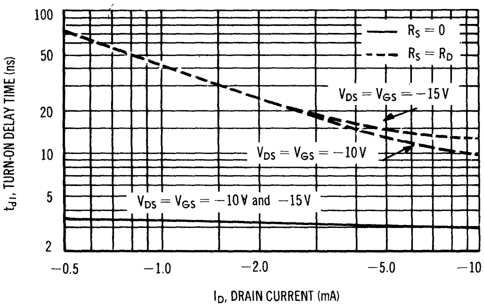


FIGURE 6 — RISE TIME

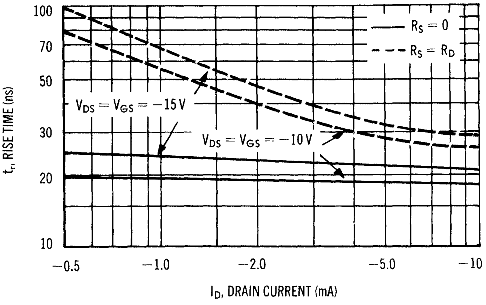


FIGURE 7 — TURN-OFF DELAY TIME

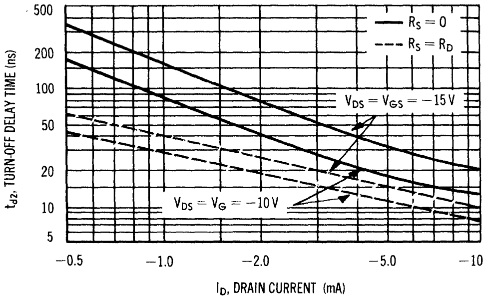


FIGURE 8 — FALL TIME

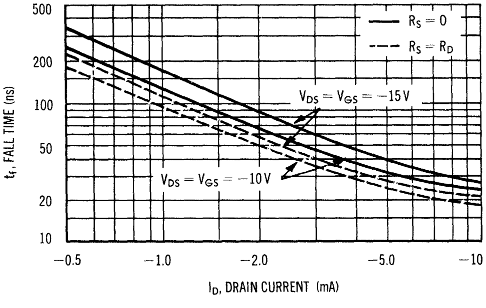
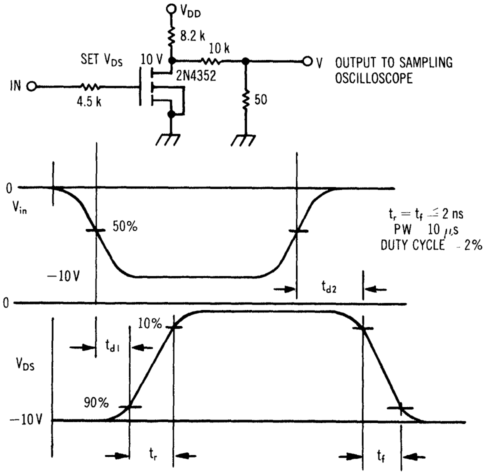


FIGURE 9 — SWITCHING CIRCUIT and WAVEFORMS



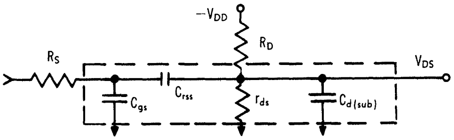
The switching characteristics shown above were measured in a test circuit similar to Figure 10. At the beginning of the switching interval, the gate voltage is at ground and the gate-source capacitance ($C_{gs} = C_{iss} - C_{rss}$) has no charge. The drain voltage is at V_{DD}, and thus the feedback capacitance (C_{rss}) is charged to V_{DD}. Similarly, the drain-substrate capacitance ($C_{d(sub)}$) is charged to V_{DD} since the substrate and source are connected to ground.

During the turn-on interval, C_{gs} is charged to V_{GS} (the input voltage) through R_S (generator impedance) (Figure 11). C_{rss} must be discharged to $V_{GS} - V_{D(on)}$ through R_S and the parallel combination of the load resistor (R_D) and the channel resistance (r_{ds}) is a function of the gate-source voltage (V_{GS}). As C_{gs} becomes charged V_{GS} is approaching V_{in} and r_{ds} decreases (see Figure 4) and since C_{rss} and $C_{d(sub)}$ are charged through r_{ds}, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and $C_{d(sub)}$, then r_{ds} (which is in parallel with R_D) will be low compared to R_D during the switching interval and will largely determine the turn-on time. On the other hand, during turn-off r_{ds} will be almost an open circuit requiring C_{rss} and $C_{d(sub)}$ to be charged through R_D and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where $R_S = 0$ and C_{gs} is charged through the pulse generator impedance only.

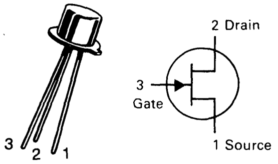
The switching curves shown with $R_S = R_D$ simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with $R_S = 0$ simulates a low source impedance drive such as might occur in complementary logic circuits.

FIGURE 10 — SWITCHING CIRCUIT with MOSFET EQUIVALENT MODEL



2N4391
thru
2N4393

CASE 22-03, STYLE 3
TO-18 (TO-206AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

Refer to MPF4391 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	40	Vdc
Drain-Gate Voltage	V_{DG}	40	Vdc
Gate-Source Voltage	V_{GS}	40	Vdc
Forward Gate Current	I_{GF}	50	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10	Watts mW/°C
Operating Junction Temperature Range	T_J	−65 to +175	°C
Storage Temperature Range	T_{stg}	−65 to +175	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	40	—	Vdc
Gate Reverse Current		I_{GSS}			nAdc
(V_{GS} = 20 Vdc, V_{DS} = 0)			—	0.1	
(V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 150°C)			—	0.2	μAdc
Gate Source Voltage		V_{GS}			Vdc
(V_{DS} = 20 Vdc, I_D = 1.0 nAdc)	2N4391		−4.0	−10	
	2N4392		−2.0	−5.0	
	2N4393		−0.5	−3.0	
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)		$V_{GS(f)}$	—	1.0	Vdc
Drain-Cutoff Current		$I_{D(off)}$			nAdc
(V_{DS} = 20 Vdc, V_{GS} = 12 Vdc)	2N4391		—	0.1	
(V_{DS} = 20 Vdc, V_{GS} = 7.0 Vdc)	2N4392		—	0.1	
(V_{DS} = 20 Vdc, V_{GS} = 5.0 Vdc)	2N4393		—	0.1	
(V_{DS} = 20 Vdc, V_{GS} = 12 Vdc, T_A = 150°C)	2N4391		—	0.2	μAdc
(V_{DS} = 20 Vdc, V_{GS} = 7.0 Vdc, T_A = 150°C)	2N4392		—	0.2	
(V_{DS} = 20 Vdc, V_{GS} = 5.0 Vdc, T_A = 150°C)	2N4393		—	0.2	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1)		I_{DSS}			mAdc
(V_{DS} = 20 Vdc, V_{GS} = 0)	2N4391		50	150	
	2N4392		25	75	
	2N4393		5.0	30	
Drain-Source On-Voltage		$V_{DS(on)}$			Vdc
(I_D = 12 mAdc, V_{GS} = 0)	2N4391		—	0.4	
(I_D = 6.0 mAdc, V_{GS} = 0)	2N4392		—	0.4	
(I_D = 3.0 mAdc, V_{GS} = 0)	2N4393		—	0.4	
Static Drain-Source On Resistance		$r_{DS(on)}$			Ohms
(I_D = 1.0 mAdc, V_{GS} = 0)	2N4391		—	30	
	2N4392		—	60	
	2N4393		—	100	
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N4391		—	30	
	2N4392		—	60	
	2N4393		—	100	

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

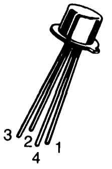
Characteristic		Symbol	Min	Max	Unit
Input Capacitance (V_{DS} = 20 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	14	pF
Reverse Transfer Capacitance		C_{rss}			pF
(V_{DS} = 0, V_{GS} = 12 Vdc, f = 1.0 MHz)	2N4391		—	3.5	
(V_{DS} = 0, V_{GS} = 7.0 Vdc, f = 1.0 MHz)	2N4392		—	3.5	
(V_{DS} = 0, V_{GS} = 5.0 Vdc, f = 1.0 MHz)	2N4393		—	3.5	
SWITCHING CHARACTERISTICS					
Rise Time		t_r			ns
($I_{D(on)}$ = 12 mAdc)	2N4391		—	5.0	
($I_{D(on)}$ = 6.0 mAdc)	2N4392		—	5.0	
($I_{D(on)}$ = 3.0 mAdc)	2N4393		—	5.0	
Fall Time		t_f			ns
($V_{GS(off)}$ = 12 Vdc)	2N4391		—	15	
($V_{GS(off)}$ = 7.0 Vdc)	2N4392		—	20	
($V_{GS(off)}$ = 5.0 Vdc)	2N4393		—	30	
Turn-On Time		t_{on}			ns
($I_{D(on)}$ = 12 mAdc)	2N4391		—	15	
($I_{D(on)}$ = 6.0 mAdc)	2N4392		—	15	
($I_{D(on)}$ = 3.0 mAdc)	2N4393		—	15	
Turn-Off Time		t_{off}			ns
($V_{GS(off)}$ = 12 Vdc)	2N4391		—	20	
($V_{GS(off)}$ = 7.0 Vdc)	2N4392		—	35	
($V_{GS(off)}$ = 5.0 Vdc)	2N4393		—	50	

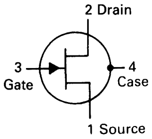
(1) Pulse Test: Pulse Width ≤ 100 μs, Duty Cycle ≤ 1.0%.

*In addition to JEDEC Registered Data.

2N4416, A

CASE 20-03, STYLE 1
TO-72 (TO-206AF)





JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

2N4416, A
JAN JTX JTXV AVAILABLE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage 2N4416 2N4416A	V_{DG}	30 35	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage	$V_{(BR)GSS}$			Vdc
(I_G = 1.0 μAdc, V_{DS} = 0) 2N4416		30	—	
2N4416A		35	—	
Gate Reverse Current	I_{GSS}			pAdc
(V_{GS} = 20 Vdc, V_{DS} = 0)		—	100	
(V_{GS} = 20 Vdc, V_{DS} = 0, T_A = +150°C)		—	200	
Gate Source Cutoff Voltage (I_D = 1.0 nAdc, V_{DS} = 15 Vdc)	$V_{GS(off)}$	—	6.0	Vdc
Gate Source Voltage (I_D = 0.5 mAdc, V_{DS} = 15 Vdc)	V_{GS}	−1.0	−5.5	Vdc
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)	$V_{GS(f)}$	—	1.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current(1) (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	5.0	15	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance(1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	4500	7500	μmhos
Real Part of Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	$y_{fs(real)}$	4000	—	μmhos
Real Part of Input Admittance	$y_{is(real)}$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		—	100	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)		—	1000	
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	50	μmhos
Real Part of Output Admittance	$y_{os(real)}$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		—	75	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)		—	100	
Imaginary Part of Input Admittance	$y_{is(imag)}$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		—	2500	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)		—	10,000	
Imaginary Part of Output Admittance	$y_{os(imag)}$			μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)		—	1000	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)		—	4000	

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

Characteristic	Symbol	Min	Max	Unit
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	4.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	0.8	pF
Common Source Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure (Figures 3 and 4) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, $R_g \approx$ 1000 Ohms, f = 100 MHz) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, $R_g \approx$ 1000 Ohms, f = 400 MHz)	NF	 — —	 2.0 4.0	dB
Small-Signal Power Gain Common Source (Figure 1) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, f = 100 MHz) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, f = 400 MHz)	G_{ps}	 18 10	 — —	dB

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 1.0%.

POWER GAIN

FIGURE 1 — EFFECTS OF DRAIN CURRENT

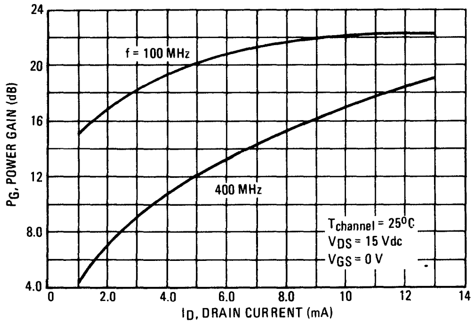
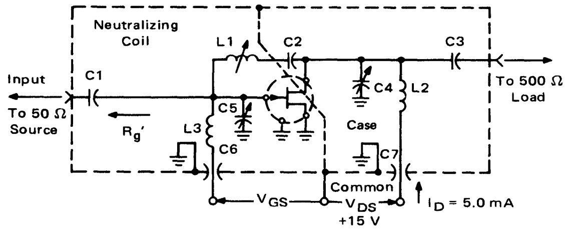


FIGURE 2 — 100 MHz and 400 MHz NEUTRALIZED TEST CIRCUIT



Reference Designation	VALUE	
	100 MHz	400 MHz
C1	7.0 pF	1.8 pF
C2	1000 pF	17 pF
C3	3.0 pF	1.0 pF
C4	1-12 pF	0.8-8.0 pF
C5	1-12 pF	0.8-8.0 pF
C6	0.0015 μF	0.001 μF
C7	0.0015 μF	0.001 μF
L1	3.0 μH*	0.2 μH**
L2	0.15 μH*	0.03 μH**
L3	0.14 μH*	0.022 μH**

Adjust V_{GS} for I_D = 50 mA V_{GS} < 0 Volts

NOTE: The noise source is a hot-cold body (AIL type 70 or equivalent) with a test receiver (AIL type 136 or equivalent).

*L1 17 turns, (approx. — depends upon circuit layout) AWG #28 enameled copper wire, close wound on 9/32" ceramic coil form. Tuning provided by a powdered iron slug.

L2 4-1/2 turns, AWG #18 enameled copper wire, 5/16" long, 3/8" I.D. (AIR CORE).

L3 3-1/2 turns, AWG #18 enameled copper wire, 1/4" long, 3/8" I.D. (AIR CORE).

**L1 6 turns, (approx. — depends upon circuit layout) AWG #24 enameled copper wire, close wound on 7/32" ceramic coil form. Tuning provided by an aluminum slug.

L2 1 turn, AWG #16 enameled copper wire, 3/8" I.D. (AIR CORE).

L3 1/2 turn, AWG #16 enameled copper wire, 1/4" I.D. (AIR CORE).

NOISE FIGURE

($T_{channel} = 25^{\circ}C$)

FIGURE 3 — EFFECTS OF DRAIN-SOURCE VOLTAGE

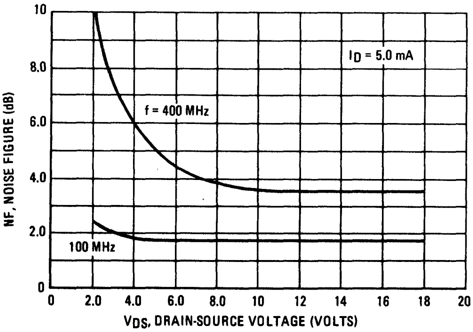
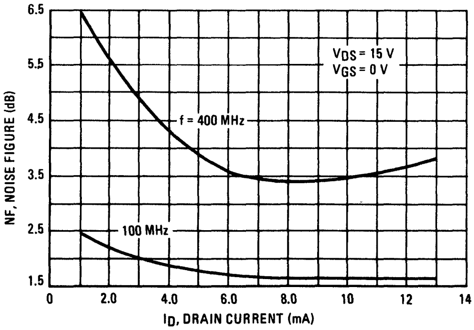
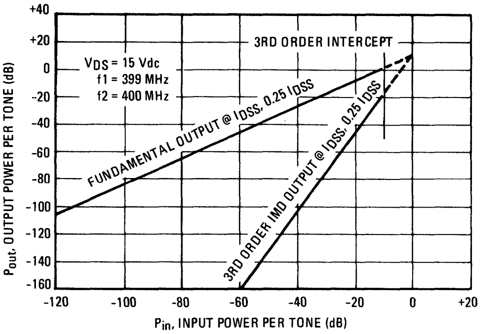


FIGURE 4 — EFFECTS OF DRAIN CURRENT



INTERMODULATION CHARACTERISTICS

FIGURE 5 — THIRD ORDER INTERMODULATION DISTORTION



COMMON SOURCE CHARACTERISTICS

ADMITTANCE PARAMETERS

($V_{DS} = 15$ Vdc, $T_{channel} = 25^{\circ}C$)

FIGURE 6 — INPUT ADMITTANCE (y_{is})

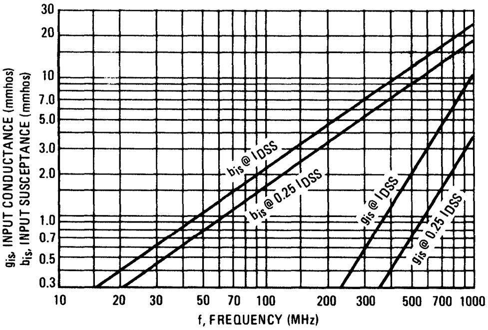


FIGURE 7 — REVERSE TRANSFER ADMITTANCE (y_{rs})

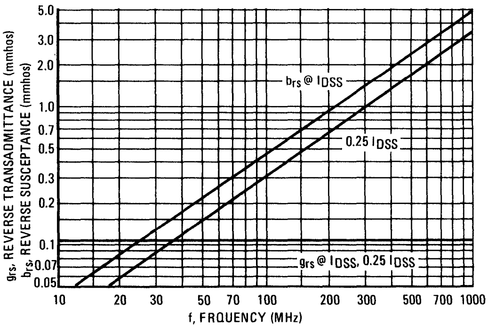


FIGURE 8 — FORWARD TRANSADMITTANCE (y_{fs})

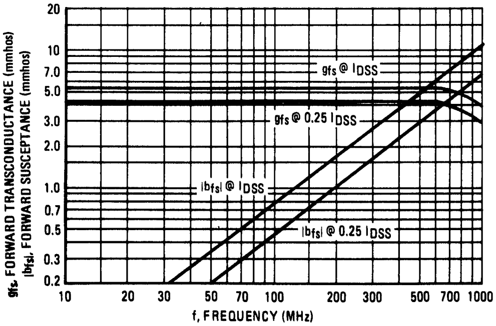
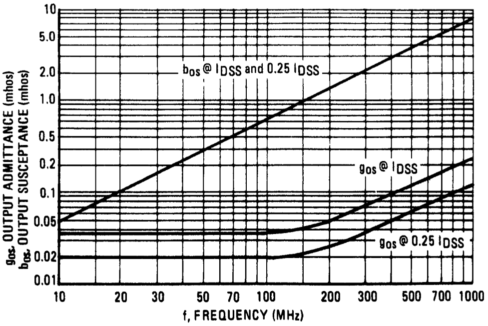


FIGURE 9 — OUTPUT ADMITTANCE (y_{os})



COMMON SOURCE CHARACTERISTICS

S-PARAMETERS

(V_{DS} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

FIGURE 10 — S_{11s}

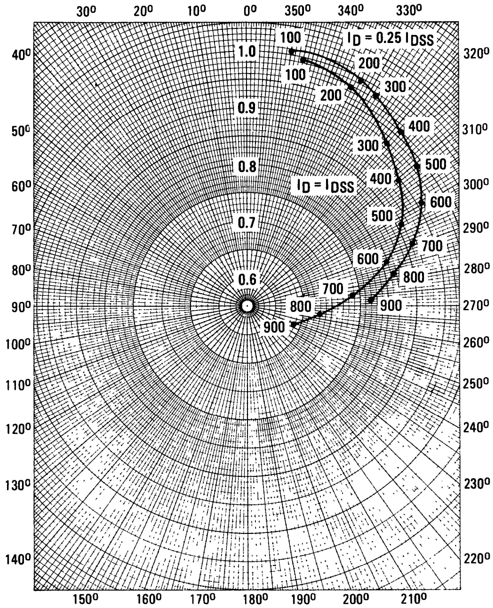


FIGURE 11 — S_{12s}

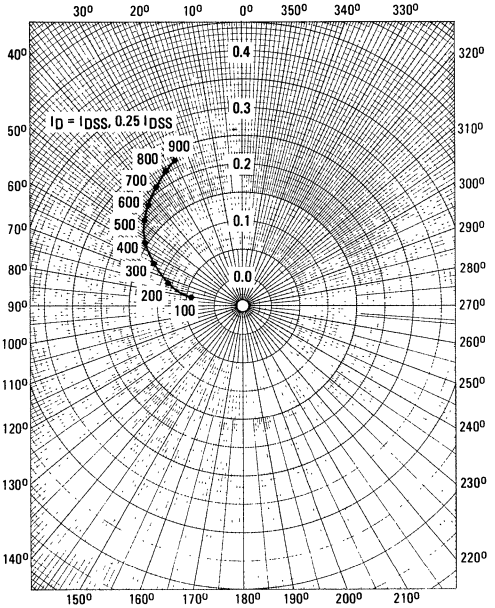


FIGURE 12 – S_{21s}

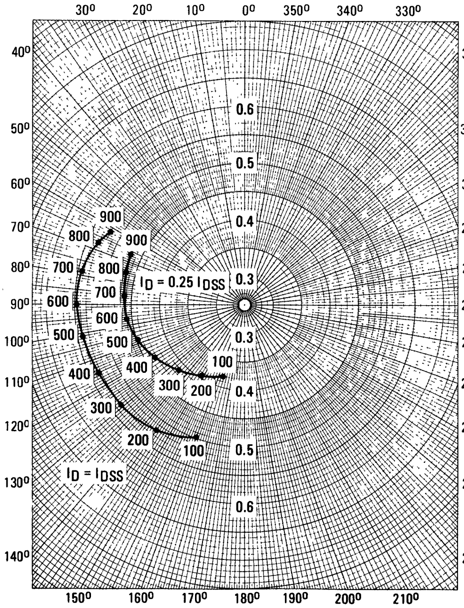
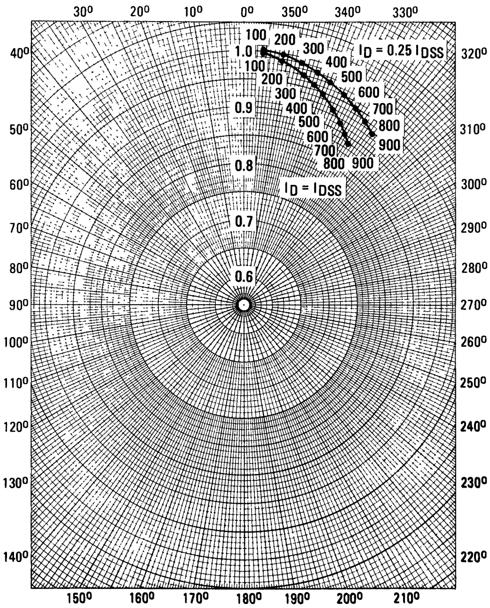


FIGURE 13 – S_{22s}



COMMON GATE CHARACTERISTICS

ADMITTANCE PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C)

FIGURE 14 – INPUT ADMITTANCE (y_{ig})

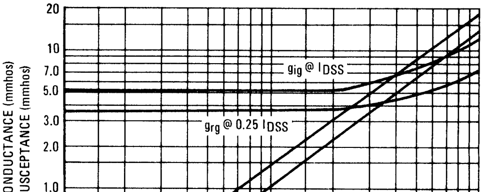


FIGURE 15 – REVERSE TRANSFER ADMITTANCE (y_{rg})

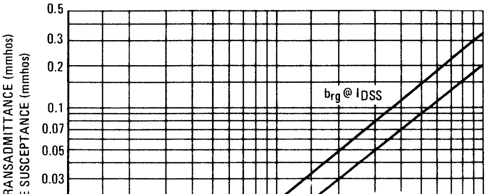


FIGURE 16 — FORWARD TRANSFER ADMITTANCE (y_{fg})

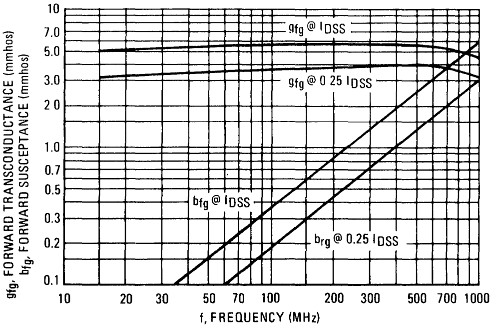
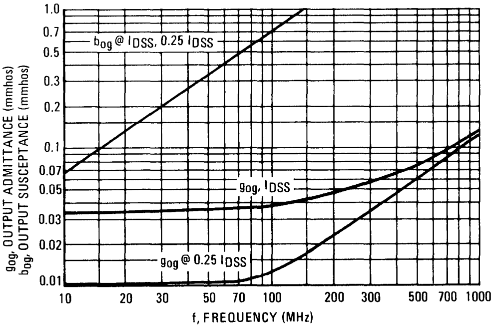


FIGURE 17 — OUTPUT ADMITTANCE (y_{og})



COMMON GATE CHARACTERISTICS

S-PARAMETERS

(V_{DG} = 15 Vdc, $T_{channel}$ = 25°C, Data Points in MHz)

FIGURE 18 — S_{11g}

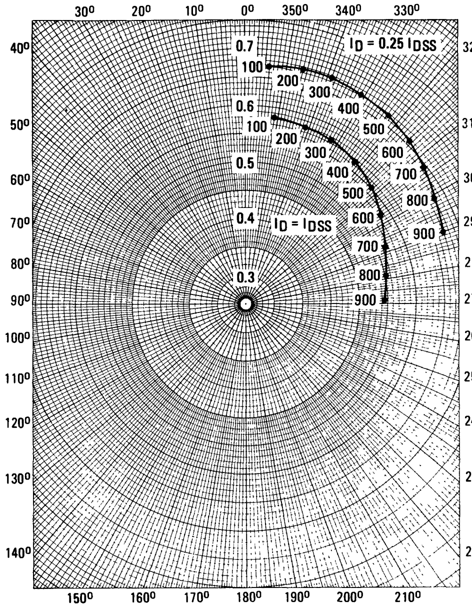


FIGURE 19 — S_{12g}

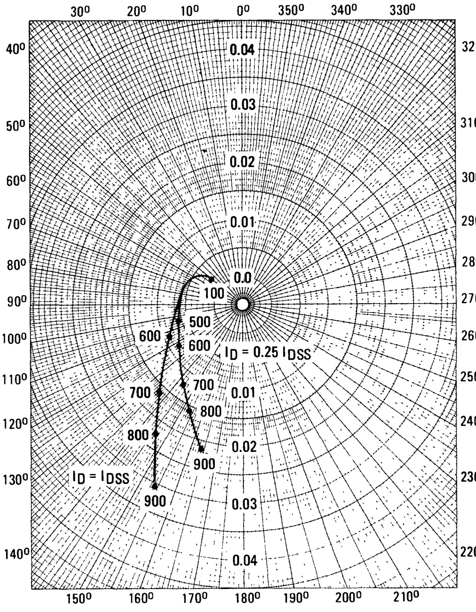


FIGURE 20 — S_{21g}

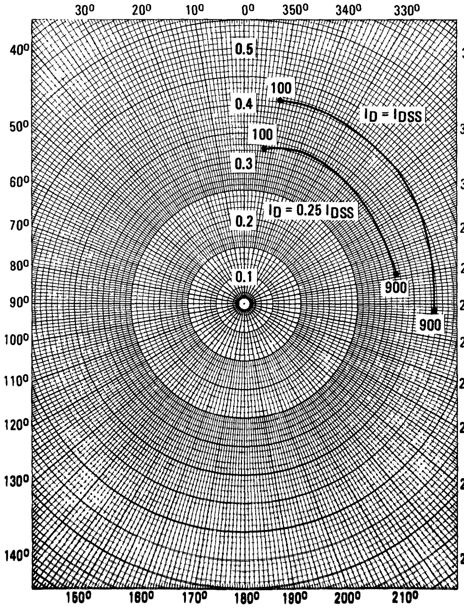
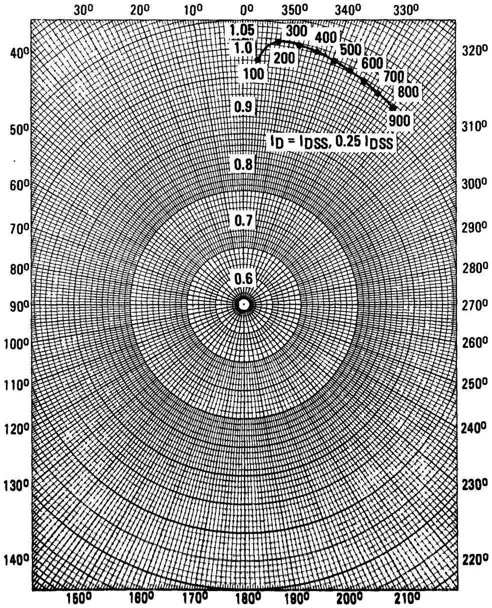


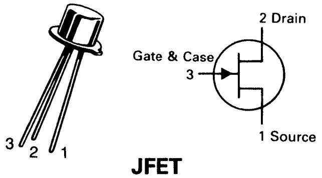
FIGURE 21 — S_{22g}



2N4856, A
thru
2N4861, A

2N4856, 2N4857, 2N4858
JAN, JTX, JTXV AVAILABLE

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	2N4856,A 2N4857,A 2N4858,A	2N4859,A 2N4860,A 2N4861,A	Unit
Drain-Source Voltage	V_{DS}	+40	+30	Vdc
Drain-Gate Voltage	V_{DG}	+40	+30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−40	−30	Vdc
Forward Gate Current	I_{GF}	50		mAdc
Total Device Dissipation	P_D			
@ T_A = 25°C		360		mW
Derate above 25°C		2.4		mW/°C
Storage Temperature Range	T_{stg}	−65 to +175		°C

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

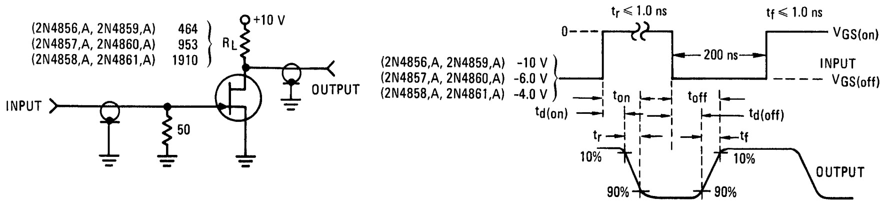
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage		$V_{(BR)GSS}$			Vdc
(I_G = 1.0 μAdc, V_{DS} = 0)	2N4856,A, 2N4857,A, 2N4858,A		−40	—	
	2N4859,A, 2N4860,A, 2N4861,A		−30	—	
Gate Reverse Current		I_{GSS}			
(V_{GS} = −20 Vdc, V_{DS} = 0)	2N4856,A 2N4857,A, 2N4858,A		—	0.25	nAdc
(V_{GS} = −15 Vdc, V_{DS} = 0)	2N4859,A, 2N4860,A, 2N4861,A		—	0.25	
(V_{GS} = −20 Vdc, V_{DS} = 0, T_A = 150°C)	2N4856,A, 2N4857,A, 2N4858,A		—	0.5	μAdc
(V_{GS} = −15 Vdc, V_{DS} = 0, T_A = 150°C)	2N4859,A, 2N4860,A, 2N4861,A		—	0.5	
Gate Source Cutoff Voltage		$V_{GS(off)}$			Vdc
(V_{DS} = 15 Vdc, I_D = 0.5 nAdc)	2N4856,A, 2N4859,A		−4.0	−10	
	2N4857,A, 2N4860,A		−2.0	−6.0	
	2N4858,A, 2N4861,A		−0.8	−4.0	
Drain Cutoff Current		$I_{D(off)}$			
(V_{DS} = 15 Vdc, V_{GS} = −10 Vdc)			—	0.25	nAdc
(V_{DS} = 15 Vdc, V_{GS} = −10 Vdc, T_A = 150°C)			—	0.5	μAdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1)		I_{DSS}			mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	2N4856,A, 2N4859,A		50	—	
	2N4857,A, 2N4860,A		20	100	
	2N4858,A, 2N4861,A		8.0	80	
Drain-Source On-Voltage		$V_{DS(on)}$			Vdc
(I_D = 20 mAdc, V_{GS} = 0)	2N4856,A, 2N4859,A		—	0.75	
(I_D = 10 mAdc, V_{GS} = 0)	2N4857,A, 2N4860,A		—	0.5	
(I_D = 5.0 mAdc, V_{GS} = 0)	2N4858,A, 2N4861,A		—	0.5	
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 0, f = 1.0 kHz)	2N4856,A, 2N4859,A		—	25	
	2N4857,A, 2N4860,A		—	40	
	2N4858,A, 2N4861,A		—	60	
Input Capacitance		C_{iss}			pF
(V_{DS} = 0, V_{GS} = −10 Vdc, f = 1.0 MHz)	2N4856 thru 2N4861		—	18	
	2N4856A thru 2N4861A		—	10	
Reverse Transfer Capacitance		C_{rss}			pF
(V_{DS} = 0, V_{GS} = −10 Vdc, f = 1.0 MHz)	2N4856 thru 2N4861		—	8.0	
	2N4856A, 2N4859A		—	4.0	
	2N4857A, 2N4858A, 2N4860A, 2N4861A		—	3.5	

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

Characteristic			Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS (See Figure 1) (2)						
Turn-On Delay Time	Conditions for 2N4856,A, 2N4859,A:	2N4856, 2N4859	$t_{d(on)}$	—	6.0	ns
		2N4856A, 2N4859A		—	5.0	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 20 mAdc,	2N4857, 2N4860		—	6.0	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −10 Vdc)	2N4857A, 2N4860A		—	6.0	
		2N4858, 2N4861		—	10	
		2N4858A, 2N4861A		—	8.0	
Rise Time	Conditions for 2N4857,A, 2N4860,A:	2N4856,A, 2N4859,A	t_r	—	3.0	ns
		2N4857,A, 2N4860,A		—	4.0	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 10 mAdc,	2N4858, 2N4861		—	10	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −6.0 Vdc)	2N4858A, 2N4861A		—	8.0	
Turn-Off Time		2N4856, 2N4859	t_{off}	—	25	
	Conditions for 2N4858,A, 2N4861,A:	2N4856A, 2N4859A		—	20	ns
		2N4857, 2N4860		—	50	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 5.0 mAdc,	2N4857A, 2N4860A		—	40	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −4.0 Vdc)	2N4858, 2N4861		—	100	
		2N4858A; 2N4861A		—	80	

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.
(2) The $I_{D(on)}$ values are nominal; exact values vary slightly with transistor parameters.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



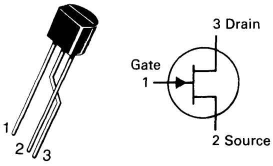
TEST CIRCUIT

VOLTAGE WAVEFORMS

NOTES: a. The input waveforms are supplied by a generator with the following characteristics:
Z_{out} = 50 ohms, Duty Cycle ≈ 2.0%.
b. Waveforms are monitored on an oscilloscope with the following characteristics:
t_r < 0.75 ns, R_{in} > 1.0 megohm, C_{in} < 2.5 pF.

2N5245
thru
2N5247

CASE 29-04, STYLE 23
TO-92 (TO-226AA)



JFET
HIGH FREQUENCY
AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	−30	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C (Free Air)	P_D	360 2.88	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	500 4.0	mW mW/°C
Lead Temperature (1/16″ from Case for 10 Seconds)	T_L	260	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

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

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = −1.0 μA, V_{DS} = 0)		$V_{(BR)GSS}$	−30	—	Vdc
Gate Reverse Current (V_{GS} = −20 V, V_{DS} = 0)		I_{GSS}	—	−1.0	nA
Gate 1 Leakage Current (V_{G1S} = −20 V, V_{DS} = 0, T_A = 100°C)		I_{G1SS}	—	−0.5	μA
Gate Source Cutoff Voltage (V_{DS} = 15 V, I_D = 10 mA)	2N5245 2N5246 2N5247	$V_{GS(off)}$	−1.0 −0.5 −1.5	−6.0 −4.0 −8.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 15 V, V_{GS} = 0, Pulsed: See Note 1)	2N5245 2N5246 2N5247	I_{DSS}	5.0 1.5 8.0	15 7.0 24	mA
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	2N5245 2N5246 2N5247	$\lvert y_{fs} \rvert$	4500 3000 4500	7500 6000 8000	μmhos
Input Admittance (V_{DS} = 15 V, V_{GS} = 0)	(100 MHz) (400 MHz)	$Re(y_{is})$	— —	100 1000	μmhos
Output Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	2N5245 2N5246 2N5247	$\lvert y_{os} \rvert$	— — —	50 50 70	μmhos
Output Conductance (V_{DS} = 15 V, V_{GS} = 0)	2N5245 (100 MHz) 2N5246 2N5247 2N5245 (400 MHz) 2N5246 2N5247	$Re(y_{os})$	— — — — — —	75 75 100 100 100 150	μmhos

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

Characteristic		Symbol	Min	Max	Unit
Forward Transconductance		Re(y_{fs})			μmhos
(V_{DS} = 15 V, V_{GS} = 0, f = 400 MHz)	2N5245		4000	—	
	2N5246		2500	—	
	2N5247		4000	—	
Input Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 Mhz)		C_{iss}	—	4.5	pF
Reverse Transfer Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	—	1.0	pF
Input Susceptance		I_M(Yis)			mmho
(V_{DS} = 15 V, V_{GS} = 0)	(100 MHz)		—	3.0	
	(400 MHz)		—	12.0	

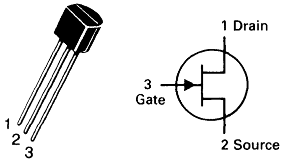
FUNCTIONAL CHARACTERISTICS

Noise Figure		NF			dB
(V_{DS} = 15 V, I_D = 5.0 mA, R'$_G$ = 1.0 kΩ)			—	2.0	
			—	4.0	
Common Source Power Gain		G_{ps}			dB
(V_{DS} = 15 V, I_D = 5.0 mA, R'$_G$ = 1.0 kΩ)	2N5245 (100 MHz)		18	—	
	2N5245 (400 MHz)		10	—	
Output Susceptance		I_M(Yos)			μmho
(V_{DS} = 15 V, V_{GS} = 0)	(100 MHz)		—	1000	
	(400 MHz)		—	4000	

Note 1: tp = 100 ms, Duty Cycle = 10%.

2N5457
thru
2N5459

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
GENERAL PURPOSE

N-CHANNEL — DEPLETION

Refer to 2N4220 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Junction Temperature Range	T_J	125	°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

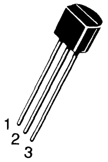
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

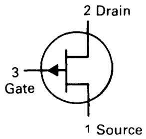
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = −10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	−25	—	—	Vdc
Gate Reverse Current		I_{GSS}				nAdc
(V_{GS} = −15 Vdc, V_{DS} = 0)			—	—	−1.0	
(V_{GS} = −15 Vdc, V_{DS} = 0, T_A = 100°C)			—	—	−200	
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
(V_{DS} = 15 Vdc, I_D = 10 nAdc)	2N5457		−0.5	—	−6.0	
	2N5458		−1.0	—	−7.0	
	2N5459		−2.0	—	−8.0	
Gate Source Voltage		V_{GS}				Vdc
(V_{DS} = 15 Vdc, I_D = 100 μAdc)	2N5457		—	−2.5	—	
(V_{DS} = 15 Vdc, I_D = 200 μAdc)	2N5458		—	−3.5	—	
(V_{DS} = 15 Vdc, I_D = 400 μAdc)	2N5459		—	−4.5	—	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current*		I_{DSS}				mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	2N5457		1.0	3.0	5.0	
	2N5458		2.0	6.0	9.0	
	2N5459		4.0	9.0	16	
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance Common Source*		$\lvert y_{fs} \rvert$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5457		1000	—	5000	
	2N5458		1500	—	5500	
	2N5459		2000	—	6000	
Output Admittance Common Source* (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)		$\lvert y_{os} \rvert$	—	10	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	—	1.5	3.0	pF

*Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

2N5460
thru
2N5465

CASE 29-04, STYLE 7
TO-92 (TO-226AA)





JFET
AMPLIFIERS

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	2N5460 2N5461 2N5462	2N5463 2N5464 2N5465	Unit
Drain-Gate Voltage	V_{DG}	40	60	Vdc
Reverse Gate-Source Voltage	V_{GSR}	40	60	Vdc
Forward Gate Current	$I_{G(f)}$	10		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82		mW mW/°C
Junction Temperature Range	T_J	−65 to +135		°C
Storage Channel Temperature Range	T_{stg}	−65 to +150		°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage		$V_{(BR)GSS}$				Vdc
(I_G = 10 μAdc, V_{DS} = 0)	2N5460, 2N5461, 2N5462		40	—	—	
	2N5463, 2N5464, 2N5465		60	—	—	
Gate Reverse Current		I_{GSS}				
(V_{GS} = 20 Vdc, V_{DS} = 0)	2N5460, 2N5461, 2N5462		—	—	5.0	nAdc
(V_{GS} = 30 Vdc, V_{DS} = 0)	2N5463, 2N5464, 2N5465		—	—	5.0	
(V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 100°C)	2N5460, 2N5461, 2N5462		—	—	1.0	μAdc
(V_{GS} = 30 Vdc, V_{DS} = 0, T_A = 100°C)	2N5463, 2N5464, 2N5465		—	—	1.0	
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
(V_{DS} = 15 Vdc, I_D = 1.0 μAdc)	2N5460, 2N5463		0.75	—	6.0	
	2N5461, 2N5464		1.0	—	7.5	
	2N5462, 2N5465		1.8	—	9.0	
Gate Source Voltage		V_{GS}				Vdc
(V_{DS} = 15 Vdc, I_D = 0.1 mAdc)	2N5460, 2N5463		0.5	—	4.0	
(V_{DS} = 15 Vdc, I_D = 0.2 mAdc)	2N5461, 2N5464		0.8	—	4.5	
(V_{DS} = 15 Vdc, I_D = 0.4 mAdc)	2N5462, 2N5465		1.5	—	6.0	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current		I_{DSS}				mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0,	2N5460, 2N5463		−1.0	—	−5.0	
f = 1.0 kHz)	2N5461, 2N5464		−2.0	—	−9.0	
	2N5462, 2N5465		−4.0	—	−16	
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance		$\lvert y_{fs} \rvert$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5460, 2N5463		1000	—	4000	
	2N5461, 2N5464		1500	—	5000	
	2N5462, 2N5465		2000	—	6000	
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)		$\lvert y_{os} \rvert$	—	—	75	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	5.0	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	—	1.0	2.0	pF
FUNCTIONAL CHARACTERISTICS						
Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0, R_G = 1.0 Megohm, f = 100 Hz, BW = 1.0 Hz)		NF	—	1.0	2.5	dB
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 Hz, BW = 1.0 Hz)		e_n	—	60	115	$\mathrm{nV}/\sqrt{\mathrm{Hz}}$

DRAIN CURRENT versus GATE SOURCE VOLTAGE

FIGURE 1 — $V_{GS(off)}$ = 2.0 VOLTS

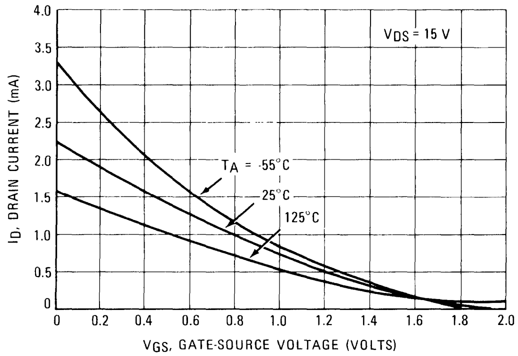


FIGURE 2 — $V_{GS(off)}$ = 4.0 VOLTS

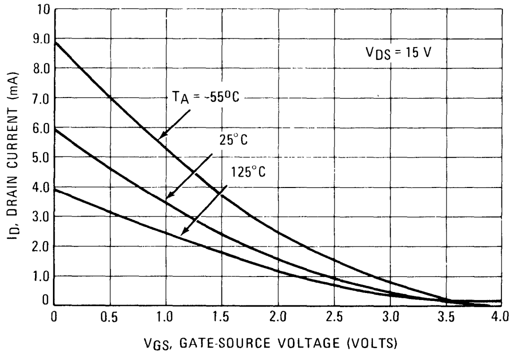
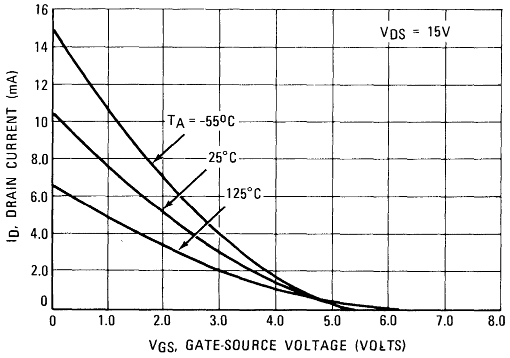


FIGURE 3 — $V_{GS(off)}$ = 5.0 VOLTS



FORWARD TRANSFER ADMITTANCE versus DRAIN CURRENT

FIGURE 4 — $V_{GS(off)}$ = 2.0 VOLTS

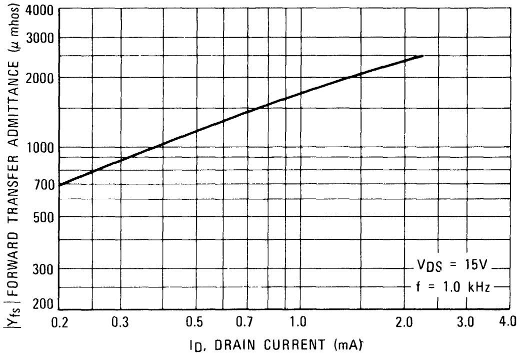


FIGURE 5 — $V_{GS(off)}$ = 4.0 VOLTS

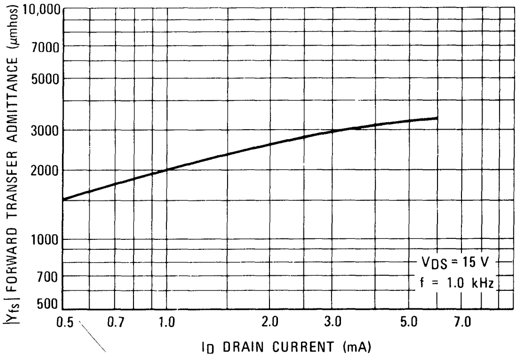


FIGURE 6 — $V_{GS(off)}$ = 5.0 VOLTS

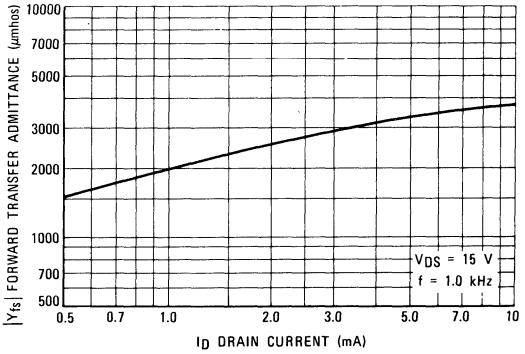


FIGURE 7 – OUTPUT RESISTANCE VERSUS DRAIN CURRENT

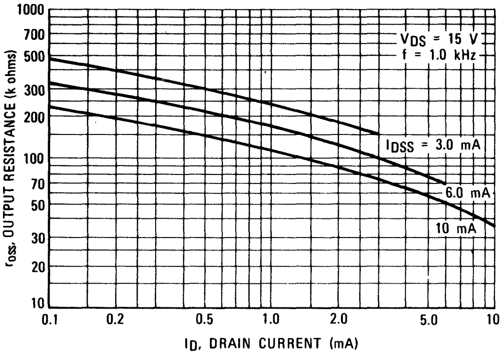


FIGURE 8 – CAPACITANCE VERSUS DRAIN-SOURCE VOLTAGE

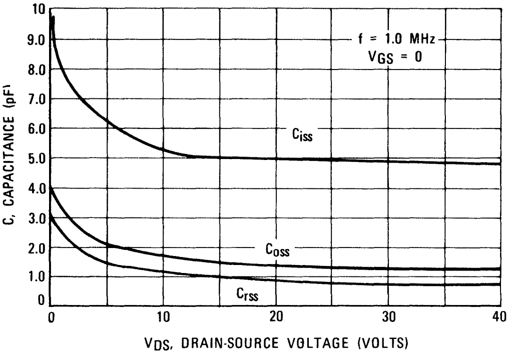


FIGURE 9 – NOISE FIGURE VERSUS FREQUENCY

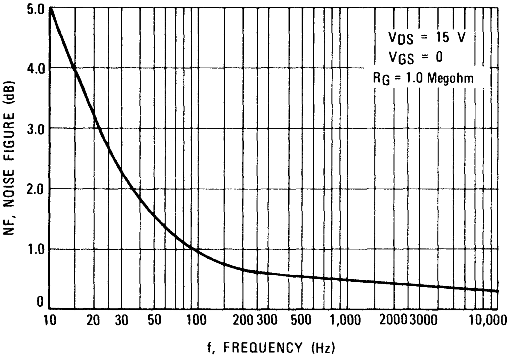


FIGURE 10 – NOISE FIGURE VERSUS SOURCE RESISTANCE

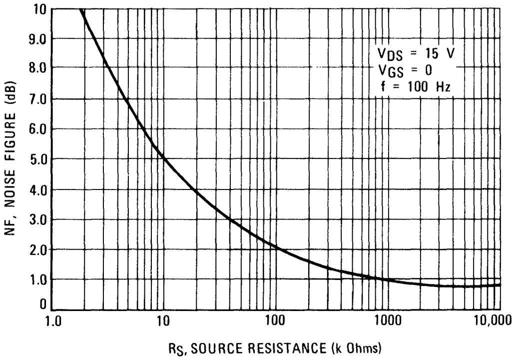
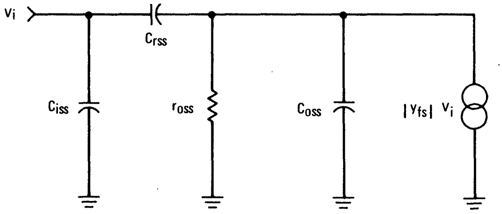


FIGURE 11 – EQUIVALENT LOW FREQUENCY CIRCUIT



Common Source
y Parameters for Frequencies
Below 30 MHz

$y_{is} = j\omega C_{iss}$

$y_{os} = j\omega C_{osp}{}^{*} + 1/r_{oss}$

$y_{fs} = |y_{fs}|$

$y_{rs} = -j\omega C_{rss}$

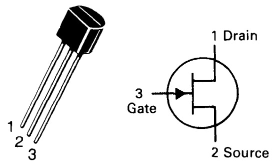
*C_{osp} is C_{oss} in parallel with Series Combination of C_{iss} and C_{rss}.

NOTE:

1 Graphical data is presented for dc conditions. Tabular data is given for pulsed conditions (Pulse Width = 630 ms, Duty Cycle = 10%).

2N5484
thru
2N5486

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	V_{GSR}	25	Vdc
Drain Current	I_D	30	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = −1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	−25	—	—	Vdc
Gate Reverse Current		I_{GSS}				
(V_{GS} = −20 Vdc, V_{DS} = 0)			—	—	−1.0	nAdc
(V_{GS} = −20 Vdc, V_{DS} = 0, T_A = 100°C)			—	—	−0.2	μAdc
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
(V_{DS} = 15 Vdc, I_D = 10 nAdc)	2N5484		−0.3	—	−3.0	
	2N5485		−0.5	—	−4.0	
	2N5486		−2.0	—	−6.0	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current		I_{DSS}				mAdc
(V_{DS} = 15 Vdc, V_{GS} = 0)	2N5484		1.0	—	5.0	
	2N5485		4.0	—	10	
	2N5486		8.0	—	20	
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance		$\lvert y_{fs} \rvert$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5484		3000	—	6000	
	2N5485		3500	—	7000	
	2N5486		4000	—	8000	
Input Admittance		$Re(y_{is})$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N5484		—	—	100	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	2N5485, 2N5486		—	—	1000	
Output Admittance		$\lvert y_{os} \rvert$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	2N5484		—	—	50	
	2N5485		—	—	60	
	2N5486		—	—	75	
Output Conductance		$Re(y_{os})$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N5484		—	—	75	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	2N5485, 2N5486		—	—	100	
Forward Transconductance		$Re(y_{fs})$				μmhos
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	2N5484		2500	—	—	
(V_{DS} = 15 Vdc, V_{GS} = 0, f = 400 MHz)	2N5485		3000	—	—	
	2N5486		3500	—	—	

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

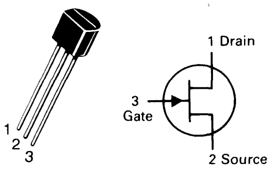
Characteristic	Symbol	Min	Typ	Max	Unit
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	—	1.0	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	—	2.0	pF

FUNCTIONAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
Noise Figure		NF				dB
(V_{DS} = 15 Vdc, V_{GS} = 0, R_G = 1.0 Megohm, f = 1.0 kHz)			—	—	2.5	
(V_{DS} = 15 Vdc, I_D = 1.0 mAdc, R_G ≈ 1.0 k ohm, f = 100 MHz)	2N5484		—	—	3.0	
(V_{DS} = 15 Vdc, I_D = 1.0 mAdc, R_G ≈ 1.0 k ohm, f = 200 MHz)	2N5484		—	4.0	—	
(V_{DS} = 15 Vdc, I_D = 4.0 mAdc, R_G ≈ 1.0 k ohm, f = 100 MHz)	2N5485, 2N5486		—	—	2.0	
(V_{DS} = 15 Vdc, I_D = 4.0 mAdc, R_G ≈ 1.0 k ohm, f = 400 MHz)	2N5485, 2N5486		—	—	4.0	
Common Source Power Gain		G_{ps}				dB
(V_{DS} = 15 Vdc, I_D = 1.0 mAdc, f = 100 MHz)	2N5484		16	—	25	
(V_{DS} = 15 Vdc, I_D = 1.0 mAdc, f = 200 MHz)	2N5484		—	14	—	
(V_{DS} = 15 Vdc, I_D = 4.0 mAdc, f = 100 MHz)	2N5485, 2N5486		18	—	30	
(V_{DS} = 15 Vdc, I_D = 4.0 mAdc, f = 400 MHz)	2N5485, 2N5486		10	—	20	

2N5555

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

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

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

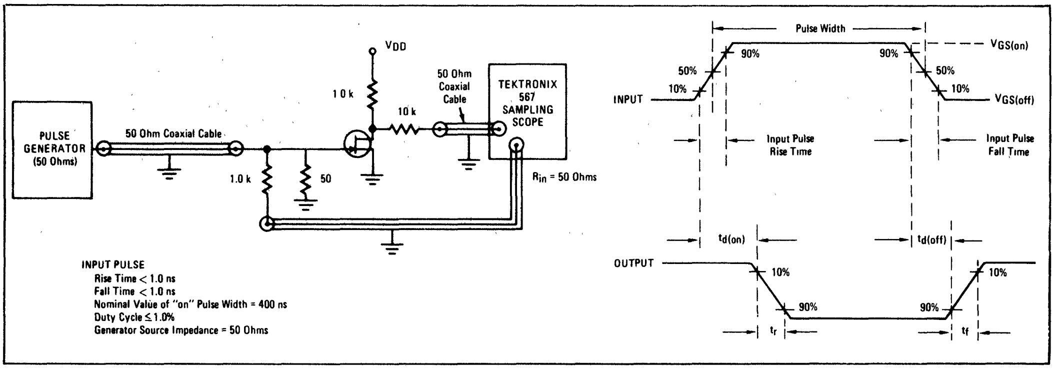
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 10\ \mu Adc$, $V_{DS} = 0$)	$V_{(BR)GSS}$	25	—	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	1.0	nAdc
Drain Cutoff Current	$I_{D(off)}$			nAdc
($V_{DS} = 12$ Vdc, $V_{GS} = -10$ V)		—	10	
($V_{DS} = 12$ Vdc, $V_{GS} = -10$ V, $T_A = 100°C$)		—	2.0	μAdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current* ($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	I_{DSS}	15	—	mAdc
Gate-Source Forward Voltage ($I_{G(f)} = 1.0$ mAdc, $V_{DS} = 0$)	$V_{GS(f)}$	—	1.0	Vdc
Drain-Source On-Voltage ($I_D = 7.0$ mAdc, $V_{GS} = 0$)	$V_{DS(on)}$	—	1.5	Vdc
Static Drain-Source On Resistance ($I_D = 0.1$ mAdc, $V_{GS} = 0$)	$r_{DS(on)}$	—	150	Ohms
SMALL-SIGNAL CHARACTERISTICS				
Small-Signal Drain-Source "ON" Resistance ($V_{GS} = 0$, $I_D = 0$, f = 1.0 kHz)	$r_{ds(on)}$	—	150	Ohms
Input Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 10$ Vdc, f = 1.0 MHz)	C_{rss}	—	1.2	pF

SWITCHING CHARACTERISTICS

Turn-On Delay Time	($V_{DD} = 10$ Vdc, $I_{D(on)} = 7.0$ mAdc,	$t_{d(on)}$	—	5.0	ns
Rise Time	$V_{GS(on)} = 0$, $V_{GS(off)} = -10$ Vdc) (See Figure 1)	t_r	—	5.0	ns
Turn-Off Delay Time	($V_{DD} = 10$ Vdc, $I_{D(on)} = 7.0$ mAdc,	$t_{d(off)}$	—	15	ns
Fall Time	$V_{GS(on)} = 0$, $V_{GS(off)} = -10$ Vdc) (See Figure 1)	t_f	—	10	ns

*Pulse Test: Pulse Width < 300 μs, Duty Cycle < 3.0%.

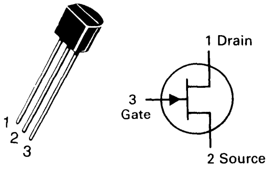
FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



INPUT PULSE
Rise Time < 1.0 ns
Fall Time < 1.0 ns
Nominal Value of "on" Pulse Width = 400 ns
Duty Cycle ≤ 1.0%
Generator Source Impedance = 50 Ohms

2N5638
thru
2N5640

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

Refer to 2N5653 for graphs.

MAXIMUM RATINGS

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

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

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

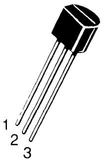
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

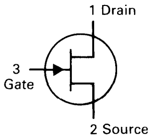
Characteristic				Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS							
Turn-On Delay Time	V_{DD} = 10 Vdc, $V_{GS(on)}$ = 0, $V_{GS(off)}$ = −10 Vdc, $R_G{}'$ = 50 ohms	$I_{D(on)}$ = 12 mAdc	2N5638	$t_{d(on)}$	—	4.0	ns
		6.0 mAdc	2N5639		—	6.0	
		3.0 mAdc	2N5640		—	8.0	
Rise Time		$I_{D(on)}$ = 12 mAdc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

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

2N5668
thru
2N5670

CASE 29-04, STYLE 5
TO-92 (TO-226AA)





JFET
VHF AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

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

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

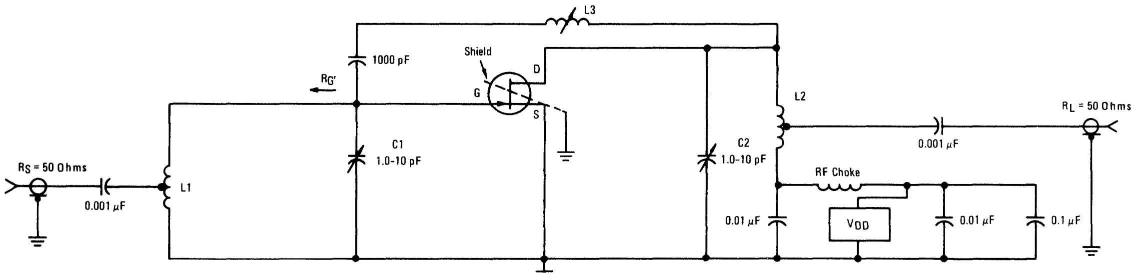
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	25	—	—	Vdc
Gate Reverse Current		I_{GSS}				
(V_{GS} = −15 Vdc, V_{DS} = 0)			—	—	2.0	nAdc
(V_{GS} = −15 Vdc, V_{DS} = 0, T_A = 100°C)			—	—	2.0	μAdc
Gate Source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

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

Characteristic	Symbol	Min	Typ	Max	Unit
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	1.4	4.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (Figure 1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz at R_G' = 1.0 k ohm)	NF	—	—	2.5	dB
Common Source Power Gain (Figure 1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 MHz)	G_{ps}	16	—	—	dB

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

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



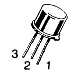
L1 ≈ 8.5 Turns of #14 AWG Tinned Copper; Dia. ≈ 3/8", ≈ 0 9" Long.
Tapped at ≈ 2-1/2 Turns (adjust to give R_G = 1.0 k ohm),
Parallel Resistance = 40 k ohms; tunes at ≈ 8.0 pF.

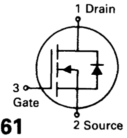
L2 ≈ 13.5 Turns #16 AWG Tinned Copper; Dia. ≈ 3/8", ≈ 1.2" Long.
Tapped at ≈ 5 Turns; Parallel Resistance = 40 k ohms,
tunes at ≈ 4.0 pF.

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

2N6659 thru 2N6661 MPF6659 thru MPF6661

2N6659,60,61
CASE 79-04, STYLE 6
TO-39 (TO-205AD)





MPF6659,60,61
CASE 29-03, STYLE 22
TO-92 (TO-226AE)

TMOS SWITCHING FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

<table>
<tr><th>Rating</th><th>Symbol</th><th colspan="2">2N6659
MPF6659</th><th colspan="2">2N6660
MPF6660</th><th colspan="2">2N6661
MPF6661</th><th>Unit</th></tr>
<tr><td>Drain-Source Voltage</td><td>V_{DS}</td><td colspan="2">35</td><td colspan="2">60</td><td colspan="2">90</td><td>Vdc</td></tr>
<tr><td>Drain-Gate Voltage</td><td>V_{DG}</td><td colspan="2">35</td><td colspan="2">60</td><td colspan="2">90</td><td>Vdc</td></tr>
<tr><td>Gate-Source Voltage</td><td>V_{GS}</td><td colspan="6">± 30</td><td>Vdc</td></tr>
<tr><td>Drain Current —
Continuous (1)
Pulsed (2)</td><td>
I_D
I_{DM}</td><td colspan="6">
2.0
3.0</td><td>Adc</td></tr>
<tr><td></td><td></td><td colspan="3">2N6659
2N6660
2N6661</td><td colspan="3">MPF6659
MPF6660
MPF6661</td><td></td></tr>
<tr><td>Total Device Dissipation
@ T_C = 25°C
Derate above 25°C</td><td>P_D</td><td colspan="3">
6.25
50</td><td colspan="3">
2.5
20</td><td>Watts
mW/°C</td></tr>
<tr><td>Total Device Dissipation
@ T_A = 25°C
Derate above 25°C</td><td>P_D</td><td colspan="3">
—
—</td><td colspan="3">
1.0
8.0</td><td>Watts
mW/°C</td></tr>
<tr><td>Operating and Storage Junction Temperature Range</td><td>T_J, T_{stg}</td><td colspan="6">−55 to +150</td><td>°C</td></tr>
</table>

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Zero-Gate-Voltage Drain Current (V_{DS} = Maximum Rating, V_{GS} = 0)		I_{DSS}	—	—	10	μAdc
Gate-Body Leakage Current (V_{GS} = 15 V, V_{DS} = 0)		I_{GSS}	—	—	100	nAdc
Drain-Source Breakdown Voltage		$V_{(BR)DSX}$				Vdc
(V_{GS} = 0, I_D = 10 μA)	2N6659, MPF6659		35	—	—	
	2N6660, MPF6660		60	—	—	
	2N6661, MPF6661		90	—	—	
ON CHARACTERISTICS(1)						
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)		$V_{GS(Th)}$	0.8	1.4	2.0	Vdc
Drain-Source On-Voltage		$V_{DS(on)}$				Vdc
(V_{GS} = 10 V, I_D = 1.0 A)	2N6659, MPF6659		—	—	1.8	
	2N6660, MPF6660		—	—	3.0	
	2N6661, MPF6661		—	—	4.0	
(V_{GS} = 5.0 V, I_D = 0.3 A)	2N6659, MPF6659		—	0.8	1.5	
	2N6660, MPF6660		—	0.9	1.5	
	2N6661, MPF6661		—	0.9	1.6	
Static Drain-Source On Resistance		$r_{DS(on)}$				Ohms
(V_{GS} = 10 Vdc, I_D = 1.0 Adc)	2N6659, MPF6659		—	—	1.8	
	2N6660, MPF6660		—	—	3.0	
	2N6661, MPF6661		—	—	4.0	
On-State Drain Current (V_{DS} = 25 V, V_{GS} = 10 V)		$I_{D(on)}$	1.0	2.0	—	Amps
SMALL-SIGNAL CHARACTERISTICS						
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	30	50	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)		C_{rss}	—	3.6	10	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)		C_{oss}	—	20	40	pF
Forward Transconductance (V_{DS} = 25 V, I_D = 0.5 A)		g_{fs}	170	—	—	mmhos

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

Characteristic	Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS(1)					
Rise Time	t_r	—	—	5.0	ns
Fall Time	t_f	—	—	5.0	ns
Turn-On Time	t_{on}	—	—	5.0	ns
Turn-Off Time	t_{off}	—	—	5.0	ns

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

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

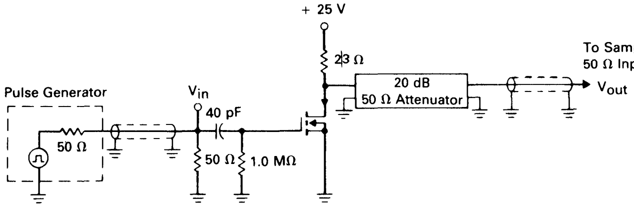


FIGURE 2 — SWITCHING WAVEFORMS

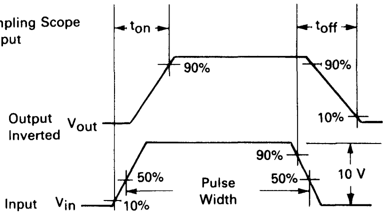


FIGURE 3 — $V_{GS(th)}$ NORMALIZED versus TEMPERATURE

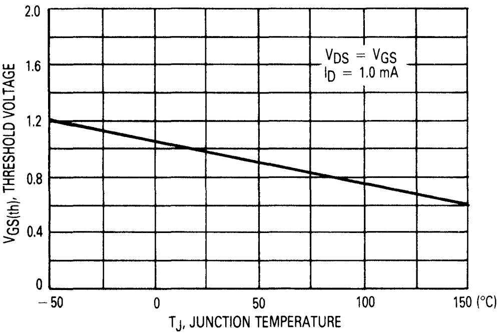


FIGURE 4 — ON-REGION CHARACTERISTICS

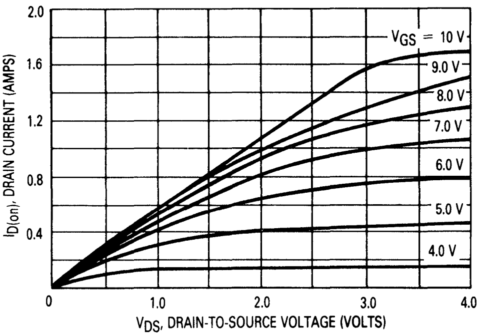


FIGURE 5 — OUTPUT CHARACTERISTICS

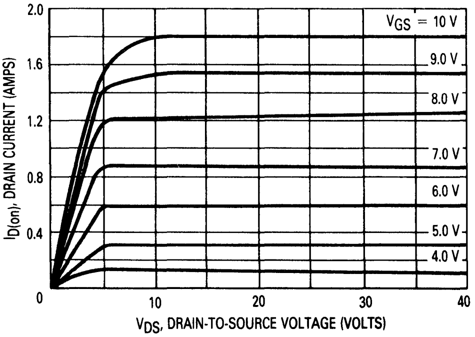


FIGURE 6 — CAPACITANCE versus DRAIN-TO-SOURCE VOLTAGE

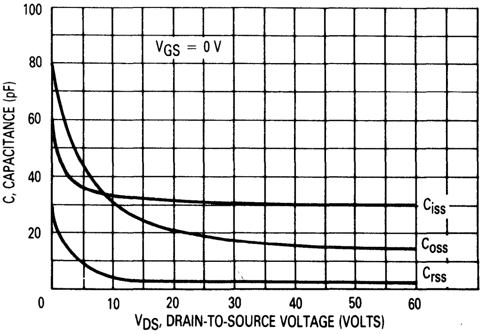
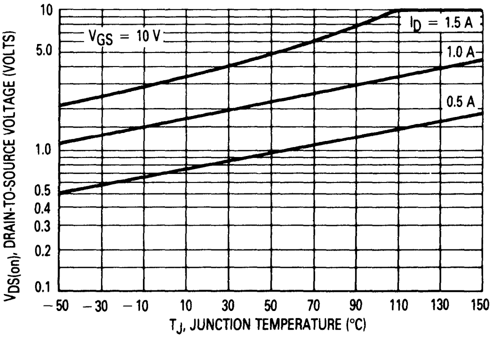
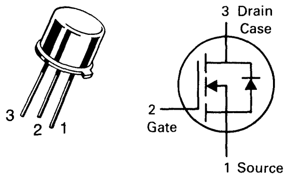


FIGURE 7 — ON-VOLTAGE versus TEMPERATURE



2N6782

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	100	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	100	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 3.5 14	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	15 0.12	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	8.33	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

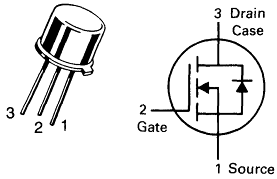
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)	$V_{(BR)DSS}$	100	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 100 V, V_{GS} = 0 V) (V_{DS} = 80 V, V_{GS} = 0 V, T_J = 125°C)	I_{DSS}	 — —	 250 1000	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)	I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)	$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 2.25 Adc) T_A = 25°C T_A = 125°C	$r_{DS(on)}$	— —	0.6 1.08	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 3.5 Adc)	$V_{DS(on)}$	—	2.1	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 2.25 Adc)	g_{fs}	1.0	3.0	mhos
DYNAMIC CHARACTERISTICS				
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	60	200	pF
Output Capacitance	C_{oss}	40	100	
Reverse Transfer Capacitance	C_{rss}	10	25	
SWITCHING CHARACTERISTICS*				
Turn-On Delay Time (V_{DD} ≈ 34 V, I_D = 2.25 Rated I_D, R_{gen} = 50 ohms)	$t_{d(on)}$	—	15	ns
Rise Time	t_r	—	25	
Turn-Off Delay Time	$t_{d(off)}$	—	25	
Fall Time	t_f	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS*				
Diode Forward Voltage (I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.75	1.5	Vdc
Forward Turn-On Time	t_{on}	—	Negligible	ns
Reverse Recovery Time	t_{rr}	—	200	ns

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

2N6784

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 2.25 9.0	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	15 0.12	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	8.33	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

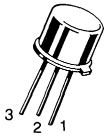
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

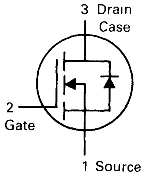
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)		$V_{(BR)DSS}$	200	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = 0.8 Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)		I_{DSS}	 — —	 250 1000	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 1.5 Adc)	T_A = 25°C T_A = 125°C	$r_{DS(on)}$	— —	1.5 2.81	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.25 Adc)		$V_{DS(on)}$	—	3.37	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 1.5 Adc)		g_{fs}	0.9	2.7	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	60	200	pF
Output Capacitance		C_{oss}	20	80	
Reverse Transfer Capacitance		C_{rss}	5.0	25	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 75 V, I_D = 1.5 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	15	ns
Rise Time		t_r	—	20	
Turn-Off Delay Time		$t_{d(off)}$	—	30	
Fall Time		t_f	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Diode Forward Voltage	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.7	1.5	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	290 (Typ)	—	ns

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

2N6788

CASE 79-05, STYLE 6
TO-39 (TO-205AF)





TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	100	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	100	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 6.0 24	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	20 0.16	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	6.25	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

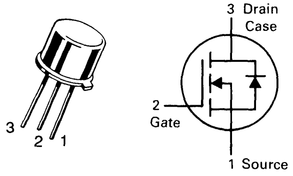
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)		$V_{(BR)DSS}$	100	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = 80 V, V_{GS} = 0, T_J = 125°C)		I_{DSS}	 — —	 1.0 4.0	mA
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 3.5 Adc)	T_A = 25°C T_A = 125°C	$r_{DS(on)}$	— —	0.3 0.54	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 6.0 Adc)		$V_{DS(on)}$	—	1.8	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 3.5 Adc)		g_{fs}	1.5	4.5	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	200	600	pF
Output Capacitance		C_{oss}	100	400	
Reverse Transfer Capacitance		C_{rss}	20	100	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 35 V, I_D = 3.5 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	40	ns
Rise Time		t_r	—	70	
Turn-Off Delay Time		$t_{d(off)}$	—	40	
Fall Time		t_f	—	70	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Diode Forward Voltage	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.8	1.8	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	230	ns

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

2N6790

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 3.5 14	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	20 0.16	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	6.25	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

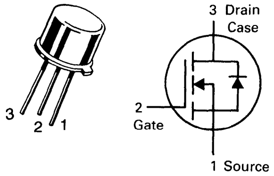
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)		$V_{(BR)DSS}$	200	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = 0.8 Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)		I_{DSS}	 — —	 250 1000	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 2.25 Adc)	T_A = 25°C T_A = 125°C	$r_{DS(on)}$	— —	0.8 1.5	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 3.5 Adc)		$V_{DS(on)}$	—	2.8	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 2.25 Adc)		g_{fs}	1.5	4.5	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	200	600	pF
Output Capacitance		C_{oss}	60	300	
Reverse Transfer Capacitance		C_{rss}	15	80	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≃ 74 V, I_D = 2.25 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	40	ns
Rise Time		t_r	—	50	
Turn-Off Delay Time		$t_{d(off)}$	—	50	
Fall Time		t_f	—	50	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward Diode Voltage	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.7	1.5	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	350	ns

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

2N6796

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET
TRANSISTOR
N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	100	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	100	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current			Adc
Continuous	I_D	8.0	
Pulsed	I_{DM}	32	
Total Power Dissipation @ T_C = 25°C	P_D	25	Watts
Derate above 25°C		0.2	W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

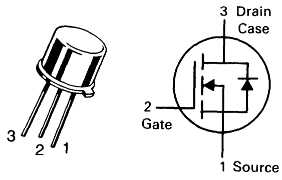
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)		$V_{(BR)DSS}$	100	—	Vdc
Zero Gate Voltage Drain Current		I_{DSS}			μAdc
(V_{DS} = Rated V_{DSS}, V_{GS} = 0)			—	250	
(V_{DS} = 80 V, V_{GS} = 0, T_J = 125°C)			—	1000	
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance		$r_{DS(on)}$	—	0.18	Ohm
(V_{GS} = 10 Vdc, I_D = 5.0 Adc) T_A = 125°C			—	0.35	
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 8.0 Adc)		$V_{DS(on)}$	—	1.56	Vdc
Forward Transconductance (V_{DS} = 15 V, I_D = 5.0 Adc)		g_{fs}	3.0	9.0	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	350	900	pF
Output Capacitance		C_{oss}	150	500	
Reverse Transfer Capacitance		C_{rss}	50	150	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≃ 30 V, I_D = 5.0 Adc, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	75	
Turn-Off Delay Time		$t_{d(off)}$	—	40	
Fall Time		t_f	—	45	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Diode Forward Voltage	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.75	1.5	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	300	ns

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

2N6798

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 5.5 22	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)	$V_{(BR)DSS}$	200	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = 0.8 Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)	I_{DSS}	 — —	 250 1000	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)	I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)	$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 3.5 Adc) T_A = 25°C T_A = 125°C	$r_{DS(on)}$	 — —	 0.4 0.75	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5.5 Adc)	$V_{DS(on)}$	—	2.2	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 3.5 Adc)	g_{fs}	2.5	7.5	mhos

DYNAMIC CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	350	900	pF
Output Capacitance		C_{oss}	100	450	
Reverse Transfer Capacitance		C_{rss}	40	150	

SWITCHING CHARACTERISTICS*

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn-On Delay Time	(V_{DD} ≈ 77 V, I_D = 3.5 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	50	
Turn-Off Delay Time		$t_{d(off)}$	—	50	
Fall Time		t_f	—	40	

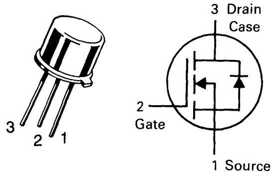
SOURCE-DRAIN DIODE CHARACTERISTICS*

Characteristic	Conditions	Symbol	Min	Max	Unit
	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.7	1.4	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	450 (Typ)	—	ns

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

2N6800

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	400	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	400	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 3.0 14	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 20	Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

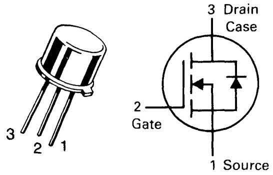
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)		$V_{(BR)DSS}$	400	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0) (V_{DS} = 0.8 Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)		I_{DSS}	 — —	 250 1000	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 2.0 Adc) T_A = 125°C		$r_{DS(on)}$	— —	1.0 2.4	Ohm
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 3.0 Adc)		$V_{DS(on)}$	—	3.0	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 2.0 Adc)		g_{fs}	2.0	6.0	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	350	900	pF
Output Capacitance		C_{oss}	50	300	
Reverse Transfer Capacitance		C_{rss}	20	80	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≃ 176 V, I_D = 2.0 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	35	
Turn-Off Delay Time		$t_{d(off)}$	—	55	
Fall Time		t_f	—	35	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	V_{SD}	0.7	1.4	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	600	ns

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

2N6802

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	500	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	500	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current			Adc
Continuous	I_D	3.5	
Pulsed	I_{DM}	11	
Total Power Dissipation @ T_C = 25°C	P_D	25	Watts
Derate above 25°C		0.2	W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.25 mA)	$V_{(BR)DSS}$	500	—	Vdc
Zero-Gate Voltage Drain Current	I_{DSS}			μAdc
(V_{DS} = Rated V_{DSS}, V_{GS} = 0)		—	250	
(V_{DS} = 0.8 Rated V_{DSS}, V_{GS} = 0, T_J = 125°C)		—	1000	
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)	I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 0.5 mA)	$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 1.5 Adc)	$r_{DS(on)}$	—	1.5	Ohms
T_A = 125°C		—	3.5	
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.5 Adc)	$V_{DS(on)}$	—	3.75	Vdc
Forward Transconductance (V_{DS} = 5.0 V, I_D = 1.5 Adc)	g_{fs}	1.5	4.5	mhos

DYNAMIC CHARACTERISTICS

Characteristic		Symbol	Min	Max	Unit
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	350	900	pF
Output Capacitance		C_{oss}	25	200	
Reverse Transfer Capacitance		C_{rss}	15	60	

SWITCHING CHARACTERISTICS*

Characteristic		Symbol	Min	Max	Unit
Turn-On Delay Time	(V_{DD} ≈ 225 V, I_D = 1.5 V, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	30	
Turn-Off Delay Time		$t_{d(off)}$	—	55	
Fall Time		t_f	—	30	

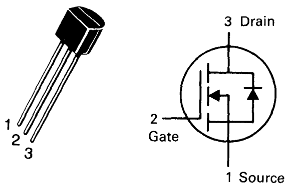
SOURCE-DRAIN DIODE CHARACTERISTICS*

Characteristic		Symbol	Min	Max	Unit
	(I_S = Rated I_D, V_{GS} = 0)	V_{SD}	0.7	1.4	Vdc
Forward Turn-On Time		t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	800	—	ns

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

2N7000

CASE 29-04, STYLE 7
TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	60	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current			mAdc
Continuous	I_D	200	
Pulsed	I_{DM}	500	
Total Power Dissipation @ T_C = 25°C	P_D	400	mW
Derate above 25°C		3.2	mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16″ from case for 10 seconds	T_L	300	°C

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 μA)	$V_{(BR)DSS}$	60	—	Vdc
Zero Gate Voltage Drain Current	I_{DSS}			
(V_{DS} = 48 V, V_{GS} = 0)		—	1.0	μAdc
(V_{DS} = 48 V, V_{GS} = 0, T_J = 125°C)		—	1.0	mA
Gate-Body Leakage Current, Forward (V_{GSF} = 15 Vdc, V_{DS} = 0)	I_{GSSF}	—	−10	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.8	3.0	Vdc
Static Drain-Source On-Resistance	$r_{DS(on)}$			Ohm
(V_{GS} = 10 Vdc, I_D = 0.5 Adc)		—	5.0	
(V_{GS} = 10 Vdc, I_D = 0.5 V, T_C = 125°C)		—	9.0	
Drain-Source On-Voltage	$V_{DS(on)}$			Vdc
(V_{GS} = 10 V, I_D = 0.5 Adc)		—	2.5	
(V_{GS} = 4.5 V, I_D = 75 mA)		—	0.4	
On-State Drain Current (V_{GS} = 4.5 V, V_{DS} = 10 V)	$I_{d(on)}$	75	—	mA
Forward Transconductance (V_{DS} = 10 V, I_D = 200 mA)	g_{fs}	100	—	μmhos

DYNAMIC CHARACTERISTICS

Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	60	pF
Output Capacitance		C_{oss}	—	25	
Reverse Transfer Capacitance		C_{rss}	—	5.0	

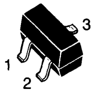
SWITCHING CHARACTERISTICS*

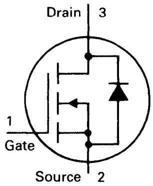
Turn-On Delay Time	(V_{DD} = 15 V, I_D = 600 mA R_{gen} = 25 ohms, R_L = 25 ohms)	t_{on}	—	10	ns
Turn-Off Delay Time		t_{off}	—	10	

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

2N7002

CASE 318-03 STYLE 21
SOT-23 (TO-236AB)





TMOS FET
TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	60	Vdc
Drain Current — Continuous T_C = 25°C(1) T_C = 100°C(1) — Pulsed(2)	I_D I_D I_{DM}	±115 ±75 ±800	mA
Gate-Source Voltage	V_{GS}	±40	Vdc
Total Power Dissipation T_C = 25°C T_C = 100°C Derate above 25°C ambient	P_D	200 80 0.16	mW mW/°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

2N7002 = 702

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

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 μA)	$V_{(BR)DSS}$	60	—	—	Vdc
Zero Gate Voltage Drain Current (V_{GS} = 0, V_{DS} = 60 V) T_J = 25°C T_J = 125°C	I_{DSS}	 — —	 — —	 1.0 500	μAdc
Gate-Body Leakage Current Forward (V_{GS} = 20 Vdc)	I_{GSSF}	—	—	100	nAdc
Gate-Body Leakage Current Reverse (V_{GS} = −20 Vdc)	I_{GSSR}	—	—	−100	nAdc

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

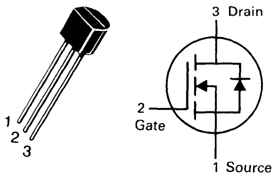
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS*					
Gate Threshold Voltage ($V_{DS} = V_{GS}$, I_D = 250 μA)	$V_{GS(th)}$	1.0	—	2.5	Vdc
On-State Drain Current ($V_{DS} \geq 2.0\ V_{DS(on)}$, V_{GS} = 10 V)	$I_{D(on)}$	500	—	—	mA
Static Drain-Source On-State Voltage (V_{GS} = 10 V, I_D = 500 mA) (V_{GS} = 5.0 V, I_D = 50 mA)	$V_{DS(on)}$	 — —	 — —	 3.75 1.5	Vdc
Static Drain-Source On-State Resistance (V_{GS} = 10 V, I_D = 500 mA) T_C = 25°C T_C = 100°C (V_{GS} = 5.0 V, I_D = 50 mA) T_C = 25°C T_C = 100°C	$r_{DS(on)}$	 — — — —	 — — — —	 7.5 13.5 7.5 13.5	Ohms
Forward Transconductance ($V_{DS} \geq 2.0\ V_{DS(on)}$, I_D = 200 mA)	g_{FS}	80	—	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	—	50	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	—	25	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	—	5.0	pF
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time (V_{DD} = 30 V, I_D ≅ 200 mA, R_G = 25 Ω, R_L = 150 Ω)	$t_{d(on)}$	—	—	20	ns
Turn-Off Delay Time	$t_{d(off)}$	—	—	20	ns
BODY-DRAIN DIODE RATINGS					
Diode Forward On-Voltage (I_S = 11.5 mA, V_{GS} = 0 V)	V_{SD}	—	—	−1.5	V
Source Current Continuous (Body Diode)	I_S	—	—	−115	mA
Source Current Pulsed	I_{SM}	—	—	−800	mA

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

2N7008

CASE 29-04, STYLE 22
TO-92 (TO-226AA)



TMOS FET
TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	60	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 150 1000	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 3.2	mW mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16″ from case for 10 seconds	T_L	300	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)		$V_{(BR)DSS}$	60	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0) (V_{DS} = 50 V, V_{GS} = 0, T_J = 125°C)		I_{DSS}	 — —	 1.0 500	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 30 Vdc, V_{DS} = 0)		I_{GSSF}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	1.0	2.5	Vdc
Static Drain-Source On-Resistance (V_{GS} = 5.0 Vdc, I_D = 50 Adc) (V_{GS} = 10 Vdc, I_D = 500 mAdc, T_C = 125°C)		$r_{DS(on)}$	 — —	 7.5 13.5	Ohm
Drain-Source On-Voltage (V_{GS} = 5.0 V, I_D = 50 mA) (V_{GS} = 10 V, I_D = 500 mA)		$V_{DS(on)}$	 — —	 1.5 3.75	Vdc
On-State Drain Current (V_{GS} = 10 V, V_{DS} ⩾ 2.0 $V_{D(on)}$)		$I_{D(on)}$	500	—	mA
Forward Transconductance (V_{DS} ⩾ 2.0 $V_{DS(on)}$, I_D = 200 mA)		g_{fs}	80	—	μmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	50	pF
Output Capacitance		C_{oss}	—	25	
Reverse Transfer Capacitance		C_{rss}	—	5.0	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} = 30 V, I_D = 200 mA R_{gen} = 25 ohms, R_L = 150 ohms)	t_{on}	—	20	ns
Turn-Off Delay Time		t_{off}	—	20	

*Pulse Test: Pulse Width ⩽ 300 μs, Duty Cycle ⩽ 2.0%.

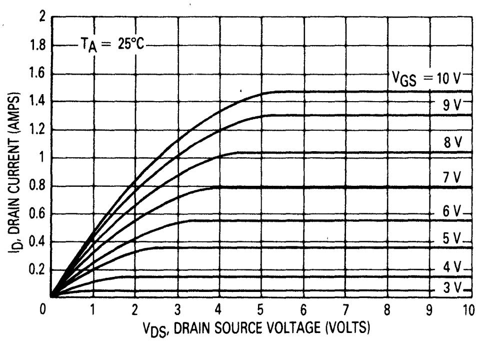


Figure 1. Ohmic Region

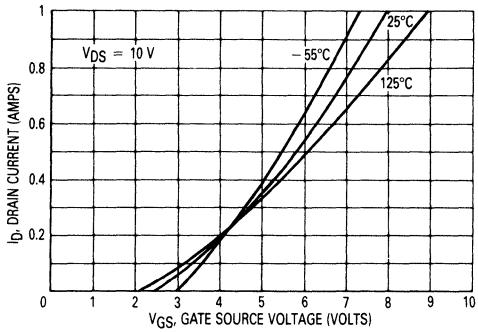


Figure 2. Transfer Characteristics

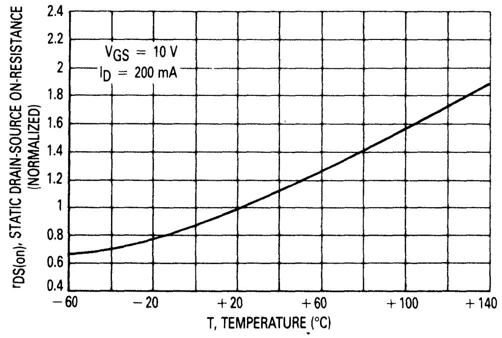


Figure 3. Temperature versus Static Drain-Source On-Resistance

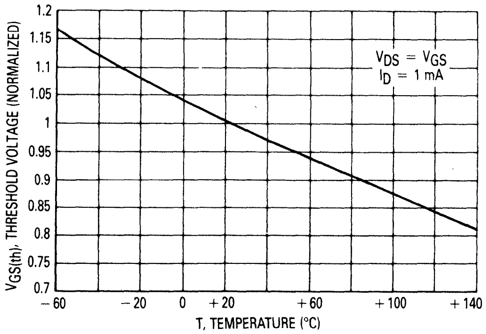
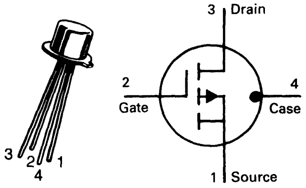


Figure 4. Temperature versus Gate Threshold Voltage

3N155

CASE 20-03, STYLE 2
TO-72 (TO-206AF)



MOSFET
SWITCHING

P-CHANNEL — ENHANCEMENT

Refer to 3N157 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	±35	Vdc
Drain-Gate Voltage	V_{DG}	±50	Vdc
Gate-Source Voltage	V_{GS}	±50	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2.0	mW mW/°C
Junction Temperature Range	T_J	−65 to +175	°C
Storage Channel Temperature Range	T_{stg}	−65 to +175	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

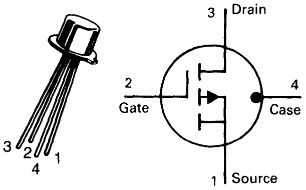
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($I_D = -10\ \mu Adc, V_G = V_S = 0$)	$V_{(BR)DSX}$	−35	—	—	Vdc
Zero-Gate-Voltage Drain Current ($V_{DS} = -10$ Vdc, $V_{GS} = 0$) ($V_{DS} = -10$ Vdc, $V_{GS} = 0$, $T_A = 125°C$)	I_{DSS}	— —	— —	−1.0 −1000	nAdc
Gate Reverse Current ($V_{GS} = +50$ Vdc, $V_{DS} = 0$) ($V_{GS} = +25$ Vdc, $V_{DS} = 0$)	I_{GSS}	— —	— —	+1000 +10	pAdc
Resistance Drain Source ($I_D = 0, V_{GS} = 0$)	$r_{DS(off)}$	$1 \times 10^{+10}$	—	—	Ohms
Resistance Gate Source Input ($V_{GS} = -25$ Vdc)	R_{GS}	—	$1 \times 10^{+16}$	—	Ohms
Gate Forward Leakage Current ($V_{GS} = -50$ Vdc, $V_{DS} = 0$) ($V_{GS} = -25$ Vdc, $V_{DS} = 0$)	$I_{G(f)}$	— —	— —	−1000 −10	pAdc
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = -10$ Vdc, $I_D = -10\ \mu Adc$) 3N155	$V_{GS(Th)}$	−1.5	—	−3.2	Vdc
Drain-Source On-Voltage ($I_D = -2.0$ mAdc, $V_{GS} = -10$ Vdc)	$V_{DS(on)}$	—	—	−1.0	Vdc
Static Drain-Source On Resistance ($I_D = 0$ mAdc, $V_{GS} = -10$ Vdc)	$r_{DS(on)}$	—	—	600	Ohms
On-State Drain Current ($V_{DS} = -15$ Vdc, $V_{GS} = -10$ Vdc)	$I_{D(on)}$	−5.0	—	—	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source Resistance ($V_{GS} = -10$ Vdc, $I_D = 0$, f = 1.0 kHz) ($V_{GS} = -15$ Vdc, $I_D = 0$, f = 1.0 kHz)	$r_{ds(on)}$	 — —	 — —	 400 350	Ohms
Forward Transfer Admittance ($V_{DS} = -15$ Vdc, $I_D = -2.0$ mAdc, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	1000	—	4000	µmhos
Input Capacitance ($V_{DS} = -15$ Vdc, $V_{GS} = -10$ Vdc, f = 140 kHz)	C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 0$, f = 140 kHz)	C_{rss}	—	—	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)} = -10$ Vdc, f = 140 kHz)	$C_{d(sub)}$	—	—	4.0	pF

SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Typ	Max	Unit
Turn-On Delay	($V_{DD} = -10$ Vdc, $I_{D(on)} = -2.0$ mAdc, $V_{GS(on)} = -10$ Vdc, $V_{GS(off)} = 0$)	t_d	—	—	45	µs
Rise Time		t_r	—	—	65	ns
Turn-Off Delay		t_s	—	—	60	ns
Fall Time		t_f	—	—	100	ns

3N157

CASE 20-03, STYLE 2
TO-72 (TO-206AF)



MOSFET AMPLIFIER AND SWITCHING

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage*	V_{DS}	±35	Vdc
Drain-Gate Voltage*	V_{DG}	±50	Vdc
Gate-Source Voltage*	V_{GS}	±50	Vdc
Drain Current*	I_D	30	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C*	P_D	300 1.7	mW mW/°C
Junction Temperature Range*	T_J	−65 to +175	°C
Storage Channel Temperature Range*	T_{stg}	−65 to +175	°C

*JEDEC Registered Limits

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($I_D = -10\ \mu Adc$, $V_G = V_S = 0$)	$V_{(BR)DSX}$	−35	—	—	Vdc
Zero-Gate-Voltage Drain Current ($V_{DS} = -15$ Vdc, $V_{GS} = 0$) ($V_{DS} = -35$ Vdc, $V_{GS} = 0$)	I_{DSS}	— —	— —	−1.0 −10	nAdc μAdc
Gate Reverse Current* ($V_{GS} = +25$ Vdc, $V_{DS} = 0$) ($V_{GS} = +50$ Vdc, $V_{DS} = 0$)	I_{GSS}	— —	— —	+10 +10	pAdc nAdc
Input Resistance ($V_{GS} = -25$ Vdc)	R_{GS}	—	$1 \times 10^{+12}$	—	Ohms
Gate Source Voltage* ($V_{DS} = -15$ Vdc, $I_D = -0.5$ mAdc) 3N157	V_{GS}	−1.5	—	−5.5	Vdc
Gate Forward Current* ($V_{GS} = -25$ Vdc, $V_{DS} = 0$) ($V_{GS} = -50$ Vdc, $V_{DS} = 0$) ($V_{GS} = -25$ Vdc, $V_{DS} = 0$, $T_A = +55°C$) ($V_{GS} = -50$ Vdc, $V_{DS} = 0$, $T_A = +55°C$)	$I_{G(f)}$	— — — —	— — — —	−10 −1.0 −10 −1.0	pAdc nAdc nAdc μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage* ($V_{DS} = -15$ Vdc, $I_D = -10\ \mu Adc$) 3N157	$V_{GS(Th)}$	−1.5	—	−3.2	Vdc
On-State Drain Current* ($V_{DS} = -15$ Vdc, $V_{GS} = -10$ Vdc)	$I_{D(on)}$	−5.0	—	—	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance* ($V_{DS} = -15$ Vdc, $I_D = -2.0$ mAdc, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	1000	—	4000	μmhos
Output Admittance* ($V_{DS} = -15$ Vdc, $I_D = -2.0$ mAdc, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	—	60	μmhos
Input Capacitance* ($V_{DS} = -15$ Vdc, $V_{GS} = 0$, f = 140 kHz)	C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance* ($V_{DS} = -15$ Vdc, $V_{GS} = 0$, f = 140 kHz)	C_{rss}	—	—	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)} = -10$ Vdc, f = 140 kHz)	$C_{d(sub)}$	—	—	4.0	pF
Noise Voltage ($R_S = 0$, BW = 1.0 Hz, $V_{DS} = -15$ Vdc, $I_D = -2.0$ mAdc, f = 100 Hz) ($R_S = 0$, BW = 1.0 Hz, $V_{DS} = -15$ Vdc, $I_D = -2.0$ mAdc, f = 1.0 kHz)	e_n	 — —	 300 120	 — 500	NV/√Hz

*JEDEC Registered Limits

FIGURE 1 – FORWARD TRANSCONDUCTANCE

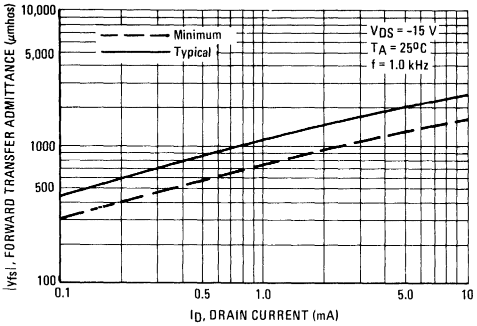


FIGURE 2 – OUTPUT TRANSCONDUCTANCE

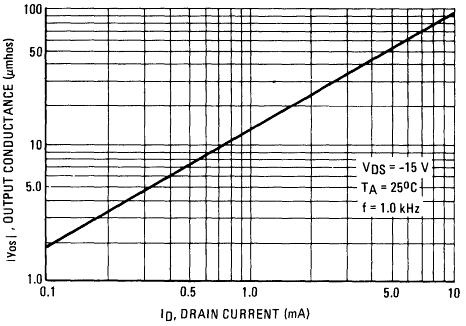


FIGURE 3 – FORWARD TRANSCONDUCTANCE versus TEMPERATURE

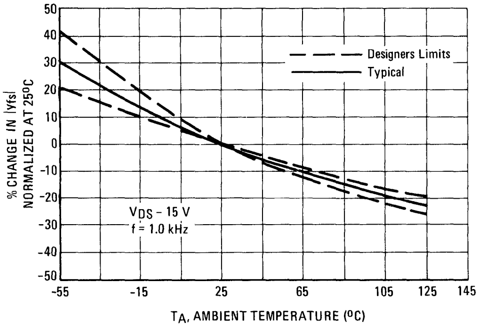


FIGURE 4 – BIAS CURVE

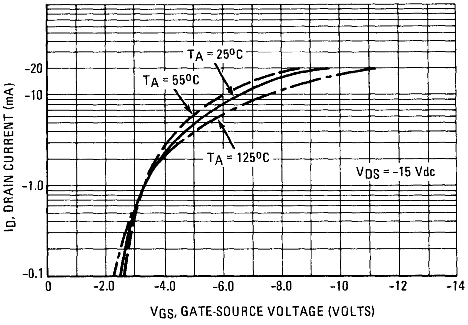


FIGURE 5 – "ON" DRAIN-SOURCE VOLTAGE

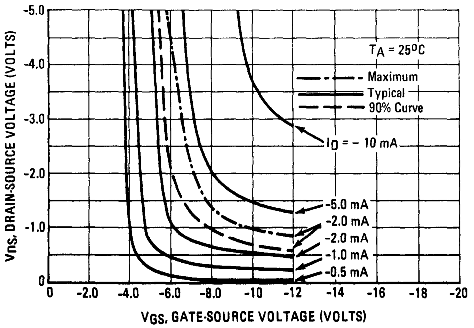
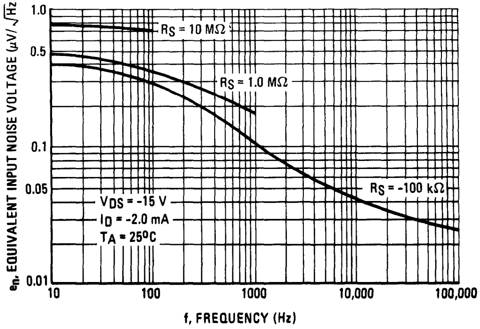


FIGURE 6 – EQUIVALENT INPUT NOISE VOLTAGE



SWITCHING CHARACTERISTICS

($T_A = 25^{\circ}C$)

FIGURE 7 – TURN-ON DELAY TIME

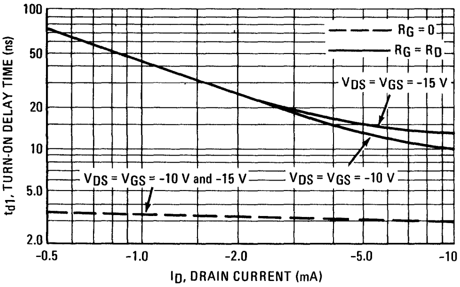


FIGURE 8 – RISE TIME

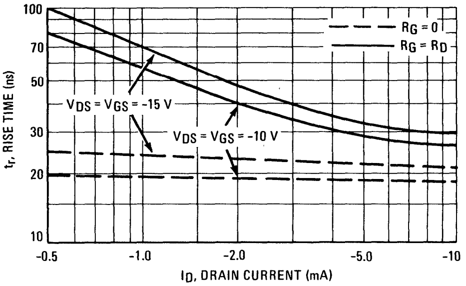


FIGURE 9 – TURN-OFF DELAY TIME

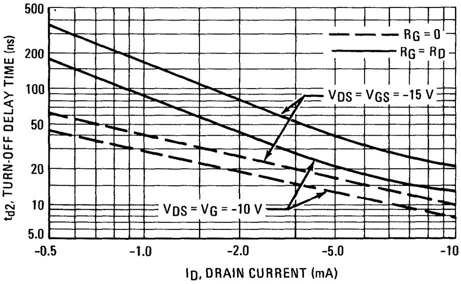


FIGURE 10 – FALL TIME

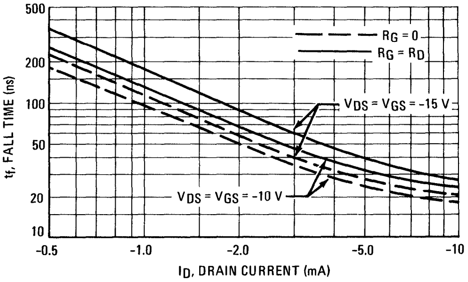


FIGURE 11 – SWITCHING CIRCUIT and WAVEFORMS

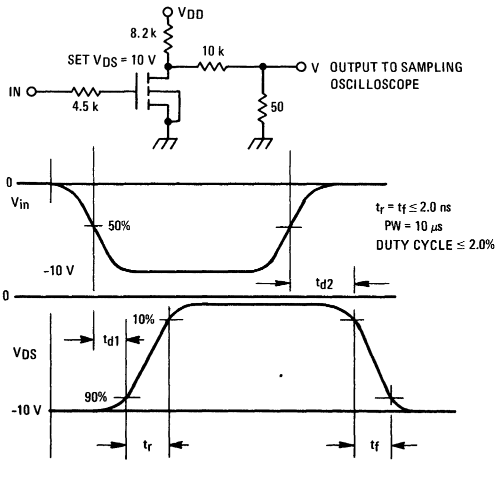
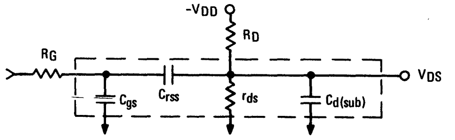


FIGURE 12 – SWITCHING CIRCUIT with MOSFET EQUIVALENT MODEL



The switching characteristics shown above were measured in a test circuit similar to Figure 11. At the beginning of the switching interval, the gate voltage is at ground and the gate source capacitance ($C_{gs} \bullet C_{rss} \bullet C_{rss}$) has no charge. The drain voltage is at V_{DD} and thus the feedback capacitance (C_{rss}) is charged to V_{DD}. Similarly, the drain substrate capacitance ($C_{d(sub)}$) is charged to V_{DD} since the substrate and source are connected to ground.

During the turn-on interval C_{gs} is charged to V_{GS} (the input voltage) through R_G (generator impedance) (Figure 12). C_{rss} must be discharged to $V_{GS} \bullet V_{D(on)}$ through R_G and the parallel combination of the load resistor (R_D) and the channel resistance (r_{ds}). In addition, $C_{d(sub)}$ is discharged to a low value ($V_{D(on)}$) through R_D in parallel with r_{ds}. During turn-off this charge flow is reversed.

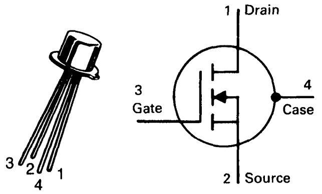
Predicting turn-on time proves to be somewhat difficult since the channel resistance (r_{ds}) is a function of the gate source voltage (V_{GS}). As C_{gs} becomes charged V_{GS} is approaching V_{in} and r_{ds} decreases (see Figure 5) and since C_{rss} and $C_{d(sub)}$ are charged through r_{ds}, turn-on time is quite non-linear.

If the charging time of C_{gs} is short compared to that of C_{rss} and $C_{d(sub)}$, then r_{ds} (which is in parallel with R_D) will be low compared to R_D during the switching interval and will largely determine the turn-on time. On the other hand, during turn-off r_{ds} will be almost an open circuit requiring C_{rss} and $C_{d(sub)}$ to be charged through R_D and resulting in a turn-off time that is long compared to the turn-on time. This is especially noticeable for the curves where $R_G \bullet 0$ and C_{gs} is charged through the pulse generator impedance only.

The switching curves shown with $R_G \bullet R_D$ simulate the switching behavior of cascaded stages where the driving source impedance is normally the same as the load impedance. The set of curves with $R_G \bullet 0$ simulates a low source impedance drive such as might occur in complementary logic circuits.

3N169
thru
3N171

CASE 20-03, STYLE 2
TO-72 (TO-206AF)



MOSFETs
SWITCHING

N-CHANNEL — ENHANCEMENT

Refer to 2N4351 for graphs.

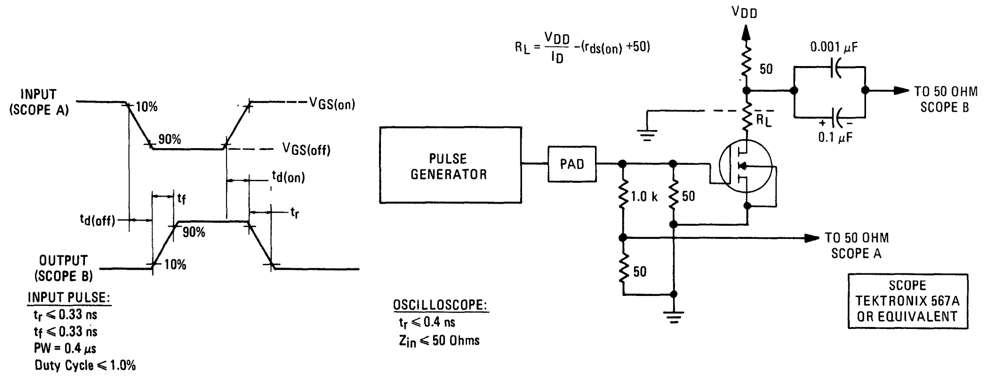
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	±35	Vdc
Gate-Source Voltage	V_{GS}	±35	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.7	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	800 4.56	mW mW/°C
Junction Temperature Range	T_J	175	°C
Storage Temperature Range	T_{stg}	−65 to +175	°C

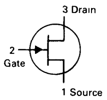
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($I_D = 10\ \mu Adc$, $V_{GS} = 0$)		$V_{(BR)DSX}$	25	—	Vdc
Zero-Gate-Voltage Drain Current		I_{DSS}			
($V_{DS} = 10$ Vdc, $V_{GS} = 0$)			—	10	nAdc
($V_{DS} = 10$ Vdc, $V_{GS} = 0$, $T_A = 125°C$)			—	1.0	μAdc
Gate Reverse Current		I_{GSS}			pAdc
($V_{GS} = -35$ Vdc, $V_{DS} = 0$)			—	10	
($V_{GS} = -35$ Vdc, $V_{DS} = 0$, $T_A = 125°C$)			—	100	
ON CHARACTERISTICS					
Gate Threshold Voltage		$V_{GS(Th)}$			Vdc
($V_{DS} = 10$ Vdc, $I_D = 10\ \mu Adc$)	3N169		0.5	1.5	
	3N170		1.0	2.0	
	3N171		1.5	3.0	
Drain-Source On-Voltage ($I_D = 10$ mAdc, $V_{GS} = 10$ Vdc)		$V_{DS(on)}$	—	2.0	Vdc
On-State Drain Current ($V_{GS} = 10$ Vdc, $V_{DS} = 10$ Vdc)		$I_{D(on)}$	10	—	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source Resistance ($V_{GS} = 10$ Vdc, $I_D = 0$, f = 1.0 kHz)		$r_{ds(on)}$	—	200	Ohms
Forward Transfer Admittance ($V_{DS} = 10$ Vdc, $I_D = 2.0$ mAdc, f = 1.0 kHz)		$\lvert y_{fs} \rvert$	1000	—	μmhos
Input Capacitance ($V_{DS} = 10$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 0$, f = 1.0 MHz)		C_{rss}	—	1.3	pF
Drain-Substrate Capacitance ($V_{D(SUB)} = 10$ Vdc, f = 1.0 MHz)		$C_{d(sub)}$	—	5.0	pF
SWITCHING CHARACTERISTICS					
Turn-On Delay Time	($V_{DD} = 10$ Vdc, $I_{D(on)} = 10$ mAdc, $V_{GS(on)} = 10$ Vdc, $V_{GS(off)} = 0$, $R_G' = 50$ Ohms) See Figure 1	$t_{d(on)}$	—	3.0	ns
Rise Time		t_r	—	10	ns
Turn-Off Delay Time		$t_{d(off)}$	—	3.0	ns
Fall Time		t_f	—	15	ns

FIGURE 1 — SWITCHING TIME TEST CIRCUIT

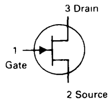


BF244, A, B, C

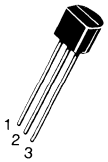


CASE 29-04, STYLE 22
TO-92 (TO-226AA)

BF245, A, B, C



CASE 29-04, STYLE 23
TO-92 (TO-226AA)



JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

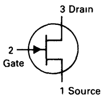
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	±30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Drain Current	I_D	100	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.88	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = 1.0 µAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	—	V
Gate-Source (V_{DS} = 15 Vdc, I_D = 200 µA)	BF245(1), BF244(2) BF245A, BF244A BF245B, BF244B BF245C, BF244C	V_{GS}	0.4 0.4 1.6 3.2	— — — —	7.5 2.2 3.8 7.5	V
Gate-Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nA)		$V_{GS(off)}$	−0.5	—	−8	V
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSS}	—	—	5	nA
ON CHARACTERISTICS						
Zero-Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	BF245(1), BF244(2) BF245A, BF244A BF245B, BF244B BF245C, BF244C	I_{DSS}	2 2 6 12		25 6.5 15 25	mA
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 KHz)		$\|Y_{fs}\|$	3.0		6.5	mmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 KHz)		$\|Y_{os}\|$		40		µmhos
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)		$\|Y_{fs}\|$		5.6		mmhos
Reverse Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 200 MHz)		$\|Y_{rs}\|$		1.0		mmhos
Input Capacitance (V_{DS} = 20 Vdc, $-V_{GS}$ = 1 Vdc)		C_{iss}		3		pF
Reverse Transfer Capacitance (V_{DS} = 20 Vdc, $-V_{GS}$ = 1 Vdc, f = 1 MHz)		C_{rss}		0.7		pF
Output Capacitance (V_{DS} = 20 Vdc, $-V_{GS}$ = 1 Vdc, f = 1 MHz)		C_{oss}		0.9		pF
Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0, R_G = 1 KΩ, f = 100 MHz)		N_F		1.5		db
Cut-off Frequency(3) (V_{DS} = 15 Vdc, V_{GS} = 0)		$F_{(Yfs)}$		700		MHz

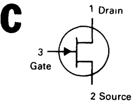
(1) On orders against the BF245, any or all subgroups might be shipped.
(2) On orders against the BF244, any or all subgroups might be shipped.
(3) The frequency at which gfs is 0.7 of its value at 1 KHz.

BF246, A, B, C

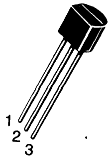


CASE 29-04, STYLE 22
TO-92 (TO-226AA)

BF247, A, B, C



CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

Refer to MPF4391 for graphs.

MAXIMUM RATINGS

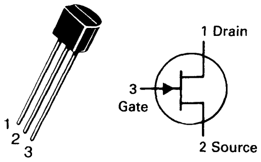
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	±25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Drain Current	I_D	100	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.88	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS							
Gate-Source Breakdown Voltage (I_G = 1 μA, V_{DS} = 0)			$V_{(BR)GSS}$	25	—	—	V
Gate-Source (V_{DS} = 15 V, I_D = 200 μA)	BF246,	BF247	V_{GS}	−0.5	—	−14	V
	BF246A,	BF247A		−1.5	—	−4	
	BF246B,	BF247B		−3	—	−7	
	BF246C,	BF247C		−5.5	—	−12	
Gate-Source Cutoff Voltage (V_{DS} = 15 V, I_D = 10 nA)			$V_{GS(off)}$	0.6	—	14.5	V
Gate Cutoff Current (V_{GS} = 15 V, V_{DS} = 0)			I_{GSS}	—	—	5	nA
ON CHARACTERISTICS							
Zero-Gate Voltage Drain Current (V_{DS} = 15 V, V_{GS} = 0)	BF246,	BF247	I_{DSS}	30		250	mA
	BF246A,	BF247A		30		80	
	BF246B,	BF247B		60		140	
	BF246C,	BF247C		110		250	
SMALL-SIGNAL CHARACTERISTICS							
Forward Transfer Admittance (V_{DS} = 15 V, I_D = 10 mA, f = 1 kHz)			$\lvert Y_{fs} \rvert$	8	23		mmhos
Reverse Transfer Capacitance (V_{DS} = 15 V, I_D = 10 mA, f = 1 kHz)			C_{rss}		3.3		pF
Input Capacitance (V_{DS} = 15 V, I_D = 10 mA, f = 1 MHz)			C_{in}		6		pF
Output Capacitance (V_{DS} = 15 V, I_D = 10 mA, f = 1 MHz)			C_{out}		5		pF
Cutoff Frequency (V_{DS} = 15 V, V_{GS} = 0)			$F_{(Yfs)}$		450		MHz

BF256, B, C

CASE 29-04, STYLE 23
TO-92 (TO-226AA)



JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	±30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Drain Current	I_D	100	mAdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.88	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

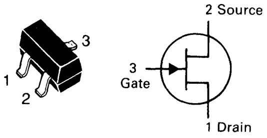
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	30	—	—	Vdc
Gate-Source Voltage (V_{DS} = 15 Vdc, I_D = 200 μA)	$V_{GS(off)}$	−0.5	—	−7.5	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	5	nAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current) (V_{DS} = 15 Vdc, V_{GS} = 0) BF256(1)	I_{DSS}	3	—	18	mAdc
BF256B		6	—	13	
BF256C		11	—	18	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1 kHz)	$\lvert Y_{fs} \rvert$	4.5	5	—	mmhos
Reverse Transfer Capacitance (V_{DS} = 20 Vdc, $-V_{GS}$ = 1Vdc, f = 1 MHz)	C_{rss}	—	0.7	—	pF
Output Capacitance (V_{DS} = 20 Vdc, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	1.0	—	pF
Noise Figure (V_{DS} = 10 Vdc, R_s = 47Ω, f = 800 MHz)	N_F	—	7.5	—	db
Cut-off Frequency(2) (V_{DS} = 15 Vdc, V_{GS} = 0)	f_{gfs}	—	1000	—	MHz
Power Gain (V_{DS} = 15 Vdc, R_s = 47 Ω, f =800 MHz)	G_p	—	11	—	dB

(1) On orders against the BF256, any or all subgroups might be shipped.
(2) The frequency at which gfs is 0.7 of its value at 1 kHz.

BFR30L
BFR31L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET AMPLIFIERS

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

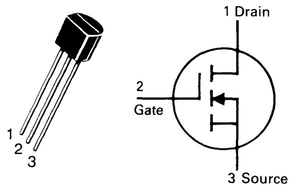
BFR30L = M1; BFR31L = M2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate Reverse Current (V_{GS} = 10 Vdc, V_{DS} = 0)		I_{GSS}	—	0.2	nAdc
Gate Source Cutoff Voltage (I_D = 0.5 nAdc, V_{DS} = 10 Vdc)	BFR30L BFR31L	$V_{GS(off)}$	— —	5.0 2.5	Vdc
Gate Source Voltage (I_D = 1.0 mAdc, V_{DS} = 10 Vdc)	BFR30L BFR31L	V_{GS}	−0.7 —	−3.0 −1.3	Vdc
(I_D = 50 µAdc, V_{DS} = 10 Vdc)	BFR30L BFR31L		— —	−4.0 −2.0	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain (V_{DS} = 10 Vdc, V_{GS} = 0)	BFR30L BFR31L	I_{DSS}	4.0 1.0	10 5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz)	BFR30L BFR31L	$\lvert Y_{fs} \rvert$	1.0 1.5	4.0 4.5	mAdc
(I_D = 200 µAdc, V_{DS} = 10 Vdc, f = 1.0 kHz)	BFR30L BFR31L		0.5 0.75	— —	
Output Admittance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 kHz)	BFR31L	$\lvert y_{os} \rvert$	40	25	µAdc
(I_D = 200 µAdc, V_{DS} = 10 Vdc)	BFR31L		20	15	
Input Capacitance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)		C_{iss}	—	5.0	pF
(I_D = 200 µAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)			—	4.0	
Reverse Transfer Capacitance (I_D = 1.0 mAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)		C_{rss}	—	1.5	pF
(I_D = 200 µAdc, V_{DS} = 10 Vdc, f = 1.0 MHz)			—	1.5	

BS107, A

CASE 29-04, STYLE 30
TO-92 (TO-226AA)



TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

Refer to MFE9200 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current			
Continuous(1)	I_D	250	mAdc
Pulsed(2)	I_{DM}	500	
Total Device Dissipation @ T_C = 25°C	P_D	0.6	Watts
Derate above 25°C			
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to 150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

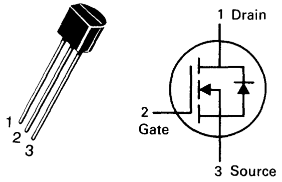
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 130 V, V_{GS} = 0)	I_{DSS}	—	—	30	nAdc
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSX}$	200	—	—	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0)	I_{GSS}	—	0.01	10	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (I_D = 1.0 mA, V_{DS} = V_{GS})	$V_{GS(Th)}$	1.0	—	3.0	Vdc
Static Drain-Source On Resistance	$r_{DS(on)}$				Ohms
BS107					
(V_{GS} = 2.6 V, I_D = 20 mA)					
(V_{GS} = 10 V, I_D = 200 mA)		—	—	28	
BS107A		—	—	14	
(V_{GS} = 10 Vdc)					
(I_D = 100 mA)		—	4.5	6.0	
(I_D = 250 mA)		—	4.8	6.4	
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	60	—	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	6.0	—	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	30	—	pF
Forward Transconductance (V_{DS} = 25 V, I_D = 250 mA)	g_{fs}	200	400	—	mmhos
SWITCHING CHARACTERISTICS					
Turn-On Time	t_{on}	—	6.0	15	ns
Turn-Off Time	t_{off}	—	12	15	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

BS170

CASE 29-04, STYLE 30
TO-92 (TO-226AA)



TMOS FET
SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	60	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current(1)	I_D	0.5	Adc
Total Device Dissipation @ $T_C = 25°C$	P_D	0.83	Watt
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate Reverse Current ($V_{GS} = 15$ V, $V_{DS} = 0$)	I_{GSS}	—	0.01	10	nAdc
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100\ \mu A$)	$V_{(BR)DSS}$	60	90	—	Vdc
ON CHARACTERISTICS(2)					
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1.0$ mA)	$V_{GS(Th)}$	0.8	2.0	3.0	Vdc
Static Drain-Source On Resistance ($V_{GS} = 10$ V, $I_D = 200$ mA)	$r_{DS(on)}$	—	1.8	5.0	Ohms
Drain Cutoff Current ($V_{DS} = 25$ V, $V_{GS} = 0$ V)	$I_{D(off)}$	—	—	0.5	μA
Forward Transconductance ($V_{DS} = 10$ V, $I_D = 250$ mA)	g_{fs}	—	200	—	mmhos
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance ($V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	60	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time ($I_D = 0.2$ A) See Figure 1	t_{on}	—	4.0	10	ns
Turn-Off Time ($I_D = 0.2$ A) See Figure 1	t_{off}	—	4.0	10	ns

(2) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

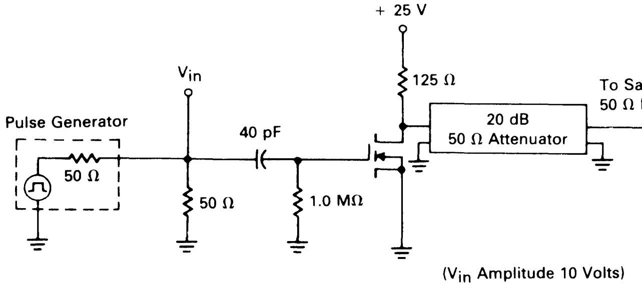


FIGURE 2 — SWITCHING WAVEFORMS

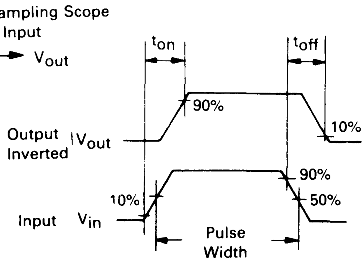


FIGURE 3 — $V_{GS(th)}$ NORMALIZED versus TEMPERATURE

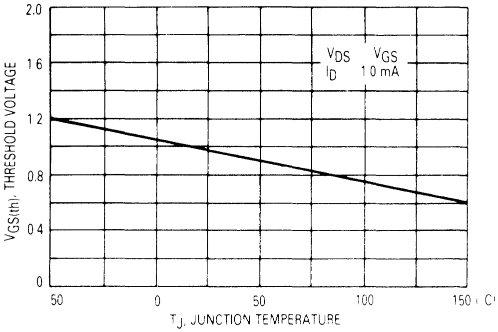


FIGURE 4 — ON-REGION CHARACTERISTICS

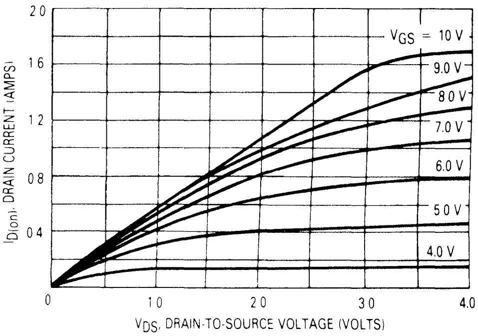


FIGURE 5 — OUTPUT CHARACTERISTICS

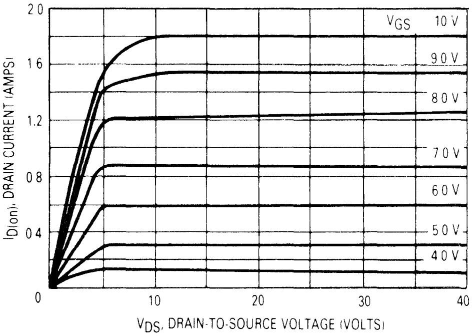
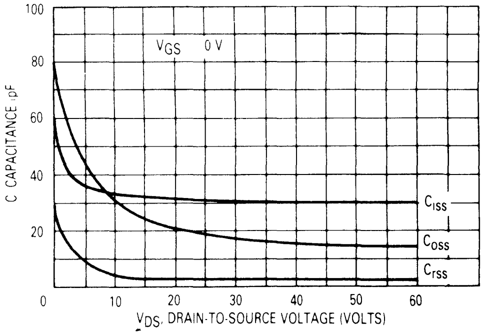
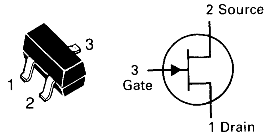


FIGURE 6 — CAPACITANCE versus DRAIN-TO-SOURCE VOLTAGE



BSR56L
thru
BSR58L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET SWITCHING TRANSISTORS

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	$\pm V_{DS}$	40	V
Drain-Gate Voltage	V_{DG}	40	V
Gate-Source Voltage	V_{GS}	40	V
Forward Gate Current	$I_{G(f)}$	50	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

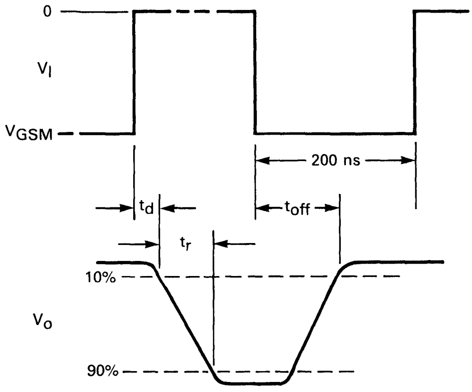
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

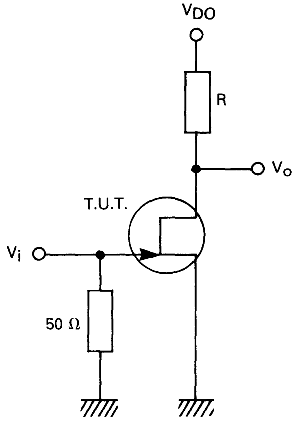
BSR56L = M4; BSR57L = M5; BSR58L = M6

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	40	—	Vdc
Gate-Reverse Current (V_{DS} = 0 V, V_{GS} = 20 V)		I_{GSS}	—	1.0	nA
Gate-Source Cutoff Voltage (V_{DS} = 15 V, I_D = 0.5 nA)	BSR56L	$V_{GS(off)}$	−4.0	−10	V
	BSR57L		−2.0	−6.0	
	BSR58L		−0.8	−4.0	
ON CHARACTERISTICS					
Zero-Gate Voltage Drain (V_{DS} = 15 V, V_{GS} = 0)	BSR56L	I_{DSS}	50	—	mA
	BSR57L		20	100	
	BSR58L		8.0	80	
Drain-Source On Voltage (I_D = 20 mA, V_{GS} = 0)	BSR56L	$V_{DS(on)}$	—	0.75	Vdc
(I_D = 10 mA, V_{GS} = 0)	BSR57L		—	0.5	
(I_D = 5.0 mA, V_{GS} = 0)	BSR58L		—	0.4	
Static Drain-Source On Resistance (I_D = 0 mAdc, V_{GS} = 0, f = 1.0 kHz)	BSR56L	$r_{DS(on)}$	—	25	Ohms
	BSR57L		—	40	
	BSR58L		—	60	
SWITCHING CHARACTERISTICS					
Delay Time: V_{DD} = 10 V; V_{GS} = 0 (V_{GSM} = 10 V, I_D = 20 mA)	BSR56L	t_d	—	6.0	ns
(V_{GSM} = 6.0 V, I_D = 10 mA)	BSR57L		—	6.0	
(V_{GSM} = 4.0 V, I_D = 5.0 mA)	BSR58L		—	10	
Rise Time: V_{DD} = 10 V; V_{GS} = 0 (V_{GSM} = 10 V, I_D = 20 mA)	BSR56L	t_r	—	3.0	ns
(V_{GSM} = 6.0 V, I_D = 10 mA)	BSR57L		—	4.0	
(V_{GSM} = 4.0 V, I_D = 5.0 mA)	BSR58L		—	10	
Turn-Off Time: V_{DD} = 10 V; V_{GS} = 0 (V_{GSM} = 10 V, I_D = 20 mA	BSR56L	t_{off}	—	25	ns
(V_{GSM} = 6.0 V, I_D = 10 mA)	BSR57L		—	50	
(V_{GSM} = 4.0 V, I_D = 5.0 mA)	BSR58L		—	100	



SWITCHING TIMES WAVEFORMS



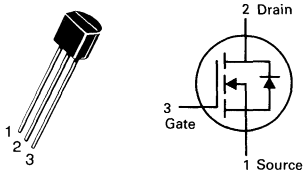
BSR56; R = 464 Ω
BSR57; R = 953 Ω
BSR58; R = 1910 Ω

Pulse Generator
$t_r = t_f \leqslant 1.0$ ns
$\delta = 0.02$
$Z_o = 50\ \Omega$

Oscilloscope
$t_r \leqslant 0.75$ ns
$R_i \geqslant 1\ M\Omega$
$C_i \leqslant 2.5$ pF

BSS89

CASE 29-04, STYLE 7
TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current — Continuous (1) — Pulsed (2)	I_D I_{DM}	400 800	mAdc
Total Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	0.6 4.8	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C
Thermal Resistance Junction to Ambient	θ_{JA}	208	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 0.5$ mA)	$V_{(BR)DSS}$	200	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 200$ V, $V_{GS} = 0$)	I_{DSS}	—	0.1	60	μAdc
Gate-Body Leakage Current ($V_{GS} = 20$ V, $V_{DS} = 0$)	I_{GSS}	—	0.01	100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage ($I_D = 1.0$ mA, $V_{DS} = V_{GS}$)	$V_{GS(th)}$	1.0	—	2.7	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V) ($I_D = 100$ mA) ($I_D = 300$ mA) ($I_D = 500$ mA)	$V_{DS(on)}$	 — — —	 0.45 1.2 3.0	 0.6 1.8 —	Vdc
On-State Drain Current ($V_{DS} = 25$ V, $V_{GS} = 10$ V)	$I_{D(on)}$	500	700	—	mA
Static Drain-Source On-Resistance ($V_{GS} = 10$ Vdc) ($I_D = 150$ mA) ($I_D = 300$ mA) ($I_D = 500$ mA)	$r_{DS(on)}$	 — — —	 4.5 — 6.0	 6.0 6.0 —	Ohms
Forward Transconductance ($V_{DS} = 25$ V, $I_D = 300$ mA)	g_{fs}	140	400	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	72	—	pF
Output Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{oss}	—	15	—	pF
Reverse Transfer Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{rss}	—	2.8	—	pF
SWITCHING CHARACTERISTICS*					
Turn-On Time (See Figure 1)	t_{on}	—	6.0	—	ns
Turn-Off Time (See Figure 1)	t_{off}	—	12	—	ns

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

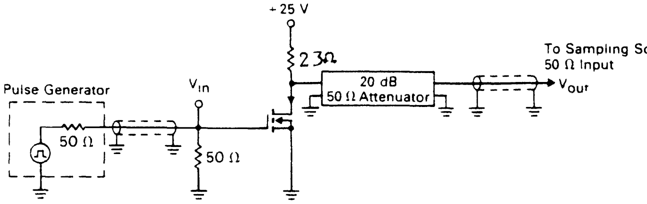


FIGURE 2 — SWITCHING WAVEFORMS

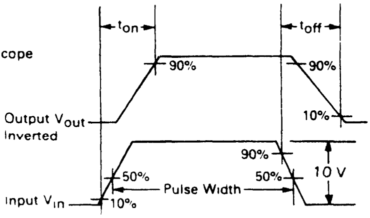


FIGURE 3 — ON VOLTAGE versus TEMPERATURE

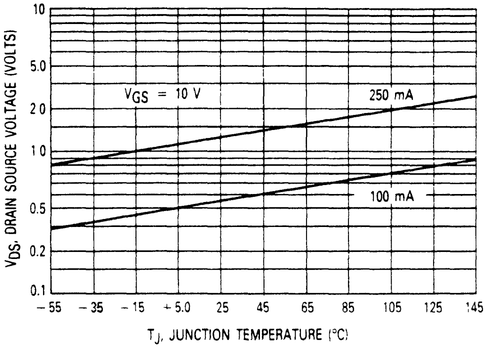


FIGURE 4 — CAPACITANCE VARIATION

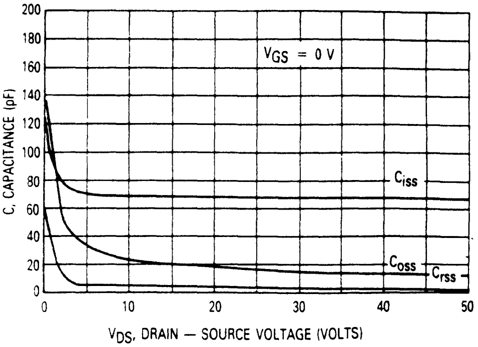


FIGURE 5 — TRANSFER CHARACTERISTIC

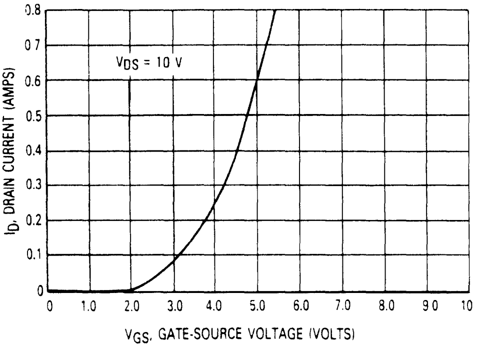


FIGURE 6 — OUTPUT CHARACTERISTIC

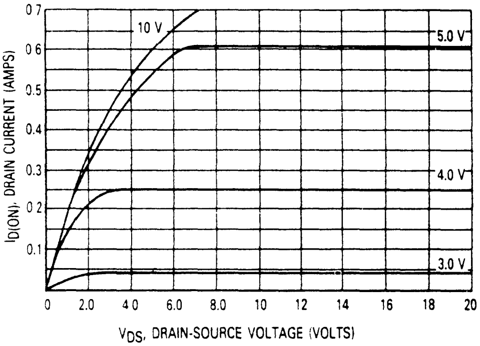
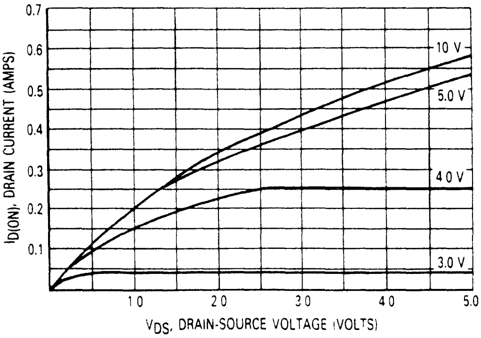
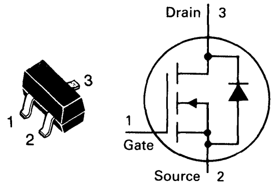


FIGURE 7 — SATURATION CHARACTERISTIC



BSS123L

CASE 318-03, STYLE 21
SOT-23 (TO-236AB)



TMOS FET TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	100	Vdc
Gate-Source Voltage	V_{GS}	±35	Vdc
Drain Current			Adc
Continuous (1)	I_D	0.17	
Pulsed (2)	I_{DM}	0.68	

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C	P_D	225	mW
Derate above 25°C		1.8	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C	P_D	300	mW
Derate above 25°C		2.4	mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

BSS123L = 5A

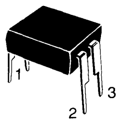
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

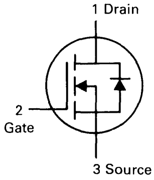
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	$V_{(BR)DSS}$	100	—	—	Vdc
Zero Gate Voltage Drain Current (V_{GS} = 0, V_{DS} = 100 V) T_J = 25°C T_J = 125°C	I_{DSS}	— —	— —	15 60	μAdc
Gate-Body Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	50	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.8	—	2.8	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 100 mA)	$r_{DS(on)}$	—	5.0	6.0	Ohms
Forward Transconductance (V_{DS} = 25 V, I_D = 100 mA)	g_{fs}	80	—	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	20	—	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	9.0	—	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	4.0	—	pF
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time (V_{CC} = 30 V, I_C = 0.28 A, V_{GS} = 10 V, R_{GS} = 50 Ω)	$t_{d(on)}$	—	20	—	ns
Turn-Off Delay Time	$t_{d(off)}$	—	40	—	ns
REVERSE DIODE					
Diode Forward On-Voltage (I_D = 0.34 A, V_{GS} = 0 V)	V_{SD}	—	—	1.3	V

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD1Z0
IRFD1Z3

FET DIP
CASE 370-01, STYLE 1





TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD1Z0	IRFD1Z3	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current				Adc
Continuous T_C = 25°C	I_D	0.5	0.4	
Pulsed	I_{DM}	4.0	3.2	
Total Power Dissipation	P_D			
@ T_C = 25°C		1.0		Watts
Derate above 25°C		8.0		mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient (Free Air Operation)	$R_{\theta JA}$	120	°C/W

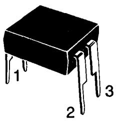
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

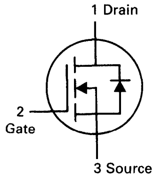
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFD1Z0 IRFD1Z3	$V_{(BR)DSS}$	100 60	— —	— —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)		I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)		I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = 20 V)		I_{GSSR}	—	—	500	nAdc
ON CHARACTERISTICS						
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})		$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = 10 Vdc, I_D = 0.25 A)	IRFD1Z0 IRFD1Z3	$r_{DS(on)}$	— —	— —	3.4 3.2	Ohms
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = 5.0 V)	IRFD1Z0 IRFD1Z3	$I_{D(on)}$	0.5 0.4	— —	— —	Adc
Forward Transconductance(1) (I_D = 0.25 A, V_{DS} = 5.0 V)		g_{fs}	0.25	—	—	mhos
CAPACITANCE						
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	70	pF
Output Capacitance		C_{oss}	—	—	30	
Reverse Transfer Capacitance		C_{rss}	—	—	10	
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	(V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.25 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	20	ns
Rise Time		t_r	—	—	25	
Turn-Off Delay Time		$t_{d(off)}$	—	—	25	
Fall Time		t_f	—	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS						
Diode Forward Voltage (V_{GS} = 0)(1)	I_S = 0.5 A, IRFD1Z0 I_S = 0.4 A, IRFD1Z3	V_F	— —	— —	1.4 1.3	Vdc
Continuous Source Current, Body Diode	IRFD1Z0 IRFD1Z3	I_S	— —	— —	0.5 0.4	Adc
Pulsed Source Current, Body Diode	IRFD1Z0 IRFD1Z3	I_{SM}	— —	— —	4.0 3.2	A
Forward Turn-On Time	(I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time		t_{rr}	—	100	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD110
IRFD113

FET DIP
CASE 370-01, STYLE 1





TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD110	IRFD113	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current				Adc
Continuous T_C = 25°C	I_D	1.0	0.8	
Pulsed	I_{DM}	8.0	6.4	
Total Power Dissipation	P_D			Watts
@ T_C = 25°C		1.0		
Derate above 25°C		8.0		mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	120	°C/W

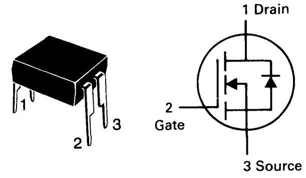
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFD110	$V_{(BR)DSS}$	100	—	—	Vdc
	IRFD113		60	—	—	
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)		I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)		I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)		I_{GSSR}	—	—	−500	nAdc
ON CHARACTERISTICS						
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})		$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = 10 Vdc, I_D = 0.8 A)	IRFD110	$r_{DS(on)}$	—	—	0.6	Ohms
	IRFD113		—	—	0.8	
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = 5.0 V)	IRFD110	$I_{D(on)}$	1.0	—	—	Adc
	IRFD113		0.8	—	—	
Forward Transconductance(1) (I_D = 0.8 A, V_{DS} = 5.0 V)		g_{fs}	0.8	—	—	mhos
CAPACITANCE						
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	200	pF
Output Capacitance		C_{oss}	—	—	100	
Reverse Transfer Capacitance		C_{rss}	—	—	25	
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	(V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.8 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	20	ns
Rise Time		t_r	—	—	25	
Turn-Off Delay Time		$t_{d(off)}$	—	—	25	
Fall Time		t_f	—	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS						
Diode Forward Voltage (V_{GS} = 0)	I_S = 1.0 A, IRFD110	V_F	—	—	2.5	Vdc
	I_S = 0.8 A, IRFD113		—	—	2.0	
Continuous Source Current, Body Diode	IRFD110	I_S	—	—	1.0	Adc
	IRFD113		—	—	0.8	
Pulsed Source Current, Body Diode	IRFD110	I_{SM}	—	—	8.0	A
	IRFD113		—	—	6.4	
Forward Turn-On Time	(I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time		t_{rr}	—	100	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD120
IRFD123

FET DIP
CASE 370-01, STYLE 1



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD120	IRFD123	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current				Adc
Continuous T_C = 25°C	I_D	1.3	1.1	
Pulsed	I_{DM}	5.2	4.4	
Total Power Dissipation	P_D			
@ T_C = 25°C		1.0		Watts
Derate above 25°C		8.0		mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	120	°C/W

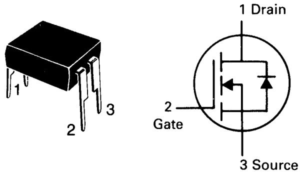
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFD120	$V_{(BR)DSS}$	100	—	—	Vdc
	IRFD123		60	—	—	
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)		I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)		I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)		I_{GSSR}	—	—	−500	nAdc
ON CHARACTERISTICS						
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})		$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = 10 Vdc, I_D = 0.6 A)	IRFD120	$r_{DS(on)}$	—	—	0.3	Ohms
	IRFD123		—	—	0.4	
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = 5.0 V)	IRFD120	$I_{D(on)}$	1.3	—	—	Adc
	IRFD123		1.1	—	—	
Forward Transconductance(1) (I_D = 0.6 A, V_{DS} = 5.0 V)		g_{fs}	0.9	—	—	mhos
CAPACITANCE						
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	600	pF
Output Capacitance		C_{oss}	—	—	400	
Reverse Transfer Capacitance		C_{rss}	—	—	100	
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	(V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.6 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	40	ns
Rise Time		t_r	—	—	70	
Turn-Off Delay Time		$t_{d(off)}$	—	—	100	
Fall Time		t_f	—	—	70	
SOURCE-DRAIN DIODE CHARACTERISTICS						
Diode Forward Voltage (V_{GS} = 0)	I_S = 1.3 A, IRFD120	V_{SD}	—	—	2.5	Vdc
	I_S = 1.1 A, IRFD123		—	—	2.3	
Continuous Source Current, Body Diode	IRFD120	I_S	—	—	1.3	Adc
	IRFD123		—	—	1.1	
Pulsed Source Current, Body Diode	IRFD120	I_{SM}	—	—	5.2	A
	IRFD123		—	—	4.4	
Forward Turn-On Time	(I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time		t_{rr}	—	280	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD210
IRFD213

FET DIP
CASE 370-01, STYLE 1



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD210	IRFD213	Unit
Drain-Source Voltage	V_{DSS}	200	150	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	200	150	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed	 I_D I_{DM}	 0.6 2.5	 0.45 1.8	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.0 0.008		 Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	120	°C/W

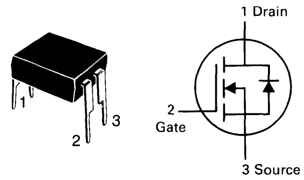
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA) IRFD210 IRFD213	$V_{(BR)DSS}$	 200 150	 — —	 — —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)	I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)	I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)	I_{GSSR}	—	—	−500	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})	$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = 10 Vdc, I_D = 0.3 A) IRFD210 IRFD213	$r_{DS(on)}$	 — —	 — —	 1.5 2.4	Ohms
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = 5.0 V) IRFD210, IRFD211 IRFD212, IRFD213	$I_{D(on)}$	 1.5 2.4	 — —	 — —	Adc
Forward Transconductance(1) (I_D = 0.3 A, V_{DS} = 5.0 V)	g_{fs}	0.5	—	—	mhos
CAPACITANCE					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	150	pF
Output Capacitance	C_{oss}	—	—	80	
Reverse Transfer Capacitance	C_{rss}	—	—	25	
SWITCHING CHARACTERISTICS					
Turn-On Delay Time (V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.3 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	15	ns
Rise Time	t_r	—	—	25	
Turn-Off Delay Time	$t_{d(off)}$	—	—	15	
Fall Time	t_f	—	—	15	
SOURCE-DRAIN DIODE CHARACTERISTICS					
Diode Forward Voltage (V_{GS} = 0) I_S = 0.6 A, IRFD210 I_S = 0.45 A, IRFD213	V_{SD}	— —	— —	2.0 1.8	Vdc
Continuous Source Current, Body Diode IRFD210 IRFD213	I_S	— —	— —	0.6 0.45	Adc
Pulsed Source Current, Body Diode IRFD210 IRFD213	I_{SM}	— —	— —	2.5 1.8	A
Forward Turn-On Time (I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time	t_{rr}	—	290	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD220
IRFD223

FET DIP
CASE 370-01, STYLE 1



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD220	IRFD223	Unit
Drain-Source Voltage	V_{DSS}	200	150	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	200	150	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed	I_D I_{DM}	0.8 2.4	0.7 5.6	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.0 0.008		Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	120	°C/W

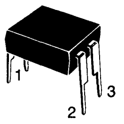
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

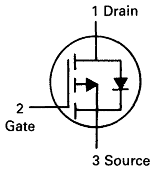
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA) IRFD220 IRFD223	$V_{(BR)DSS}$	200 150	— —	— —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)	I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)	I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)	I_{GSSR}	—	—	−500	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})	$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = 10 Vdc, I_D = 0.4 A) IRFD220 IRFD223	$r_{DS(on)}$	— —	— —	0.8 1.2	Ohms
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = 5.0 V) IRFD220 IRFD223	$I_{D(on)}$	0.8 0.7	— —	— —	Adc
Forward Transconductance(1) (I_D = 0.4 A, V_{DS} = 5.0 V)	g_{fs}	0.5	—	—	mhos
CAPACITANCE					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	600	pF
Output Capacitance	C_{oss}	—	—	300	
Reverse Transfer Capacitance	C_{rss}	—	—	80	
SWITCHING CHARACTERISTICS					
Turn-On Delay Time (V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.4 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	40	ns
Rise Time	t_r	—	—	60	
Turn-Off Delay Time	$t_{d(off)}$	—	—	100	
Fall Time	t_f	—	—	60	
SOURCE-DRAIN DIODE CHARACTERISTICS					
Diode Forward Voltage (V_{GS} = 0) I_S = 0.8 A, IRFD220 I_S = 0.7 A, IRFD223	V_{SD}	— —	— —	2.0 1.8	Vdc
Continuous Source Current, Body Diode IRFD220 IRFD223	I_S	— —	— —	0.8 0.7	Adc
Pulsed Source Current, Body Diode IRFD220 IRFD223	I_{SM}	— —	— —	6.4 5.6	A
Forward Turn-On Time (I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time	t_{rr}	—	150	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD9110
IRFD9112

FET DIP
CASE 370-01, STYLE 1





TMOS FET TRANSISTORS

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD9110	IRFD9112	Unit
Drain-Source Voltage	V_{DSS}	−100		Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	−100		Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed	 I_D I_{DM}	 −0.7 −3.0	 −0.6 −2.5	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.0 8.0		 Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient (Free Air Operation)	$R_{\theta JA}$	120	°C/W

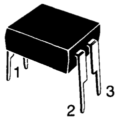
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

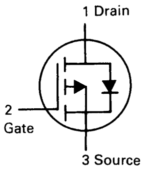
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = −250 μA)		$V_{(BR)DSS}$	100	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)		I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = −20 V)		I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = 20 V)		I_{GSSR}	—	—	500	nAdc
ON CHARACTERISTICS						
Gate Threshold Voltage (I_D = −250 μA, V_{DS} = V_{GS})		$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = −10 Vdc, I_D = −0.3 A)	IRFD9110 IRFD9112	$r_{DS(on)}$	— —	— —	1.2 1.6	Ohms
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = −5.0 V)	IRFD9110 IRFD9112	$I_{D(on)}$	0.7 0.6	— —	— —	Adc
Forward Transconductance(1) (I_D = −0.3 A, V_{DS} = −5.0 V)		g_{fs}	0.6	—	—	mhos
CAPACITANCE						
Input Capacitance	(V_{DS} = −25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	250	pF
Output Capacitance		C_{oss}	—	—	100	
Reverse Transfer Capacitance		C_{rss}	—	—	35	
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	(V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = −0.3 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	30	ns
Rise Time		t_r	—	—	60	
Turn-Off Delay Time		$t_{d(off)}$	—	—	40	
Fall Time		t_f	—	—	40	
SOURCE-DRAIN DIODE CHARACTERISTICS						
Diode Forward Voltage (V_{GS} = 0)	I_S = −0.7 A, IRFD9110 I_S = −0.6 A, IRFD9112	V_{SD}	— —	— —	−5.5 −5.3	Vdc
Continuous Source Current, Body Diode	IRFD9110 IRFD9112	I_S	— —	— —	−0.7 −0.6	Adc
Pulsed Source Current, Body Diode	IRFD9110 IRFD9112	I_{SM}	— —	— —	−3.0 −2.5	A
Forward Turn-On Time	(I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time		t_{rr}	—	120	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFD9120
IRFD9123

FET DIP
CASE 370-01, STYLE 1





TMOS FET TRANSISTORS

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFD9120	IRFD9123	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed	 I_D I_{DM}	 1.0 8.0	 0.8 6.4	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	 1.0 8.0		 Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient (Free Air Operation)	$R_{\theta JA}$	120		°C/W

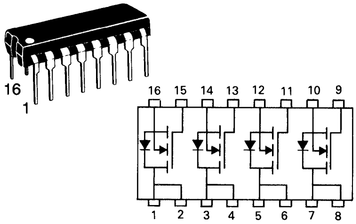
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = −250 μA)	IRFD9120 IRFD9123	$V_{(BR)DSS}$	100 60	— —	— —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)		I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = −20 V)		I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = 20 V)		I_{GSSR}	—	—	500	nAdc
ON CHARACTERISTICS						
Gate Threshold Voltage (I_D = −250 μA, V_{DS} = V_{GS})		$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) (V_{GS} = −10 Vdc, I_D = −0.8 A)	IRFD9120 IRFD9123	$r_{DS(on)}$	— —	— —	0.6 0.8	Ohms
On-State Drain Current(1) (V_{GS} = 10 V, V_{DS} = −5.0 V)	IRFD9120 IRFD9123	$I_{D(on)}$	1.0 0.8	— —	— —	Adc
Forward Transconductance(1) (I_D = −0.8 A, V_{DS} = −5.0 V)		g_{fs}	0.8	—	—	mhos
CAPACITANCE						
Input Capacitance	(V_{DS} = −25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	450	pF
Output Capacitance		C_{oss}	—	—	350	
Reverse Transfer Capacitance		C_{rss}	—	—	100	
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	(V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = −0.8 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	50	ns
Rise Time		t_r	—	—	100	
Turn-Off Delay Time		$t_{d(off)}$	—	—	100	
Fall Time		t_f	—	—	100	
SOURCE-DRAIN DIODE CHARACTERISTICS						
Diode Forward Voltage (V_{GS} = 0)	I_S = −1.0 A, IRFD9120 I_S = −0.8 A, IRFD9123	V_F	— —	— —	6.3 6.0	Vdc
Continuous Source Current, Body Diode	IRFD9120 IRFD9123	I_S	— —	— —	1.0 0.8	Adc
Pulsed Source Current, Body Diode	IRFD9120 IRFD9123	I_{SM}	— —	— —	8.0 6.4	A
Forward Turn-On Time	(I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time		t_{rr}	—	150	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFE110
IRFE113

CASE 648-08, STYLE 2



QUAD TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating		Symbol	IRFE110	IRFE113	Unit
Drain-Source Voltage		V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)		V_{DGR}	100	60	Vdc
Gate-Source Voltage		V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed		 I_D I_{DM}	 1.0 8.0	 0.8 6.4	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	Package	P_D	3.0 30		Watts mW/°C
	Per Device		1.0 8.0		Watt mW/°C
Operating and Storage Temperature Range		T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient (Free Air Operation)	$R_{\theta JA}$	40 Total Package 125 Each FET	°C/W

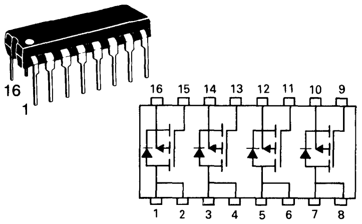
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS EACH FET					
Drain-Source Breakdown Voltage IRFE110 (V_{GS} = 0, I_D = 250 μA) IRFE113	$V_{(BR)DSS}$	100 60	— —	— —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)	I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)	I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)	I_{GSSR}	—	—	500	nAdc
ON CHARACTERISTICS EACH FET					
Gate Threshold Voltage (I_D = 250 μA, V_{DS} = V_{GS})	$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) IRFE110 (V_{GS} = 10 Vdc, I_D = 0.8 A) IRFE113	$r_{DS(on)}$	— —	— —	0.6 0.8	Ohms
On-State Drain Current(1) IRFE110 (V_{GS} = 10 V, V_{DS} = 5.0 V) IRFE113	$I_{D(on)}$	1.0 0.8	— —	— —	Adc
Forward Transconductance(1) (I_D = 0.8 A, V_{DS} = 5.0 V)	g_{fs}	0.8	—	—	mhos
CAPACITANCE EACH FET					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	200	pF
Output Capacitance	C_{oss}	—	—	100	
Reverse Transfer Capacitance	C_{rss}	—	—	25	
SWITCHING CHARACTERISTICS EACH FET					
Turn-On Delay Time (V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = 0.8 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	20	ns
Rise Time	t_r	—	—	25	
Turn-Off Delay Time	$t_{d(off)}$	—	—	25	
Fall Time	t_f	—	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS EACH FET					
Diode Forward Voltage (V_{GS} = 0) I_S = 1.0 A, IRFE110 I_S = 0.8 A, IRFE113	V_F	— —	— —	2.5 2.0	Vdc
Continuous Source Current, Body Diode IRFE110 IRFE113	I_S	— —	— —	1.0 0.8	Adc
Pulsed Source Current, Body Diode IRFE110 IRFE113	I_{SM}	— —	— —	8.0 6.4	A
Forward Turn-On Time (I_S = Rated I_S, V_{GS} = 0)	t_{on}	negligible			ns
Reverse Recovery Time	t_{rr}	—	100	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFE9120
IRFE9123

CASE 648-08, STYLE 2



QUAD TMOS FET TRANSISTORS

P-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating		Symbol	IRFE9120	IRFE9123	Unit
Drain-Source Voltage		V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 20 kΩ)		V_{DGR}	100	60	Vdc
Gate-Source Voltage		V_{GS}	±20		Vdc
Drain Current Continuous T_C = 25°C Pulsed		 I_D I_{DM}	 1.0 8.0	 0.8 6.4	Adc
Total Power Dissipation @ T_C = 25°C	Package	P_D	3.0 30		Watts mW/°C
Derate above 25°C	Per Device		1.0 8.0		Watt mW/°C
Operating and Storage Temperature Range		T_J, T_{stg}	−55 to +150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient (Free Air Operation)	$R_{\theta JA}$	40 Total Package 125 Each FET	°C/W

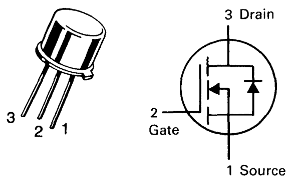
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS EACH FET					
Drain-Source Breakdown Voltage IRFE9120 (V_{GS} = 0, I_D = −250 μA) IRFE9123	$V_{(BR)DSS}$	100 60	— —	— —	Vdc
Zero Gate Voltage Drain Current (V_{DSS} = Rated V_{DSS}, V_{GS} = 0 V)	I_{DSS}	—	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 20 V)	I_{GSSF}	—	—	500	nAdc
Gate-Body Leakage Current, Reverse (V_{GSR} = −20 V)	I_{GSSR}	—	—	500	nAdc
ON CHARACTERISTICS EACH FET					
Gate Threshold Voltage (I_D = −250 μA, V_{DS} = V_{GS})	$V_{GS(th)}$	2.0	—	4.0	Vdc
Static Drain-Source On-Resistance(1) IRFE9120 (V_{GS} = −10 Vdc, I_D = −0.8 A) IRFE9123	$r_{DS(on)}$	— —	— —	0.6 0.8	Ohms
On-State Drain Current(1) IRFE9120 (V_{GS} = −10 V, V_{DS} = 5.0 V) IRFE9123	$I_{D(on)}$	1.0 0.8	— —	— —	Adc
Forward Transconductance(1) (I_D = −0.8 A, V_{DS} = 5.0 V)	g_{fs}	0.8	—	—	mhos
CAPACITANCE EACH FET					
Input Capacitance (V_{DS} = −25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	—	450	pF
Output Capacitance	C_{oss}	—	—	350	
Reverse Transfer Capacitance	C_{rss}	—	—	100	
SWITCHING CHARACTERISTICS EACH FET					
Turn-On Delay Time (V_{DS} ≈ 0.5 $V_{(BR)DSS}$, I_D = −0.8 A, Z_o = 50 Ω)	$t_{d(on)}$	—	—	50	ns
Rise Time	t_r	—	—	100	
Turn-Off Delay Time	$t_{d(off)}$	—	—	100	
Fall Time	t_f	—	—	100	
SOURCE-DRAIN DIODE CHARACTERISTICS EACH FET					
Diode Forward Voltage (V_{GS} = 0) I_S = −1.0 A, IRFE9120 I_S = −0.8 A, IRFE9123	V_F	— —	— —	6.3 6.0	Vdc
Continuous Source Current, Body Diode IRFE9120 IRFE9123	I_S	— —	— —	1.0 0.8	Adc
Pulsed Source Current, Body Diode IRFE9120 IRFE9123	I_{SM}	— —	— —	8.0 6.4	A
Forward Turn-On Time (I_S = Rated I_S, V_{GS} = 0)	t_{on}		negligible		ns
Reverse Recovery Time	t_{rr}	—	150	—	

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF110
IRFF113

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF110	IRFF113	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 3.5 14	 3.0 12	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	15 0.12		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	8.33	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

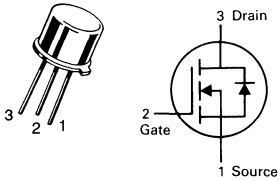
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF110 IRFF113	$V_{(BR)DSS}$	100 60	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 1.5 Adc)	IRFF110 IRFF113	$r_{DS(on)}$	— —	0.6 0.8	Ohm
On-State Drain Current (V_{GS} = 10 Vdc, V_{DS} = 15 V)	IRFF110 IRFF113	$I_{D(on)}$	3.5 3.0	— —	A
Forward Transconductance (I_D = 1.5 A, V_{DS} = 15 V)		g_{fs}	1.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	200	pF
Output Capacitance		C_{oss}	—	100	
Reverse Transfer Capacitance		C_{rss}	—	25	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 0.5 Rated V_{DSS}, I_D = 1.5 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	20	ns
Rise Time		t_r	—	25	
Turn-Off Delay Time		$t_{d(off)}$	—	25	
Fall Time		t_f	—	20	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF110	V_{SD}	—	2.5	Vdc
	IRFF113	V_{SD}	—	2.0	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	200 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF120
IRFF123

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF120	IRFF123	Unit
Drain-Source Voltage	V_{DSS}	100	60	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	100	60	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current				Adc
Continuous	I_D	6.0	5.0	
Pulsed	I_{DM}	24	20	
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	20 0.16		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	6.25	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

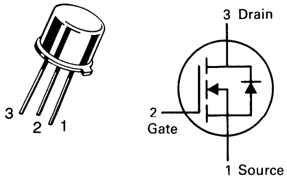
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF120 IRFF123	$V_{(BR)DSS}$	100 60	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 3.0 Adc)	IRFF120 IRFF123	$r_{DS(on)}$	— —	0.3 0.4	Ohm
On-State Drain Current (V_{GS} = 10 V, V_{DS} = 15 V)	IRFF120 IRFF123	$I_{D(on)}$	6.0 5.0	— —	A
Forward Transconductance (I_D = 3.0 A, V_{DS} = 15 V)		g_{fs}	1.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	600	pF
Output Capacitance		C_{oss}	—	400	
Reverse Transfer Capacitance		C_{rss}	—	100	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 0.5 Rated V_{DSS}, I_D = 3.0 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	40	ns
Rise Time		t_r	—	70	
Turn-Off Delay Time		$t_{d(off)}$	—	100	
Fall Time		t_f	—	70	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF120	V_{SD}	—	2.5	Vdc
	IRFF123	V_{SD}	—	2.3	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	200 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF210
IRFF213

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF210	IRFF213	Unit
Drain-Source Voltage	V_{DSS}	200	150	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	150	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 2.2 9.0	 1.8 7.5	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	15 0.12		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	8.33	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

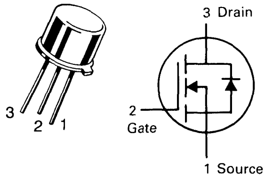
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF210 IRFF213	$V_{(BR)DSS}$	200 150	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 1.25 A)	IRFF210 IRFF213	$r_{DS(on)}$	— —	1.5 2.4	Ohm
Forward Transconductance (I_D = 1.25 A, V_{DS} = 5.0 V)		g_{fs}	0.8	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	200	pF
Output Capacitance		C_{oss}	—	80	
Reverse Transfer Capacitance		C_{rss}	—	25	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} = 0.5 Rated V_{DSS}, I_D = 1.25 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	15	ns
Rise Time		t_r	—	25	
Turn-Off Delay Time		$t_{d(off)}$	—	15	
Fall Time		t_f	—	15	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF210	V_{SD}	—	2.0	Vdc
	IRFF213	V_{SD}	—	1.8	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	200 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF220
IRFF223

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF220	IRFF223	Unit
Drain-Source Voltage	V_{DSS}	200	150	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	150	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current				Adc
Continuous	I_D	3.5	3.0	
Pulsed	I_{DM}	14	12	
Total Power Dissipation @ T_C = 25°C	P_D	20		Watts
Derate above 25°C		0.16		W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	6.25	°C/W
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	175	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

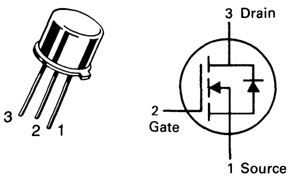
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF220 IRFF223	$V_{(BR)DSS}$	200 150	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 2.0 Adc)	IRFF220 IRFF223	$r_{DS(on)}$	— —	0.8 1.2	Ohm
On-State Drain Current (V_{GS} = 10 Vdc, V_{DS} = 5.0 Vdc)	IRFF220 IRFF223	$I_{D(on)}$	3.5 3.0	— —	A
Forward Transconductance (I_D = 2.0 A, V_{DS} = 5.0 V)		g_{fs}	1.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	600	pF
Output Capacitance		C_{oss}	—	300	
Reverse Transfer Capacitance		C_{rss}	—	80	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 0.5 Rated $V_{(BR)DSS}$, I_D = 2.0 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	40	ns
Rise Time		t_r	—	60	
Turn-Off Delay Time		$t_{d(off)}$	—	100	
Fall Time		t_f	—	60	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF220	V_{SD}	—	2.0	Vdc
	IRFF223	V_{SD}	—	1.8	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	350 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF230
IRFF233

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF230	IRFF233	Unit
Drain-Source Voltage	V_{DSS}	200	150	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	200	150	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 5.5 22	 4.5 18	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

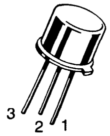
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

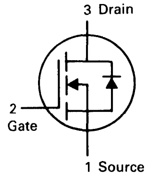
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF230 IRFF233	$V_{(BR)DSS}$	200 150	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 3.0 A)	IRFF230 IRFF233	$r_{DS(on)}$	— —	0.4 0.6	Ohm
Forward Transconductance (I_D = 3.0 A, V_{DS} = 5.0 V)		g_{fs}	2.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	800	pF
Output Capacitance		C_{oss}	—	450	
Reverse Transfer Capacitance		C_{rss}	—	150	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 90 V, I_D = 3.0 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	50	
Turn-Off Delay Time		$t_{d(off)}$	—	50	
Fall Time		t_f	—	40	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF230	V_{SD}	—	2.0	Vdc
	IRFF233	V_{SD}	—	1.8	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	450 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF330
IRFF333

CASE 79-05, STYLE 6
TO-39 (TO-205AF)





TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF330	IRFF333	Unit
Drain-Source Voltage	V_{DSS}	400	350	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	400	350	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 3.5 14	 3.0 12	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

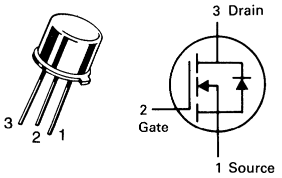
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 250 μA)	IRFF330 IRFF333	$V_{(BR)DSS}$	400 350	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)		I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)		I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)		I_{GSSR}	—	100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)		$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 2.0 Adc)	IRFF330 IRFF333	$r_{DS(on)}$	— —	1.0 1.5	Ohm
On-State Drain Current (V_{GS} = 10 V, V_{DS} = 5.0 V)	IRFF330 IRFF333	$I_{D(on)}$	3.5 3.0	— —	A
Forward Transconductance (I_D = 2.0 A, V_{DS} = 5.0 V)		g_{fs}	2.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance	(V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	900	pF
Output Capacitance		C_{oss}	—	300	
Reverse Transfer Capacitance		C_{rss}	—	80	
SWITCHING CHARACTERISTICS*					
Turn-On Delay Time	(V_{DD} ≈ 175 V, I_D = 2.0 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time		t_r	—	35	
Turn-Off Delay Time		$t_{d(off)}$	—	55	
Fall Time		t_f	—	35	
SOURCE-DRAIN DIODE CHARACTERISTICS*					
Forward On-Voltage	IRFF330	V_{SD}	—	1.6	Vdc
	IRFF333	V_{SD}	—	1.5	Vdc
Forward Turn-On Time	(I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time		t_{rr}	—	600 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

IRFF430
IRFF433

CASE 79-05, STYLE 6
TO-39 (TO-205AF)



TMOS FET TRANSISTORS

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	IRFF430	IRFF433	Unit
Drain-Source Voltage	V_{DSS}	500	450	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 mΩ)	V_{DGR}	500	450	Vdc
Gate-Source Voltage	V_{GS}	±20		Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 2.75 11	 2.25 9.0	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2		Watts W/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case	$R_{\theta JC}$	5.0	°C/W
Maximum Lead Temperature 1.6 mm from Case for 10 s	T_L	300	°C

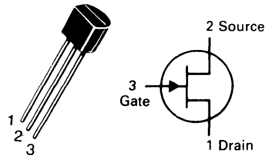
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage IRFF430 (V_{GS} = 0, I_D = 250 μA) IRFF433	$V_{(BR)DSS}$	500 450	— —	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Rated V_{DSS}, V_{GS} = 0)	I_{DSS}	—	250	μAdc
Gate-Body Leakage Current, Forward (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSSF}	—	100	nAdc
Gate-Body Leakage Current, Reverse (V_{GS} = −20 Vdc, V_{DS} = 0)	I_{GSSR}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 250 μA)	$V_{GS(th)}$	2.0	4.0	Vdc
Static Drain-Source On-Resistance IRFF430 (V_{GS} = 10 Vdc, I_D = 1.5 Adc) IRFF433	$r_{DS(on)}$	— —	1.5 2.0	Ohm
On-State Drain Current IRFF430 (V_{GS} = 10 Vdc, V_{DS} = 5.0 V) IRFF433	$I_{D(on)}$	2.75 2.25	— —	A
Forward Transconductance (V_{DS} = 5.0 Vdc, I_D = 1.5 A)	g_{fs}	1.5	—	mhos
DYNAMIC CHARACTERISTICS				
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	800	pF
Output Capacitance	C_{oss}	—	200	
Reverse Transfer Capacitance	C_{rss}	—	60	
SWITCHING CHARACTERISTICS*				
Turn-On Delay Time (V_{DD} ≈ 225 V, I_D = 1.5 A, R_{gen} = 50 ohms)	$t_{d(on)}$	—	30	ns
Rise Time	t_r	—	30	
Turn-Off Delay Time	$t_{d(off)}$	—	55	
Fall Time	t_f	—	30	
SOURCE-DRAIN DIODE CHARACTERISTICS*				
Forward On-Voltage IRFF430	V_{SD}	—	1.4	Vdc
IRFF433	V_{SD}	—	1.3	Vdc
Forward Turn-On Time (I_S = Rated $I_{D(on)}$, V_{GS} = 0)	t_{on}	—	Negligible	ns
Reverse Recovery Time	t_{rr}	—	800 (Typ)	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

J107 thru J110

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET GENERAL-PURPOSE TRANSISTORS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	−25	Vdc
Gate-Source Voltage	V_{GS}	−25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Junction Temperature Range	T_J	135	°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (V_{DS} = 0, I_G = −10 μAdc)		$V_{(BR)GSS}$	−25	—	—	Vdc
Gate Reverse Current		I_{GSS}				nAdc
(V_{GS} = −15 Vdc, V_{DS} = 0)			—	—	−3.0	
(V_{GS} = −15 Vdc, V_{DS} = 0, T_A = 100°C)			—	—	−200	
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
(V_{DS} = 15 Vdc, I_D = 10 nAdc)	J107		−0.5	—	−4.5	
	J108		−3.0	—	−10	
	J109		−2.0	—	−6.0	
	J110		−0.5	—	−4.0	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1)		I_{DSS}				mAdc
(V_{DS} = 15, V_{GS} = 0)	J107		100	—	—	
	J108		80	—	—	
	J109		40	—	—	
	J110		10	—	—	
Drain-Source On-Resistance		$r_{DS(on)}$				ohms
(V_{DS} < 0.1 V, V_{GS} = 0 V)	J107		—	—	8.0	
	J108		—	—	8.0	
	J109		—	—	12	
	J110		—	—	18	
SMALL-SIGNAL CHARACTERISTICS						
Drain Gate + Source Gate On-Capacitance (V_{DS} = 0 Vdc, V_{GS} = 0, f = 1.0 MHz)		$C_{dg(on)}$ + $C_{sg(on)}$	—	—	85	pF
Drain Gate Off-Capacitance (V_{DS} = 0 Vdc, V_{GS} = −10 V, f = 1.0 MHz)		$C_{dg(off)}$	—	—	15	pF
Source Gate Off-Capacitance (V_{DS} = 0 Vdc, V_{GS} = −10 V, f = 1.0 MHz)		$C_{sg(off)}$	—	—	15	pF

(1) Pulse Duration 300 μs, Duty Cycle ≤ 2.0%.

FIGURE 1 — COMMON SOURCE INPUT CAPACITANCE versus GATE-SOURCE VOLTAGE

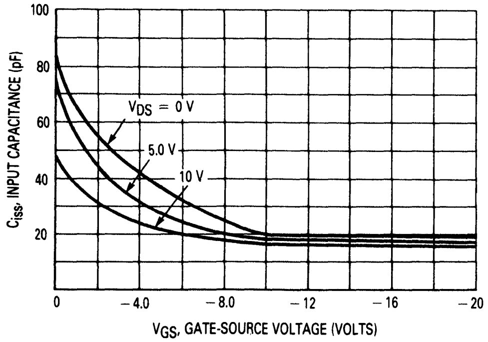


FIGURE 2 — COMMON SOURCE REVERSE FEEDBACK CAPACITANCE versus GATE-SOURCE VOLTAGE

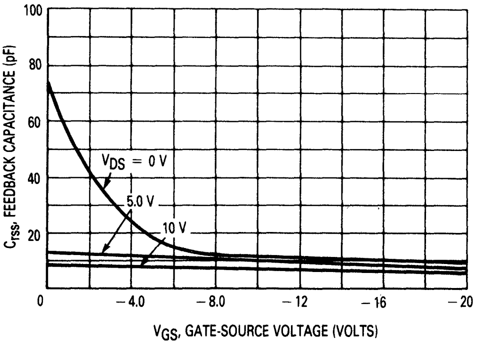


FIGURE 3 — ON-RESISTANCE versus GATE-SOURCE CUTOFF VOLTAGE

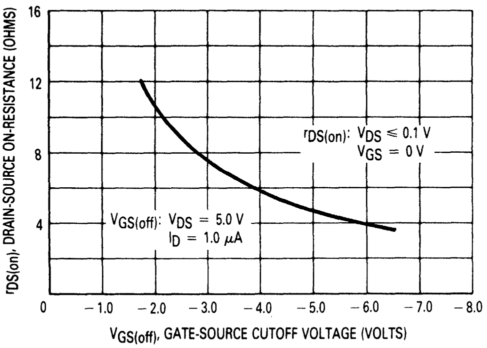


FIGURE 4 — OUTPUT CHARACTERISTIC

$V_{GS(off)} = -2.0$ V

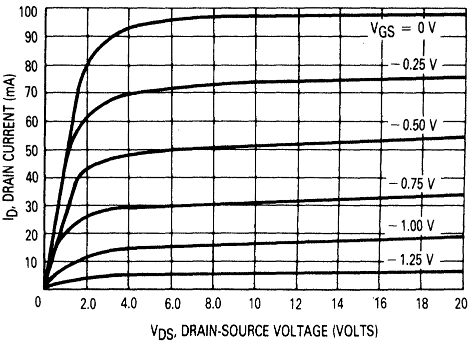


FIGURE 5 — OUTPUT CHARACTERISTIC

$V_{GS(off)} = -3.0$ V

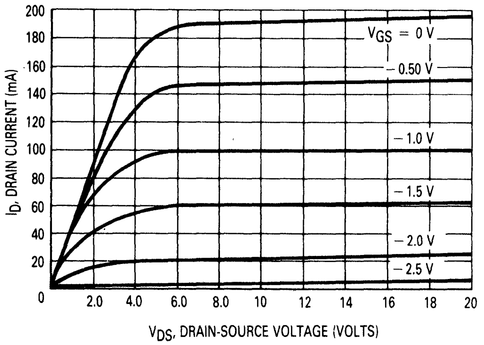


FIGURE 6 — OUTPUT CHARACTERISTIC

$V_{GS(off)} = -4.0$ V

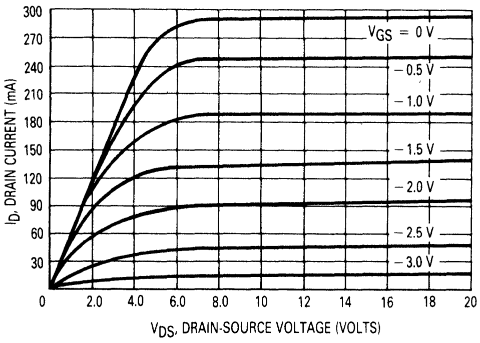
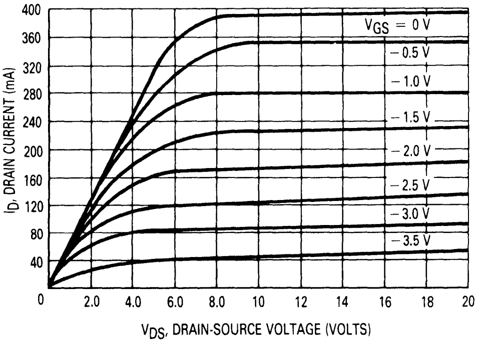


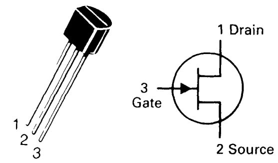
FIGURE 7 — OUTPUT CHARACTERISTIC

$V_{GS(off)} = -5.0$ V



J111 thru J113

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET CHOPPER TRANSISTORS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	−35	Vdc
Gate-Source Voltage	V_{GS}	−35	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.68	mW mW/°C
Lead Temperature	T_L	300	°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

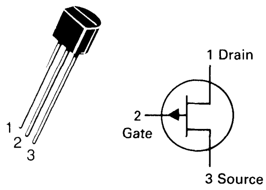
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu A$)		$V_{(BR)GSS}$	35	—	Vdc
Gate Reverse Current ($V_{GS} = -15$ V)		I_{GSS}	—	−1.0	nA
Gate Source Cutoff Voltage ($V_{DS} = 5.0$ V, $I_D = 1.0\ \mu A$)	J111 J112 J113	$V_{GS(off)}$	−3.0 −1.0 −0.5	−10 −5.0 −3.0	V
Drain-Cutoff Current ($V_{DS} = 5.0$ V, $V_{GS} = -10$ V)		$I_{D(off)}$	—	1.0	nA
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current* ($V_{DS} = 15$ V)	J111 J112 J113	I_{DSS}	20 5.0 2.0	— — —	mA
Static Drain-Source On Resistance ($V_{DS} = 0.1$ V)	J111 J112 J113	$r_{DS(on)}$	— — —	30 50 100	Ohms
Drain Gate and Source Gate On-Capacitance ($V_{DS} = V_{GS} = 0$, f = 1.0 MHz)		$C_{dg(on)} + C_{sg(on)}$	—	28	pF
Drain Gate Off-Capacitance ($V_{GS} = -10$ V, f = 1.0 MHz)		$C_{dg(off)}$	—	5.0	pF
Source Gate Off-Capacitance ($V_{GS} = -10$ V, f = 1.0 MHz)		$C_{sg(off)}$	—	5.0	pF

*Pulse Width = 300 μs, Duty Cycle = 3.0%.

J174 thru J177

CASE 29-04, STYLE 30
TO-92 (TO-226AA)



JFET CHOPPER TRANSISTORS

P-CHANNEL — DEPLETION

Refer to MPF970 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

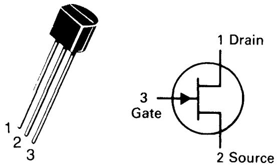
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current ($V_{GS} = 20$ Volts)		I_{GSS}	—	1.0	nA
Gate Source Cutoff Voltage		$V_{GS(off)}$			Vdc
($V_{DS} = -15$ V, $I_D = -10$ nA)	J174		5.0	10	
	J175		3.0	6.0	
	J176		1.0	4.0	
	J177		0.8	2.5	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current		I_{DSS}*			mA
($V_{DS} = -15$ V)	J174		−2.0	−100	
	J175		−7.0	−60	
	J176		−2.0	−25	
	J177		−1.5	−20	
Static Drain-Source On Resistance		$r_{DS(on)}$			Ω
($V_{DS} \leqslant -0.1$ Volt)	J174		—	85	
	J175		—	125	
	J176		—	250	
	J177		—	300	

*Pulse Width = 300 μs, Duty Cycle ≤ 3.0%.

J201 thru J203

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
LOW FREQUENCY/LOW NOISE

N-CHANNEL — DEPLETION

Refer to 2N4220 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	40	Vdc
Drain-Gate Voltage	V_{DG}	40	Vdc
Gate-Source Voltage	V_{GS}	40	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	310 2.82	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

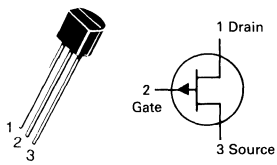
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu A$)		$V_{(BR)GSS}$	−40	—	Vdc
Gate Reverse Current ($V_{GS} = -20$ V)		I_{GSS}	—	−100	pA
Gate Source Cutoff Voltage ($V_{DS} = 20$ V, $I_D = 10$ nA)	J201	$V_{GS(off)}$	−0.3	−1.5	Vdc
	J202		−0.8	−4.0	
	J203		−2.0	−10.0	
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 20$ V)	J201	I_{DSS}*	0.2	1.0	mA
	J202		0.9	4.5	
	J203		4.0	20.0	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 20$ V, f = 1.0 kHz)	J201	$\|y_{fs}\|$*	500	—	μmhos
	J202		1000	—	
	J203		1500	—	

*Pulse Width ≤ 2.0 ms.

J270

CASE 29-04, STYLE 30
TO-92 (TO-226AA)



JFET
CHOPPER TRANSISTOR

P-CHANNEL — DEPLETION

Refer to MPF970 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Gate Current	I_G	50	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 3.27	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

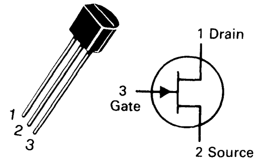
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$)	$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current ($V_{GS} = 20$ Volts)	I_{GSS}	—	200	pA
Gate Source Cutoff Voltage ($V_{DS} = -15$ V, $I_D = -1.0$ nA)	$V_{GS(off)}$	0.5	2.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current ($V_{DS} = -15$ V)	I_{DSS}*	−2.0	−15	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = -15$ V, f = 1.0 kHz)	$\|y_{fs}\|$	6000	15000	µmhos
Output Admittance ($V_{DS} = -15$ V, f = 1.0 kHz)	$\|y_{os}\|$	—	200	µmhos
Input Capacitance ($V_{DS} = -15$ V, f = 1.0 MHz)	C_{iss}	—	32	pF
Reverse Transfer Capacitance ($V_{DS} = -15$ V, f = 1.0 MHz)	C_{rss}	—	8.0	pF

*Pulse Width ≤ 2.0 ms.

J300

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
HIGH FREQUENCY AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

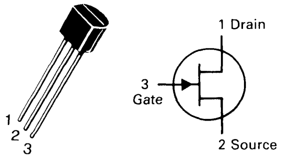
Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	−25	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 3.5	mW mW/°C
Lead Temperature (1/16″ from Case for 10 Seconds)	T_L	300	°C
Junction Temperature Range	T_J	−55 to +150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = −1.0 μA, V_{DS} = 0)	$V_{(BR)GSS}$	−25	—	Vdc
Gate Reverse Current (V_{GS} = −15 V, V_{DS} = 0)	I_{GSS}	—	500	pA
Gate Source Cutoff Voltage (V_{DS} = 10 V, I_D = 1.0 mA)	$V_{GS(off)}$	−1.0	−6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current (V_{DS} = 10 V, V_{GS} = 0)	I_{DSS}	6.0	30	mA
Gate-Source Forward Voltage (V_{DS} = 0, I_G = 1.0 mA)	$V_{GS(f)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 10 V, I_D = 5.0 mA, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	4500	9000	μmhos
Output Admittance (V_{DS} = 10 V, I_D = 5.0 mA, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	200	μmhos
Input Capacitance (V_{DS} = 10 V, I_D = 5.0 mA, f = 1.0 MHz)	C_{iss}	—	5.5	pF
Reverse Transfer Capacitance (V_{DS} = 10 V, I_D = 5.0 mA, f = 1.0 MHz)	C_{rss}	—	1.7	pF

J304
J305

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET HIGH FREQUENCY AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

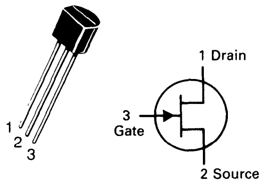
Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	−30	Vdc
Gate-Source Voltage	V_{GS}	−30	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 3.5	mW mW/°C
Lead Temperature (1/16″ from Case for 10 Seconds)	T_L	300	°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu A$, $V_{DS} = 0$)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current ($V_{GS} = -20\ V$, $V_{DS} = 0$)		I_{GSS}	—	100	pA
Gate Source Cutoff Voltage ($V_{DS} = 15\ V$, $I_D = 1.0\ nA$)	J304 J305	$V_{GS(off)}$	−2.0 −0.5	−6.0 −3.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 15\ V$, $V_{GS} = 0$)	J304 J305	I_{DSS}	5.0 1.0	15 8.0	mA
SMALL-SIGNAL CHARACTERISTICS					
Output Admittance ($V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$)		$\lvert y_{os} \rvert$	—	50	µmhos
Forward Transconductance ($V_{DS} = 15\ V$, $V_{GS} = 0$, $f = 1.0\ kHz$)	J304 J305	$Re(y_{fs})$	4500 3000	7500 —	µmhos

J308 thru J310

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

Refer to U308 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 3.5	mW mW/°C
Junction Temperature Range	T_J	−55 to +125	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu A$, $V_{DS} = 0$)		$V_{(BR)GSS}$	−25	—	—	Vdc
Gate Reverse Current		I_{GSS}				
($V_{GS} = -15$ V, $V_{DS} = 0$, $T_A = 25°C$)			—	—	−1.0	nA
($V_{GS} = -15$ V, $V_{DS} = 0$, $T_A = +125°C$)			—	—	−1.0	μA
Gate Source Cutoff Voltage		$V_{GS(off)}$				Vdc
($V_{DS} = 10$ V, $I_D = 1.0$ nA)	J308		−1.0	—	−6.5	
	J309		−1.0	—	−4.0	
	J310		−2.0	—	−6.5	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1)		I_{DSS}				mA
($V_{DS} = 10$ V, $V_{GS} = 0$)	J308		12	—	60	
	J309		12	—	30	
	J310		24	—	60	
Gate-Source Forward Voltage ($V_{DS} = 0$, $I_G = 1.0$ mA)		$V_{GS(f)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Common-Source Input Conductance		$Re(y_{is})$				mmhos
($V_{DS} = 10$ V, $I_D = 10$ mA, f = 100 MHz)	J308		—	0.7	—	
	J309		—	0.7	—	
	J310		—	0.5	—	
Common-Source Output Conductance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 100 MHz)		$Re(y_{os})$	—	0.25	—	mmhos
Common-Gate Power Gain ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 100 MHz)		G_{pg}	—	16	—	dB
Common-Source Forward Transconductance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 100 MHz)		$Re(y_{fs})$	—	12	—	mmhos
Common-Gate Input Conductance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 100 MHz)		$Re(y_{ig})$	—	12	—	mmhos
Common-Source Forward Transconductance		g_{fs}				μmhos
($V_{DS} = 10$ V, $I_D = 10$ mA, f = 1.0 kHz)	J308		8000	—	20000	
	J309		10000	—	20000	
	J310		8000	—	18000	
Common-Source Output Conductance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 1.0 kHz)		g_{os}	—	—	250	μmhos

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
Common-Gate Forward Transconductance		g_{fg}				μmhos
(V_{DS} = 10 V, I_D = 10 mA, f = 1.0 kHz)	J308		—	13000	—	
	J309		—	13000	—	
	J310		—	12000	—	
Common-Gate Output Conductance		g_{og}				μmhos
(V_{DS} = 10 V, I_D = 10 mA, f = 1.0 kHz)	J308		—	150	—	
	J309		—	100	—	
	J310		—	150	—	
Gate-Drain Capacitance (V_{DS} = 0, V_{GS} = −10 V, f = 1.0 MHz)		C_{gd}	—	1.8	2.5	pF
Gate-Source Capacitance (V_{DS} = 0, V_{GS} = −10 V, f = 1.0 MHz)		C_{gs}	—	4.3	5.0	pF

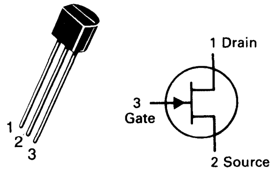
FUNCTIONAL CHARACTERISTICS

Noise Figure (V_{DS} = 10 V, I_D = 10 mA, f = 450 MHz)	NF	—	1.5	—	dB
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 10 V, I_D = 10 mA, f = 100 Hz)	$\bar{e}_n$	—	10	—	nV/√Hz

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

JF1033B, S, Y

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
HIGH FREQUENCY AMPLIFIERS

N-CHANNEL DEPLETION

MAXIMUM RATINGS

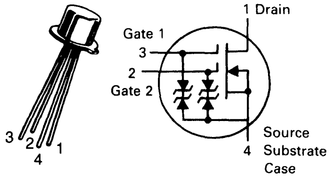
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	20	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Drain Current	I_D	20	mA
Forward Gate Current	I_{GF}	10	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = −10 μA)	$V_{(BR)GSS}$	−25	—	Vdc
Drain-Source Breakdown Voltage (I_D = 10 μA)	$V_{(BR)DGO}$	20	—	Vdc
Gate Reverse Current (V_{GS} = −10 V, V_{DS} = 0)	I_{GSS}	—	−100	nA
Gate Source Cutoff Voltage (V_{DS} = 10 V, I_D = 10 μA)	$V_{GS(off)}$	−1.0	−8.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current (V_{DS} = 10 V, V_{GS} = 0)	I_{DSS}			mA
JF1033Y		2.5	6.0	
JF1033B		5.0	12.0	
JF1033S		10.0	20.0	
SMALL-SIGNAL CHARACTERISTICS				
Forward Transconductance (V_{DS} = 10 V, V_{GS} = 0, f = 1.0 kHz)	$Re(y_{fs})$	4.5	13.0	mmhos
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DS} = 10 V, V_{GS} = 0, f = 100 MHz)	NF	—	2.5	dB

MFE120
thru
MFE122

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFET VHF AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	+25	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.7	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

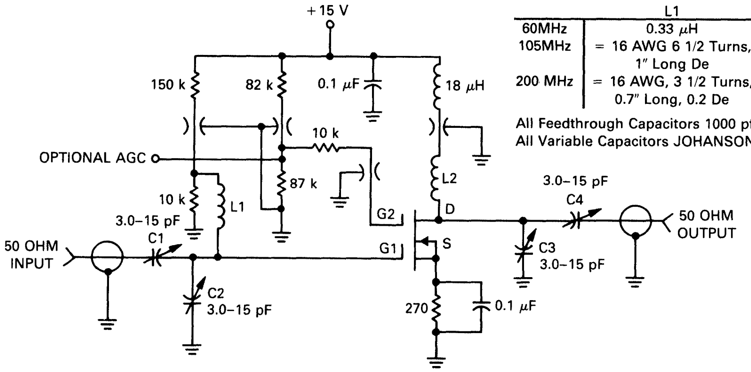
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (I_D = 100 μAdc, V_S = 0, V_{G1S} = −4.0 V, V_{G2S} = + 4.0 V)	$V_{(BR)DSX}$	25	—	—	Vdc
Gate 1-Source Breakdown Voltage (I_{G1} = ±10 μAdc, V_{G2S} = 0)	$V_{(BR)G1SO}$	±7.0	—	±20	Vdc
Gate 2-Source Breakdown Voltage (I_{G2} = ±10 μAdc, V_{G2S} = 0)	$V_{(BR)G2SO}$	±7.0	—	±20	Vdc
Gate 1 Leakage Current (V_{G1S} = +6.0 Vdc, V_{G2S} = 0, V_{DS} = 0)	I_{G1SS}	—	—	20	nAdc
Gate 2 Leakage Current (V_{G2S} = +6.0 Vdc, V_{G1S} = 0, V_{DS} = 0)	I_{G2SS}	—	—	20	nAdc
Gate 1 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 200 μAdc)	$V_{G1S(off)}$	—	—	−4.0	Vdc
Gate 2 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G1S} = 0, I_D = 200 μAdc)	$V_{G2S(off)}$	—	—	−4.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 15 Vdc, V_{G1S} = 0, V_{G2S} = 4.0 Vdc) MFE120	I_{DSS}	2.0	7.0	18	mAdc
MFE121		5.0	10	30	
MFE122		2.0	9.0	20	
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (Gate 1 to Drain) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 kHz) MFE120,22	$\|Y_{fs}\|$	8000	—	18,000	μmhos
MFE121		10,000	—	20,000	
Input Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = I_{DSS}, f = 1.0 MHz) MFE120,22	C_{iss}	—	4.5	7.0	pF
MFE121		—	4.5	6.0	
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc, f = 1.0 MHz)	C_{rss}	—	0.023	—	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = I_{DSS}, f = 1.0 MHz) MFE120,22	C_{oss}	—	2.5	4.0	pF
MFE121		—	2.5	3.5	

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS						
Noise Figure (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc, Z_S is optimized for NF)		NF				dB
(f = 105 MHz — Figure 1)	MFE120		—	2.9	5.0	
(f = 60 MHz — Figure 3)	MFE121		—	2.6	5.0	
(f = 200 MHz — Figure 3)	MFE121		—	2.6	5.0	
Common Source Power Gain (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc, Z_S is optimized for NF)		G_{ps}				dB
(f = 105 MHz — Figure 1)	MFE120		17	19.6	—	
(f = 60 MHz — Figure 3)	MFE121		20	27.8	—	
(f = 200 MHz — Figure 3)	MFE121		17	18.6	—	
Level of Unwanted Signal for 1.0% Cross Modulation (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc)		—	—	100	—	mV
Common-Source Conversion Power Gain (Gate 1 Injection, Figure 2) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, Local Oscillator Voltage = 925 mVrms)		G_c				dB
(Signal Frequency = 60 MHz, Local Oscillator Frequency = 104 MHz)	MFE122		15	16.5	—	
(Signal Frequency = 200 MHz, Local Oscillator Frequency = 244 MHz)	MFE122		12	13.3	—	

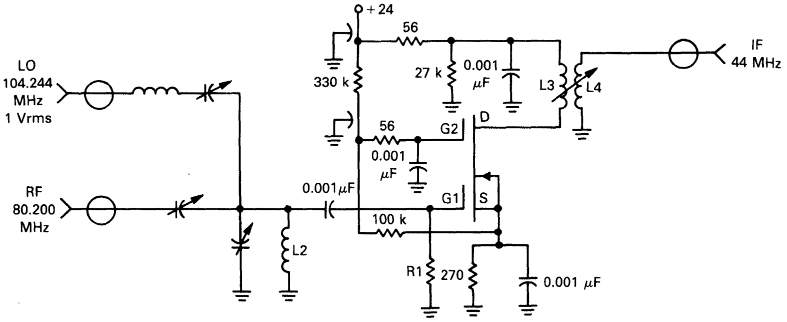
FIGURE 1 — 60, 105 AND 200 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT



	L1	L2
60MHz 105MHz	0.33 µH = 16 AWG 6 1/2 Turns, 1″ Long De	0.47 µH = 16 AWG 5 1/4 Turns, 1″ Long, 7/16″ De
200 MHz	= 16 AWG, 3 1/2 Turns, 0.7″ Long, 0.2 De	=16 AWG, 4 1/2 Turns, 0.65″ Long, 0.2″ De

All Feedthrough Capacitors 1000 pf.
All Variable Capacitors JOHANSON JMC2951, 3.0–15 pF

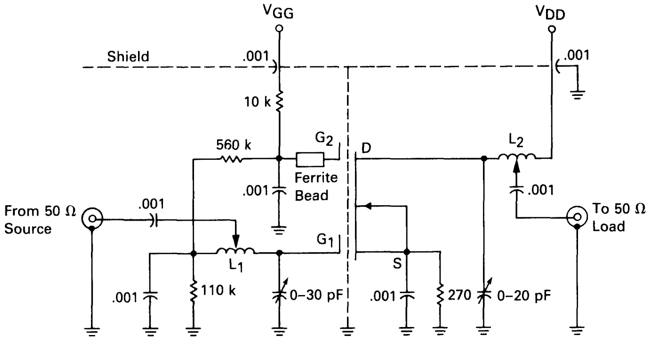
FIGURE 2 — 60 AND 200 MHz CONVERSION GAIN TEST CIRCUIT



	R1	L1	L2	L3	L4
60 MHz	10 k	10 Turns = 22 Enameled on MILLER 4500 4 Core	0.33 µH DELEVAN	15 Turns =25 Enameled on MILLER 4500 1 Core	4 Turns = 20 Enameled on Sure Core as L3
200 MHz	1.0 k	3 1/2 Turns = 18.1/4″ De. 1/2″ Long	2 1/2 Turns =15.3/8″ De. 1/2″ Long	15 Turns = 26 Enameled on MILLER 4500 1 Core	4 Turns = 26 Enameled on Sure Core as L3

All Feedthrough Capacitors 1000 pf.
All Variable Capacitors JOHANSON JMC2951, 3.0–15 pF

FIGURE 3 – 60 AND 200 MHz CONVERSION POWER GAIN



L_1 2½ T #18, ¼″ diameter center tapped
L_2 3½ T #18, 5/16″ diameter tapped ½T from cold end
C = μF unless otherwise specified

COMMON-SOURCE ADMITTANCE PARAMETERS
(V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc)

FIGURE 4 – INPUT ADMITTANCE

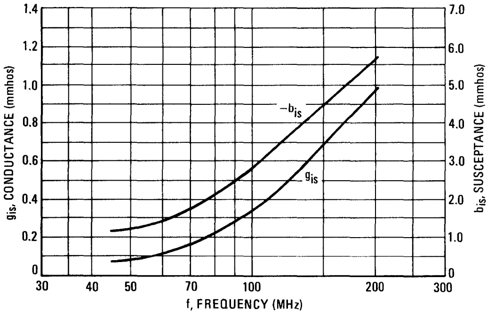


FIGURE 5 – REVERSE TRANSFER ADMITTANCE

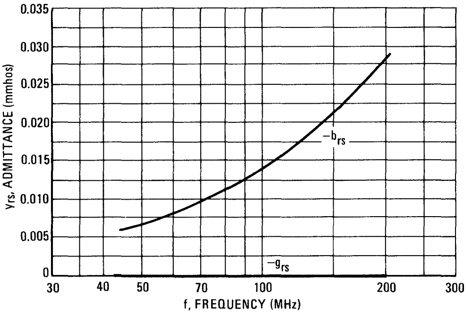


FIGURE 6 – FORWARD TRANSFER ADMITTANCE

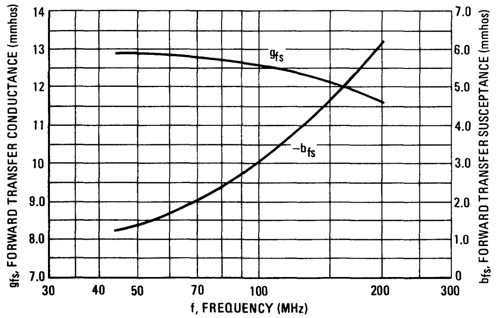


FIGURE 7 – OUTPUT ADMITTANCE

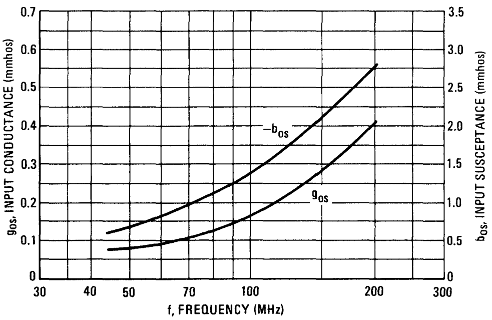


FIGURE 8 — GAIN REDUCTION

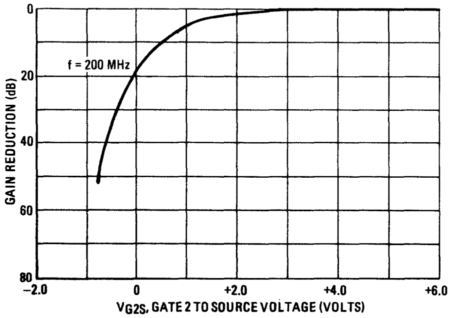
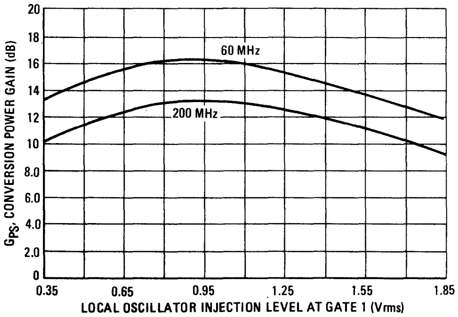
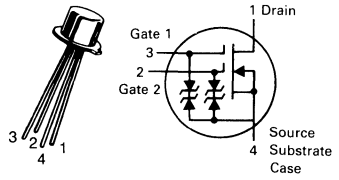


FIGURE 9 — CONVERSION POWER GAIN



MFE130
thru
MFE132

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFET VHF AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ $T_A = 25°C$ (Package Limitation) Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Channel Temperature Range	$T_{channel}$ T_{stg}	−65 to +175	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($I_D = 10\ \mu Adc$, $V_S = 0$, $V_{G1} = -4.0$ V, $V_{G2} = +4.0$ V)	$V_{(BR)DSX}$	25	—	—	Vdc
Gate 1-Source Breakdown Voltage ($I_{G1} = \pm 10\ \mu Adc$, $V_{G2S} = 0$)	$V_{(BR)G1SO}$	±7.0	—	±20	Vdc
Gate 2-Source Breakdown Voltage ($I_{G2} = \pm 10\ \mu Adc$, $V_{G2S} = 0$)	$V_{(BR)G2SO}$	±7.0	—	±20	Vdc
Gate 1 Leakage Current ($V_{G1S} = \pm 6.0$ Vdc, $V_{G2S} = 0$, $V_{DS} = 0$)	I_{G1SS}	—	—	20	nAdc
Gate 2 Leakage Current ($V_{G2S} = \pm 6.0$ Vdc, $V_{G1S} = 0$, $V_{DS} = 0$)	I_{G2SS}	—	—	20	nAdc
Gate 1 to Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $V_{G2S} = 4.0$ Vdc, $I_D = 200\ \mu Adc$)	$V_{G1S(off)}$	—	—	−4.0	Vdc
Gate 2 to Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $V_{G1S} = 0$, $I_D = 200\ \mu Adc$)	$V_{G2S(off)}$	—	—	−4.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 15$ Vdc, $V_{G1S} = 0$, $V_{G2S} = 4.0$ Vdc)	I_{DSS}	3.0	10	30	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (Gate 1 connected to Drain) ($V_{DS} = 15$ Vdc, $V_{G2S} = 4.0$ Vdc, $I_D = 10$ mAdc, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	8000	—	20000	μmhos
Input Capacitance ($V_{DS} = 15$ Vdc $V_{G2S} = 4.0$ Vdc, $I_D = I_{DSS}$, f = 1.0 MHz)	C_{iss}	—	4.5	7.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $V_{G2S} = 4.0$ Vdc, $I_D = 6.0$ mAdc, f = 1.0 MHz)	C_{rss}	—	0.023	0.05	pF
Output Capacitance ($V_{DS} = 15$ Vdc, $V_{G2S} = 4.0$ Vdc, $I_D = I_{DSS}$, f = 1.0 MHz)	C_{oss}	—	2.5	4.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (Figure 7) ($V_{DS} = 15$ Vdc, $V_{G2S} = 4.0$ Vdc, $I_D = 6.0$ mAdc, Z_S is optimized for NF) (f = 105 MHz) MFE130 (f = 60 MHz) MFE131 (f = 100 MHz) MFE131	NF	 — — —	 2.9 2.5 3.0	 5.0 5.0 5.0	dB

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
Common Source Power Gain (Figure 7) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc, Z_S is optimized for NF)		G_{ps}				dB
(f = 105 MHz)	MFE130		17	23	—	
(f = 60 MHz)	MFE131		20	27	—	
(f = 200 MHz)	MFE131		17	20	—	
Level of Unwanted Signal for 1.0% Cross Modulation (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc)		—	—	100	—	mV
Common-Source Conversion Power Gain (Gate 1 Injection, Figure 8) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, Local Oscillator Voltage = 925 mVrms)		G_c				dB
(Signal Frequency = 60 MHz, Local Oscillator Frequency = 104 MHz)	MFE132		15	16.5	—	
(Signal Frequency = 200 MHz, Local Oscillator Frequency = 244 MHz)	MFE132		12	14	—	

COMMON-SOURCE ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 6.0 mAdc)

FIGURE 1 — INPUT ADMITTANCE

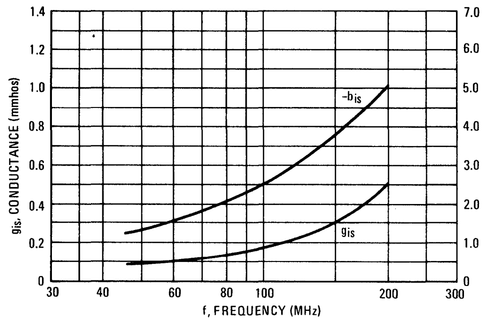


FIGURE 2 — REVERSE TRANSFER ADMITTANCE

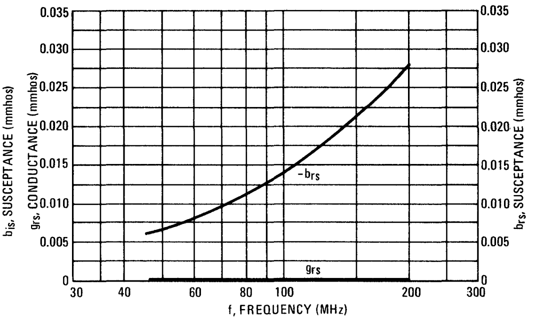


FIGURE 3 — FORWARD TRANSFER ADMITTANCE

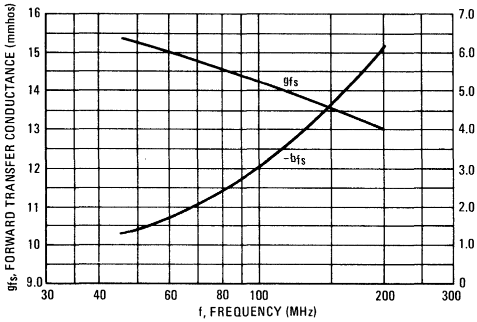


FIGURE 4 — OUTPUT ADMITTANCE

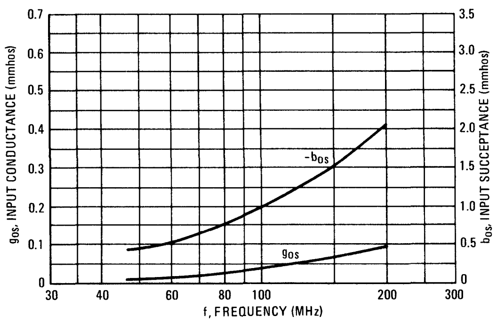


FIGURE 5 – GAIN REDUCTION

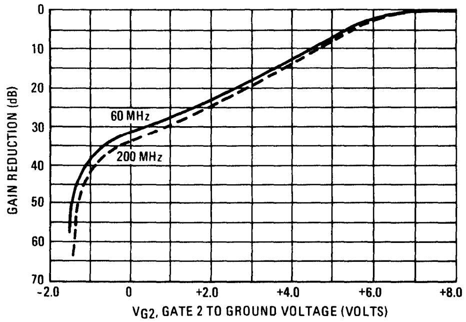


FIGURE 6 – CONVERSION POWER GAIN

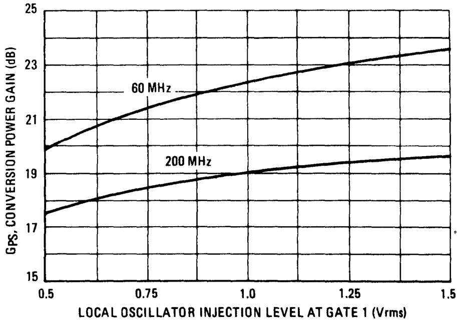
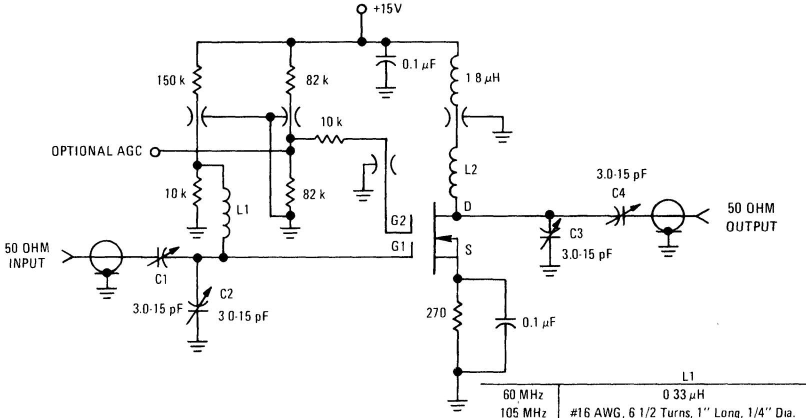


FIGURE 7 – 60, 105 AND 200 MHz POWER GAIN AND NOISE FIGURE TEST CIRCUIT

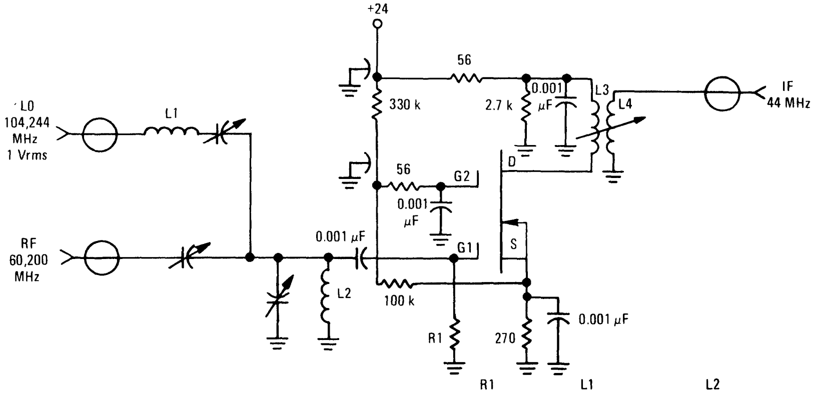


	L1	L2
60 MHz	0 33 μH	0.47 μH
105 MHz	#16 AWG, 6 1/2 Turns, 1" Long, 1/4" Dia.	#16 AWG, 5 1/4 Turns, 1" Long, 7/16" Dia.
200 MHz	#16 AWG, 3 1/2 Turns, 0.7" Long, 0.2" Dia.	#16 AWG, 4 1/2 Turns, 0.65" Long, 0.2" Dia.

All Feedthrough Capacitors 1000 pF

All Variable Capacitors JOHANSON JMC2951, 3.0-15 pF

FIGURE 8 – 60 AND 200 MHz CONVERSION GAIN TEST CIRCUIT



	R1	L1	L2	L3	L4
60 MHz	10 k	10 Turns #22 Enameled on MILLER 4500-4 Core	0.33 μH DELEVAN	15 Turns #26 Enameled on MILLER 4500-1 Core	4 Turns #26 Enameled on Same Core as L3
200 MHz	1.0 k	3 1/2 Turns #18, 1/4" Dia., 1/2" Long	2 1/2 Turns #18, 3/8" Dia., 1/2" Long	15 Turns #26 Enameled on MILLER 4500-1 Core	4 Turns #26 Enameled on Same Core as L3

All Feedthrough Capacitors 1000 pF.

All Variable Capacitors JOHANSON JMC2951, 3.0-15 pF.

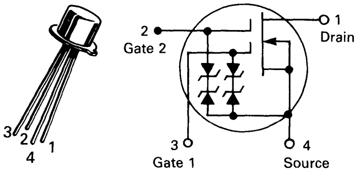
N-CHANNEL DUAL-GATE SILICON-NITRIDE PASSIVATED MOS FIELD-EFFECT TRANSISTORS

. . . depletion mode dual gate transistors designed for VHF amplifier and mixer applications.

- MFE201 — VHF Amplifier
  MFE202 — VHF Mixer
  MFE203 — IF Amplifier
- Low Reverse Transfer Capacitance —
  C_{rss} = 0.03 pF (Max)
- High Forward Transfer Admittance —
  $|y_{fs}|$ = 8–20 mmhos — MFE201, MFE202
  = 7–15 mmhos — MFE203
- Diode Protected Gates

MFE201
thru
MFE203

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFETs

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSX}	20	Vdc
Drain-Gate Voltage	V_{DG1} V_{DG2}	30 30	Vdc
Gate Current	I_{G1} I_{G2}	±10 ±10	mAdc
Drain Current — Continuous	I_D	50	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.4	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 8.0	Watt mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature Range	T_J	−65 to +175	°C
Lead Temperature, 1/16″ From Seated Surface for 10 Seconds	T_L	300	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

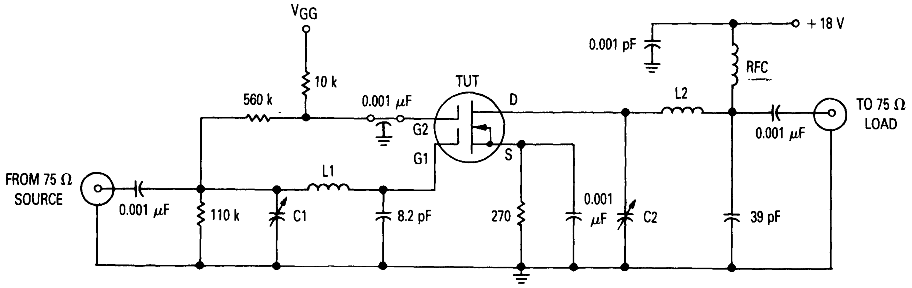
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_S = 0, V_{G1S} = V_{G2S} = −5.0 Vdc)	$V_{(BR)DSX}$	20	—	—	Vdc
Gate 1 — Source Breakdown Voltage(1) (I_{G1} = ±10 mAdc, V_{G2S} = V_{DS} = 0)	$V_{(BR)G1SO}$	±6.0	±12	±30	Vdc
Gate 2 — Source Breakdown Voltage(1) (I_{G2} = ±10 mAdc, V_{G1S} = V_{DS} = 0)	$V_{(BR)G2SO}$	±6.0	±12	±30	Vdc
Gate 1 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 20 μAdc)	$V_{G1S(off)}$	−0.5	−1.5	−5.0	Vdc
Gate 2 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G1S} = 0, I_D = 20 μAdc)	$V_{G2S(off)}$	−0.2	−1.4	−5.0	Vdc
Gate 1 Leakage Current (V_{G1S} = ±5.0 Vdc, V_{G2S} = V_{DS} = 0) (V_{G2S} = −5.0 Vdc, V_{G2S} = V_{DS} = 0, T_A = 150°C)	I_{G1SS}	— —	±0.04 —	±10 −10	nAdc μAdc
Gate 2 Leakage Current (V_{G2S} = ±5.0 Vdc, V_{G1S} = V_{DS} = 0) (V_{G2S} = −5.0 Vdc, V_{G1S} = V_{DS} = 0, T_A = 150°C)	I_{G2SS}	— —	±0.05 —	±10 −10	nAdc μAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current(2) (V_{DS} = 15 Vdc, V_{G1S} = 0, V_{G2S} = 4.0 Vdc) MFE201, MFE202 MFE203	I_{DSS}	6.0 3.0	13 11	30 15	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance(3) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, V_{G1S} = 0, f = 1.0 kHz) MFE201, MFE202 MFE203	$\|y_{fs}\|$	8.0 7.0	12.8 12.5	20 15	mmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = I_{DSS}, f = 1.0 MHz)	C_{iss}	—	4.3	—	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = I_{DSS}, f = 1.0 MHz)	C_{oss}	—	1.7	—	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 MHz)	C_{rss}	0.005	0.014	0.03	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Noise Figure	NF				dB
(V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE201		—	1.8	4.5	
(V_{DD} = 18 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) MFE203		—	5.3	6.0	
Common Source Power Gain	G_{ps}				dB
(V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE201		15	20	25	
(V_{DD} = 18 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) MFE203		20	25	30	
(V_{DD} = 18 Vdc, f_{LO} = 245 MHz, f_{RF} = 200 MHz) (Figure 2) MFE202	G_c(5)	15	19	25	
Bandwidth	BW				MHz
(V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE201		5.0	—	9.0	
(V_{DD} = 18 Vdc, f_{LO} = 245 MHz, f_{RF} = 200 MHz) (Figure 2) MFE202		4.5	—	7.5	
(V_{DD} = 18 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) MFE203		3.0	—	6.0	
Gain Control Gate-Supply Voltage(4)	$V_{GG(GC)}$				Vdc
(V_{DD} = 18 Vdc, ΔG_{ps} = −30 dB, f = 200 MHz) (Figure 1) MFE201		0	−1.0	−3.0	
(V_{DD} = 18 Vdc, ΔG_{ps} = −30 dB, f = 45 MHz) (Figure 3) MFE203		0	−0.6	−3.0	

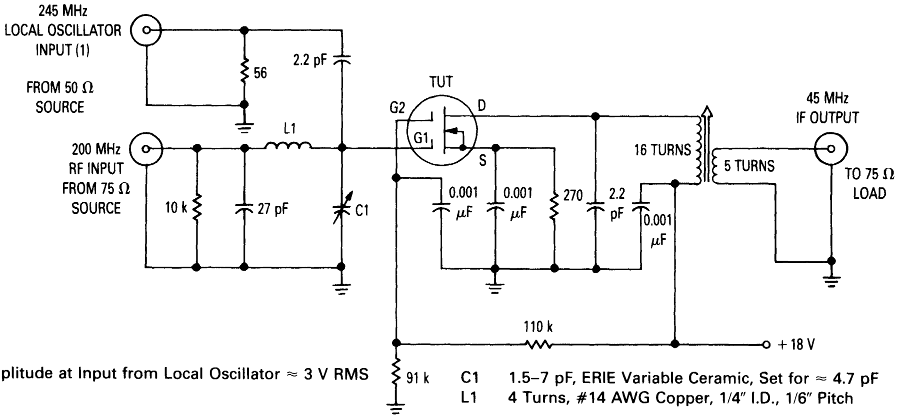
Notes:

1. All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.
2. Pulse Test: Pulse Width = 300 µs, Duty Cycle ≤ 2.0%.
3. This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating.
4. ΔG_{ps} is defined as the change in G_{ps} from the value at V_{GG} = 7.0 volts (MFE201) and V_{GG} = 6.0 volts (MFE203).
5. Power Gain Conversion.



C1	4–30 pF, ERIE Variable Ceramic, Set for ≈ 22 pF	L2	3 Turns, #14 AWG Copper, 1/4″ I.D., 1/8″ Pitch
C2	4–30 pF, ERIE Variable Ceramic, Set for ≈ 10 pF	RFC	DELEVAN No. 153712, 1 µH
L1	4 Turns, #14 AWG Copper, 1/4″ I.D., 1/6″ Pitch		

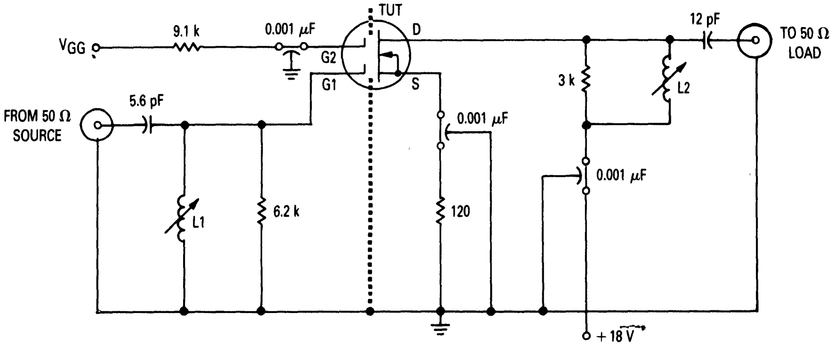
Figure 1. 200 MHz Test Circuit Schematic For MFE201



(1) Amplitude at Input from Local Oscillator ≈ 3 V RMS

C1 1.5–7 pF, ERIE Variable Ceramic, Set for ≈ 4.7 pF
L1 4 Turns, #14 AWG Copper, 1/4″ I.D., 1/6″ Pitch

Figure 2. 200 MHz to 45 MHz Test Circuit Schematic For MFE202



L1 14 Turns, #30 AWG Copper, Close-Wound 7/32″ OD form with ARNOLD ENGINEERING "J" Tuning Core

L2 10 Turns, #30 AWG Copper, Close-Wound 7/32″ OD form with ARNOLD ENGINEERING "J" Tuning Core

Figure 3. 45 MHz Test Circuit Schematic
MFE203

TYPICAL CHARACTERISTICS

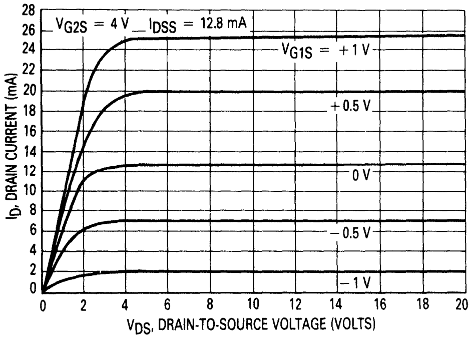


Figure 4. Drain Current versus Drain-to-Source Voltage

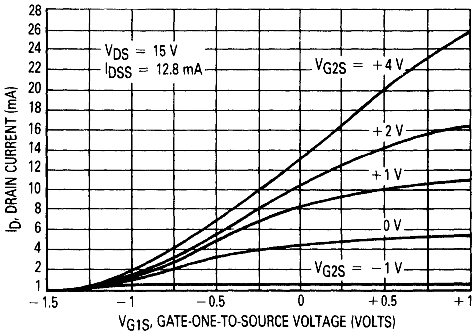


Figure 5. Drain Current versus Gate-One-to-Source Voltage

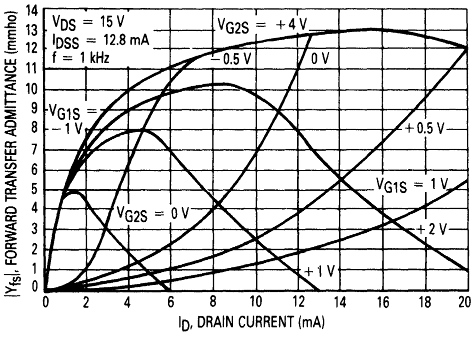


Figure 6. Small-Signal Common-Source Gate-One Forward Transfer Admittance versus Drain Current

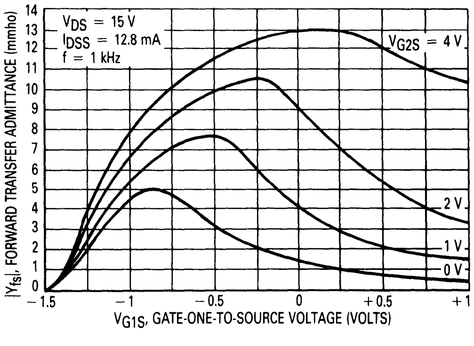


Figure 7. Small-Signal Common-Source Gate-One Forward Transfer Admittance versus Gate-One-to-Source Voltage

TYPICAL CHARACTERISTICS

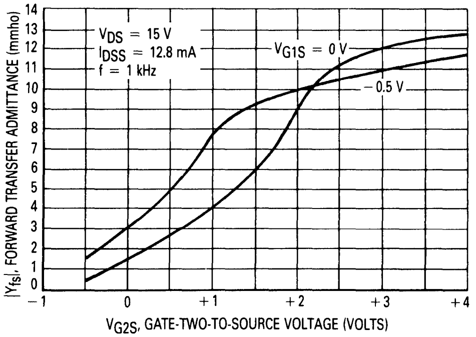


Figure 8. Small-Signal Common-Source Gate-One Forward Transfer Admittance versus Gate-Two-to-Source Voltage

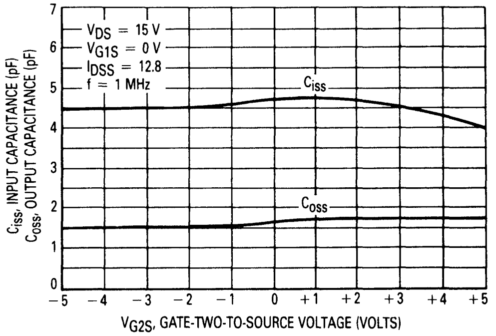


Figure 9. Small-Signal Common-Source Gate-One Input and Output Capacitance versus Gate-Two-to-Source Voltage

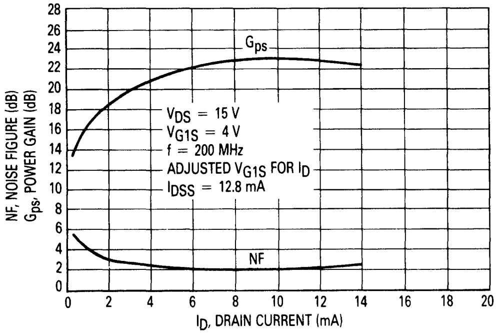


Figure 10. Common-Source Power Gain and Spot Noise Figure versus Drain Current

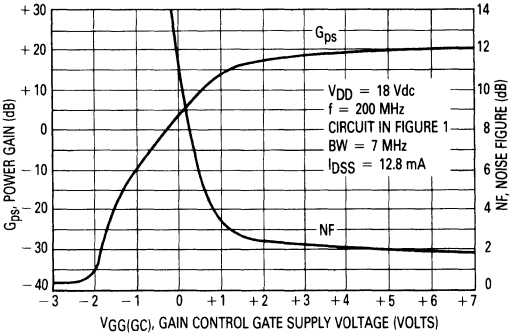


Figure 11. Common-Source Power Gain and Spot Noise Figure versus Gain Control Gate-Supply Voltage — MFE201

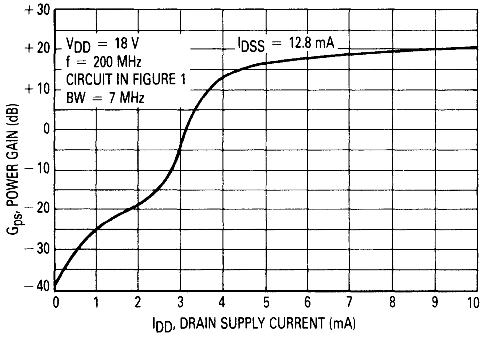


Figure 12. Common-Source Power Gain versus Drain Supply Current — MFE201

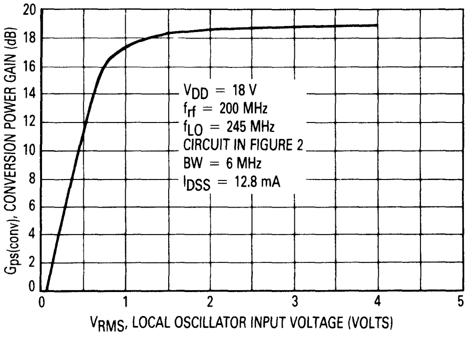


Figure 13. Small-Signal Common-Source Conversion Power Gain versus Local Oscillator Input Voltage — MFE202

TYPICAL CHARACTERISTICS

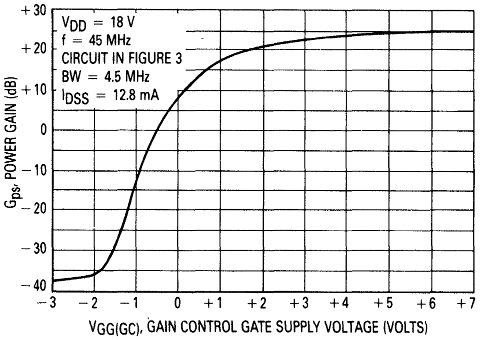


Figure 14. Small-Signal Common Source Insertion Power Gain versus Gain Control Gate-Supply Voltage — MFE203

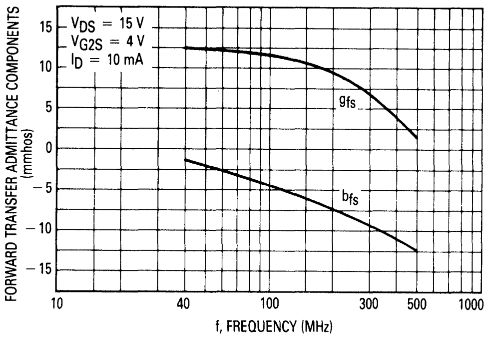


Figure 15. Small-Signal Gate One Forward Transfer Admittance versus Frequency

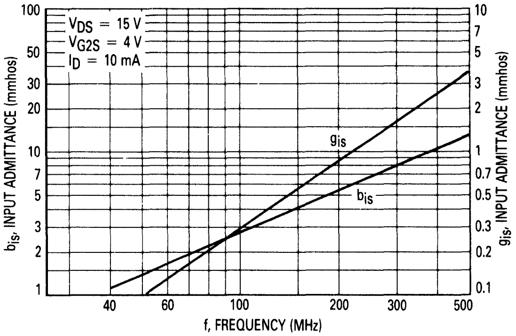


Figure 16. Small-Signal Gate One Input Admittance versus Frequency

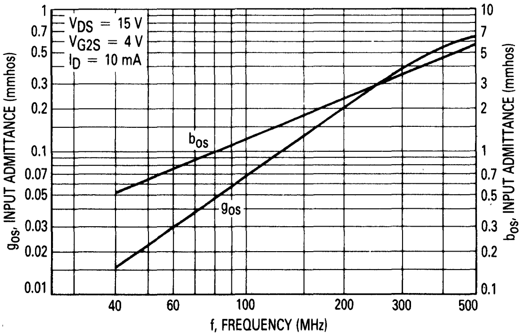


Figure 17. Small-Signal Gate One Output Admittance versus Frequency

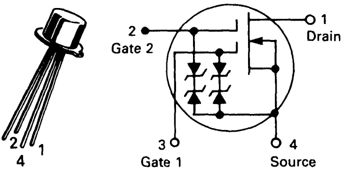
N-CHANNEL DUAL-GATE SILICON-NITRIDE PASSIVATED MOS FIELD-EFFECT TRANSISTOR

. . . depletion mode dual gate transistor designed and characterized for UHF communications applications.

- Package — Hermetic Metal TO-206AF
- Silicon Nitride Passivation for Excellent Long Term Stability
- Zener Diode Protected Gates
- Common Source Power Gain — G_{ps} = 28 dB (Min) @ f = 450 MHz
- Noise Figure — 5.0 dB Max @ f = 450 MHz

MFE204

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFETs

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSX}	20	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Drain Current	I_D	50	mA
Reverse Gate Current	I_G	−10	mA
Forward Gate Current	I_{GF}	10	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.4	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 0.8	mW mW/°C
Lead Temperature	T_L	300	°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65°C to +175°C	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (I_D = 10 μA, V_{G1} = V_{G2} = −5.0 V)	$V_{(BR)DSX}$	25	—	Vdc
Gate 1-Source Breakdown Voltage (I_{G1} = ±10 mA) Note 1	$V_{(BR)G1SO}$	±6.0	±30	Vdc
Gate 2-Source Breakdown Voltage (I_{G2} = ±10 mA) Note 1	$V_{(BR)G2SO}$	±6.0	±30	Vdc
Gate 1 Leakage Current (V_{G1S} = ±5.0 V, V_{G2S} = V_{DS} = 0)	I_{G1SS}	—	±10	nA
Gate 2 Leakage Current (V_{G2S} = ±5.0 V, V_{G1S} = V_{DS} = 0)	I_{G2SS}	—	±10	nA
Gate 1 to Source Cutoff Voltage (V_{DS} = 15 V, V_{G2S} = 4.0 V, I_D = 20 μA)	$V_{G1S(off)}$	−0.5	−4.0	Vdc
Gate 2 to Source Cutoff Voltage (V_{DS} = 15 V, V_{G1S} = 0 V, I_D = 20 μA)	$V_{G2S(off)}$	−0.2	−4.0	Vdc
ON CHARACTERISTICS				
Zero-Gate Voltage Drain Current* (V_{DS} = 15 V, V_{G2S} = 4.0 V, V_{G1S} = 0 V)	I_{DSS}*	6.0	30	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 V, V_{G2S} = 4.0 V, V_{G1S} = 0 V, f = 1.0 kHz) Note 2	$\lvert Y_{fs} \rvert$	10	22	mmhos
Input Capacitance (V_{DS} = 15 V, V_{G2S} = 4.0 V, I_D = I_{DSS}, f = 1.0 MHz)	C_{iss}	Typ. 3.0		pF
Reverse Transfer Capacitance (V_{DS} = 15 V, V_{G2S} = 4.0 V, I_D = 10 mA, f = 1.0 MHz)	C_{rss}	0.005	0.03	pF
Output Capacitance (V_{DS} = 15 V, V_{G2S} = 4.0 V, I_D = I_{DSS}, f = 1.0 MHz)	C_{oss}	Typ. 1.4		pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DD} = 18 V, V_{GG} = 7.0 V, f = 200 MHz) (V_{DS} = 15 V, V_{G2S} = 4.0 V, I_D = 10 mA, f = 450 MHz)	NF	 — —	 3.5 5.0	dB
Common Source Power Gain (V_{DD} = 18 V, V_{GG} = 7.0 V, f = 200 MHz) (V_{DS} = 15 V, V_{G2G} = 4.0 V, I_D = 10 mA, f = 450 MHz)	G_{ps}	 20 14	 28 —	dB
Bandwidth (V_{DD} = 18 V, V_{GG} = 7.0 V, f = 200 MHz)	BW	7.0	12	MHz

*PW = 30 μs, Duty Cycle ≤ 2.0%.

Notes:

1. All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.
2. This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating.

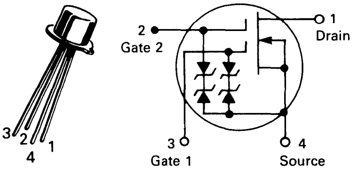
N-CHANNEL DUAL-GATE SILICON-NITRIDE PASSIVATED MOS FIELD-EFFECT TRANSISTOR

. . . depletion mode dual gate transfer designed and characterized for UHF communications applications.

- Package —
  Hermetic Metal TO-206AF
- Silicon Nitride Passivation for Excellent Long Term Stability
- Zener Diode Protected Gates
- Third Order Intermodulation Distortion Curve Provided
- Common Source Power Gain —
  G_{ps} = 10 dB (Min) @ f = 500 MHz
- Noise Figure — 6.0 dB Max @ f = 500 MHz

MFE209

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFETs

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSX}	20	Vdc
Drain-Gate Voltage	V_{DG1} V_{DG2}	30 30	Vdc
Gate Current	I_{G1R} I_{G1F} I_{G2R} I_{G2F}	−10 10 −10 10	mAdc
Drain Current — Continuous	I_D	30	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +200	°C
Operating Channel Temperature	$T_{channel}$	200	°C
Lead Temperature, 1/16″ From Seated Surface for 10 Seconds	T_L	260	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_{G1S} = −4.0 Vdc, V_{G2S} = 4.0 Vdc)	$V_{(BR)DSX}$	20	—	—	Vdc
Gate 1 — Source Breakdown Voltage (I_{G1} = 10 mAdc, V_{G2S} = V_{DS} = 0)	$V_{(BR)G1SSF}$	7.0	—	22	Vdc
Gate 1 — Source Reverse Breakdown Voltage (I_{G1} = −10 mAdc, V_{G2S} = V_{DS} = 0)	$V_{(BR)G1SSR}$	−7.0	—	−22	Vdc
Gate 2 — Source Forward Breakdown Voltage (I_{G2} = 10 mAdc, V_{G1S} = V_{DS} = 0)	$V_{(BR)G2SSF}$	7.0	—	22	Vdc
Gate 2 — Source Reverse Breakdown Voltage (I_{G2} = −10 mAdc, V_{G1S} = V_{DS} = 0)	$V_{(BR)G2SSR}$	−7.0	—	−22	Vdc
Gate 1 — Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 50 μAdc)	$V_{G1S(off)}$	−0.1	—	−4.0	Vdc
Gate 2 — Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G1S} = 0, I_D = 50 μAdc)	$V_{G2S(off)}$	−0.1	—	−4.0	Vdc
Gate 1 — Terminal Forward Current (V_{G1S} = 6.0 Vdc, V_{G2S} = V_{DS} = 0)	I_{G1SSF}	—	—	20	nAdc
Gate 1 — Terminal Reverse Current (V_{G1S} = −6.0 Vdc, V_{G2S} = V_{DS} = 0) (V_{G1S} = −6.0 Vdc, V_{G2S} = V_{DS} = 0, T_A = 150°C)	I_{G1SSR}	— —	— —	−20 −10	nAdc μAdc
Gate 2 — Terminal Forward Current (V_{G2S} = 6.0 Vdc, V_{G1S} = V_{DS} = 0)	I_{G2SSF}	—	—	20	nAdc
Gate 2 — Terminal Reverse Current (V_{G2S} = −6.0 Vdc, V_{G1S} = V_{DS} = 0) (V_{G2S} = −6.0 Vdc, V_{G1S} = V_{DS} = 0, T_A = 150°C)	I_{G2SSR}	— —	— —	−20 −10	nAdc μAdc
ON CHARACTERISTICS					
Gate 1 — Zero Voltage Drain Current (V_{DS} = 15 Vdc, V_{G1S} = 0, V_{G2S} = 4.0 Vdc)	I_{DSS}	5.0	—	30	mAdc

(continued)

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	$\|y_{fs}\|$	10	13	20	mmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, $I_D \geq$ 5.0 mAdc, f = 1.0 MHz)	C_{iss}	—	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, $I_D \geq$ 5.0 mAdc, f = 1.0 MHz)	C_{rss}	0.005	0.023	0.03	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, $I_D \geq$ 5.0 mAdc, f = 1.0 MHz)	C_{oss}	0.5	2.0	4.0	pF
Common-Source Noise Figure (Figure 11) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 500 MHz)	NF	—	4.5	6.0	dB
Common-Source Power Gain (Figure 11) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 500 MHz)	G_{ps}	10	13	20	dB
Bandwidth (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 500 MHz)	BW	7.0	—	17	MHz

TYPICAL SCATTERING PARAMETERS

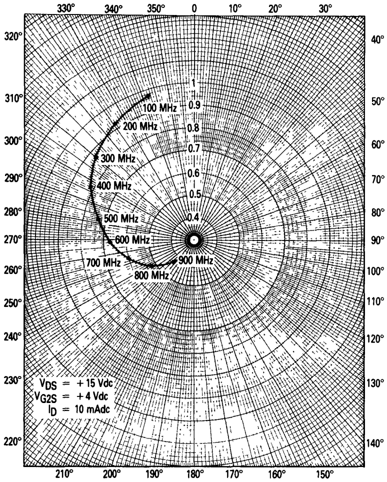


Figure 1. S_{11}, Input Reflection Coefficient versus Frequency

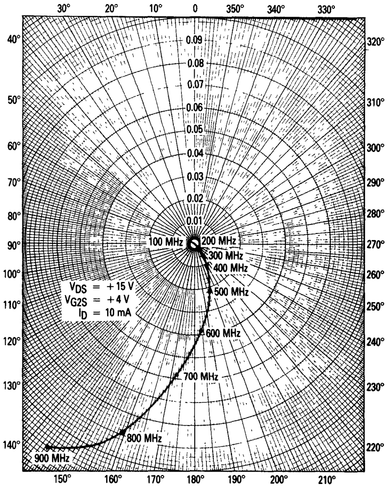


Figure 2. S_{12}, Reverse Transmission Coefficient versus Frequency

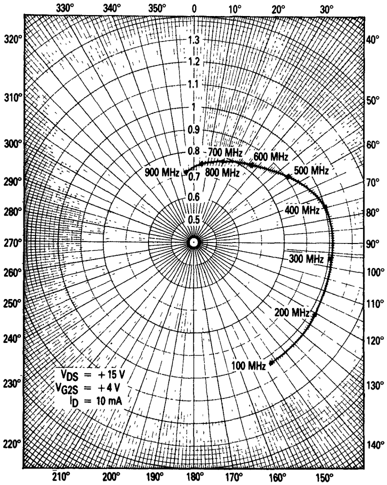


Figure 3. S_{21}, Forward Transmission Coefficient versus Frequency

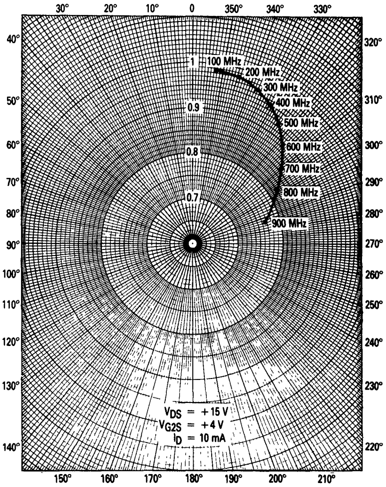


Figure 4. S_{22}, Output Reflection Coefficient versus Frequency

TYPICAL COMMON-SOURCE ADMITTANCE PARAMETERS

(V_{DS} = 15 Vdc, V_{GS2} = 4 Vdc, I_D = 10 mAdc)

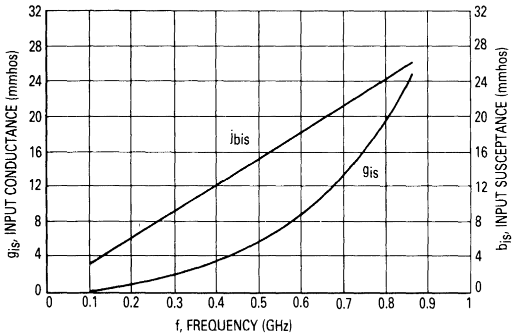


Figure 5. Y_{11}, Input Admittance versus Frequency

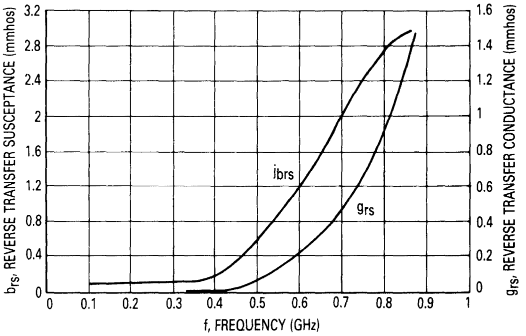


Figure 6. Y_{12}, Reverse Transfer Admittance versus Frequency

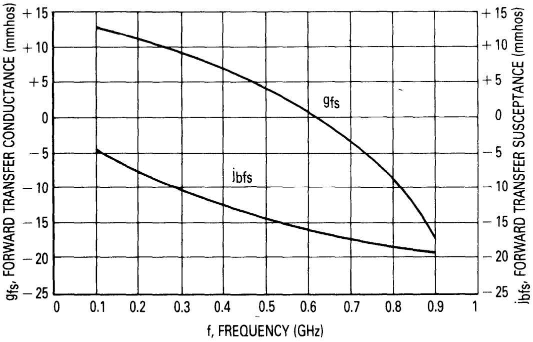


Figure 7. Y_{21}, Forward Transfer Admittance versus Frequency

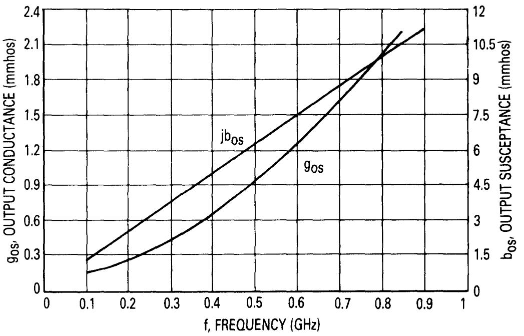
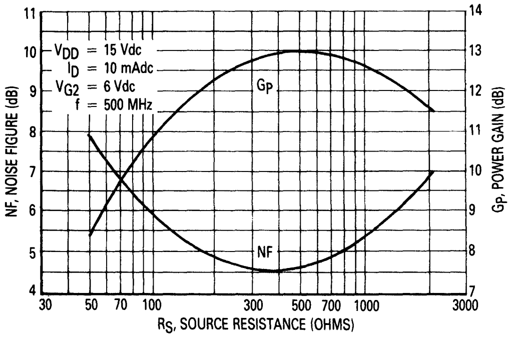


Figure 8. Y_{22}, Output Admittance versus Frequency

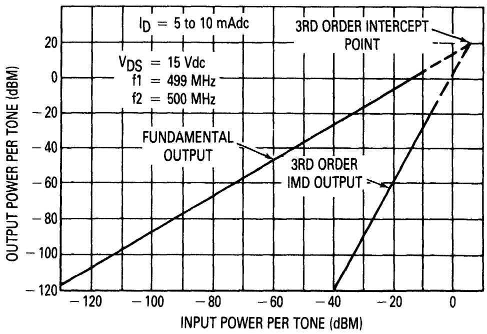
The S and Y Parameters were Measured with a Hewlett Packard HP8542A Network Analyzer.



(SEE SCHEMATIC FIGURE 11)

Figure 9. Power Gain and Noise Figure versus Source Resistance

The Test Circuit shown in Figure 11 was used to generate Power Gain and Noise Figure as a function of Source Resistance curves.



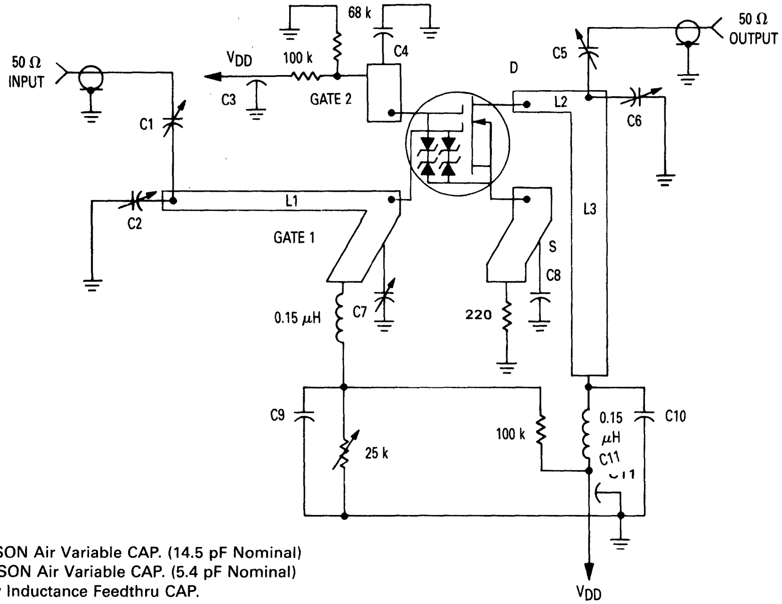
(SEE SCHEMATIC FIGURE 11)

Figure 10. Third Order Intermodulation Distortion

Figure 10 shows the typical third order intermodulation distortion (IMD) performance at 500 MHz.

Both fundamental output and third order IMD output characteristics are plotted. The curves have been extrapolated to show the third order intermodulation output intercept point.

The performance is typical for I_D between 5 mAdc and 10 mAdc. The test circuit shown in Figure 12 was used to generate the IMD Data.



C1 = 1–20 pF JOHANSON Air Variable CAP. (14.5 pF Nominal)
C2 = 1–10 pF, JOHANSON Air Variable CAP. (5.4 pF Nominal)
C3, C11 = 470 pF, Low Inductance Feedthru CAP.
C4, C8, C9, C10 = 250 pF, Low Inductance, UNDERWOOD CAP. (J-101)
C5 = 0.4–6 pF, JOHANSON Air Variable CAP. (0.92 pF Nominal)
C6 = 1–10 pF JOHANSON Air Variable CAP. (5.9 pF Nominal)
C7 = 1–10 pF, JOHANSON Air Variable CAP. (3 pF Nominal)
L1 = 2.52 x 0.1 inches
L2 = 0.4 x 0.1 inches
L3 = 1.23 x 0.2 inches
} On 2 sided glass Teflon®, 1 oz. copper clad, 1/16″ ϵ_R = 2.55

®Trademark of E.I. Dupont, DeNeumours and Co., Inc.

Figure 11. Test Circuit For Power Gain, Noise Figure and Third Order Intermodulation Distortion

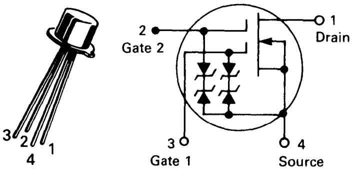
N-CHANNEL DUAL-GATE SILICON-NITRIDE PASSIVATED MOS FIELD-EFFECT TRANSISTORS

... high Y_{fs} depletion mode dual gate transistors designed for VHF amplifier and mixer applications.

- MFE211 — VHF Amplifier/IF Amplifier
  MFE212 — VHF Mixer
- High Forward Transfer Admittance — $|Y_{fs}|$ = 17–40 mmhos
- Low Reverse Transfer Capacitance — C_{rss} = 0.03 pF (Max)
- Diode Protected Gates

MFE211
MFE212

CASE 20-03, STYLE 9
TO-72 (TO-206AF)



DUAL-GATE MOSFETs

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSX}	20	Vdc
Drain-Gate Voltage	V_{DG1} V_{DG2}	35 35	Vdc
Gate Current	I_{G1} I_{G2}	±10 ±10	mAdc
Drain Current — Continuous	I_D	50	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.4	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.2 8.0	Watt mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature Range	T_J	−65 to +175	°C
Lead Temperature, 1/16″ From Seated Surface for 10 Seconds	T_L	300	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (I_D = 10 μAdc, V_{G1S} = V_{G2S} = −4.0 Vdc)		$V_{(BR)DSX}$	20	—	Vdc
Gate 1 — Source Breakdown Voltage(1) (I_{G1} = ±10 mAdc, V_{G2S} = V_{DS} = 0)		$V_{(BR)G1SO}$	±6.0	—	Vdc
Gate 2 — Source Breakdown Voltage(1) (I_{G2} = ±10 mAdc, V_{G1S} = V_{DS} = 0)		$V_{(BR)G2SO}$	±6.0	—	Vdc
Gate 1 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 20 μAdc)	MFE211 MFE212	$V_{G1S(off)}$	−0.5 −0.5	−5.5 −4.0	Vdc
Gate 2 to Source Cutoff Voltage (V_{DS} = 15 Vdc, V_{G1S} = 0, I_D = 20 μAdc)	MFE211 MFE212	$V_{G2S(off)}$	−0.2 −0.2	−2.5 −4.0	Vdc
Gate 1 Leakage Current (V_{G1S} = ±5.0 Vdc, V_{G2S} = V_{DS} = 0) (V_{G1S} = −5.0 Vdc, V_{G2S} = V_{DS} = 0, T_A = 150°C)		I_{G1SS}	 — —	 ±10 −10	 mAdc μAdc
Gate 2 Leakage Current (V_{G2S} = ±5.0 Vdc, V_{G1S} = V_{DS} = 0) (V_{G2S} = −5.0 Vdc, V_{G1S} = V_{DS} = 0, T_A = 150°C)		I_{G2SS}	 — —	 ±10 −10	 nAdc μAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current(2) (V_{DS} = 15 Vdc, V_{G1S} = 0, V_{G2S} = 4.0 Vdc)		I_{DSS}	6.0	40	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance(3) (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, V_{G1S} = 0, f = 1.0 kHz)		$\lvert y_{fs}\rvert$	17	40	mmhos
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{G2S} = 4.0 Vdc, I_D = 10 mAdc, f = 1.0 MHz)		C_{rss}	0.005	0.05	pF

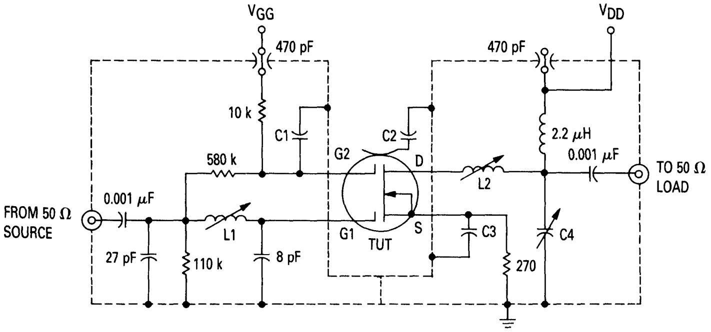
(continued)

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE211 (V_{DD} = 24 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 2) MFE212	NF	 — —	 3.5 4.0	dB
Common Source Power Gain (V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE211 (V_{DD} = 18 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 3) MFE211 (V_{DD} = 18 Vdc, f_{LO} = 245 MHz, f_{RF} = 200 MHz) (Figure 3) MFE212	G_{ps} G_c(5)	 24 29 21	 35 37 28	dB
Bandwidth (V_{DD} = 18 Vdc, V_{GG} = 7.0 Vdc, f = 200 MHz) (Figure 1) MFE211 (V_{DD} = 18 Vdc, f_{LO} = 245 MHz, f_{RF} = 200 MHz) (Figure 3) MFE212 (V_{DD} = 18 Vdc, V_{GG} = 6.0 Vdc, f = 45 MHz) (Figure 2) MFE211	BW	 5.0 4.0 3.5	 12 7.0 6.0	MHz
Gain Control Gate-Supply Voltage(4) (V_{DD} = 18 Vdc, ΔG_{ps} = −30 dB, f = 200 MHz) (Figure 1) MFE211 (V_{DD} = 18 Vdc, ΔG_{ps} = −30 dB, f = 45 MHz) (Figure 2) MFE211	$V_{GG(GC)}$	 — —	 −2.0 ±1.0	Vdc

Notes:

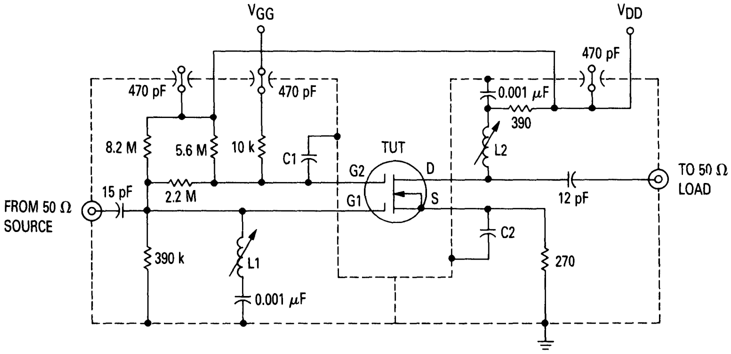
1. All gate breakdown voltages are measured while the device is conducting rated gate current. This ensures that the gate-voltage limiting network is functioning properly.
2. Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%.
3. This parameter must be measured with bias voltages applied for less than 5 seconds to avoid overheating. The signal is applied to gate 1 with gate 2 at ac ground.
4. ΔG_{ps} is defined as the change in G_{ps} from the value at V_{GG} = 7.0 volts (MFE211).
5. Power Gain Conversion. Amplitude at input from local oscillator is adjusted for maximum G_c.



C1, C2 & C3: Leadless disc ceramic, 0.001 μF
C4: ARCO 462, 5–80 pF, or equivalent

L1: 3 Turns #18, 3/16″ diameter aluminum slug
L2: 8 Turns #20, 3/16″ diameter aluminum slug

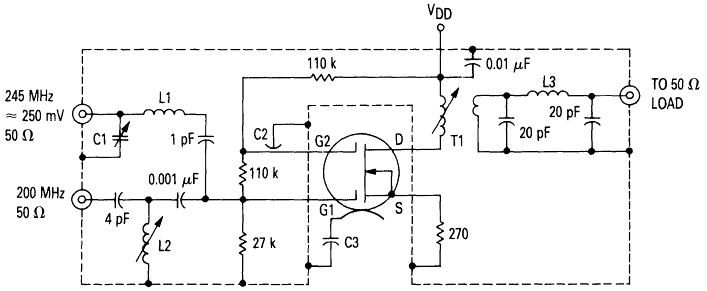
Figure 1. 200 MHz Power Gain, Gain Control Voltage, and Noise Figure Test Circuit for MFE211



C1: Leadless disc ceramic, 0.001 μF
C2: Leadless disc ceramic, 0.01 μF

L1: 8 Turns #28, 5/32″ diameter form, type "J" slug
L2: 9 Turns #28, 5/32″ diameter form, type "J" slug

Figure 2. 45 MHz Power Gain and Noise Figure Test Circuit for MFE211



L1: 7 Turns #34, 1/4″ diameter aluminum slug
L2: 5-1/2 Turns #20, 1/4″ diameter aluminum slug
L3: 7 Turns #24, 1/4″ diameter air core

C1: Arco type 462, 5–80 pF
C2: 0.001 μF leadless disc
C3: 0.01 μF leadless disc

T1: Pri: 25 Turns #30, close wound on 1/4″ diameter form, type "J" slug
Sec: 4 Turns #30, centered over primary

Figure 3. 200 MHz-to-45 MHz Circuit for Conversion Power Gain for MFE212

TYPICAL CHARACTERISTICS

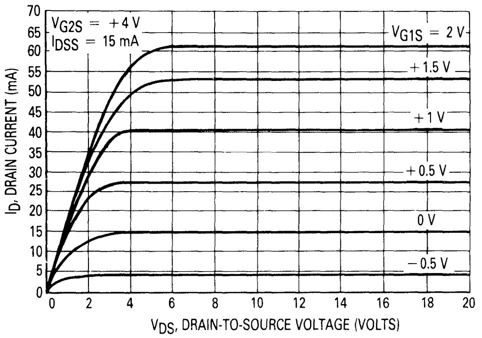


Figure 4. Drain Current versus Drain-to-Source Voltage

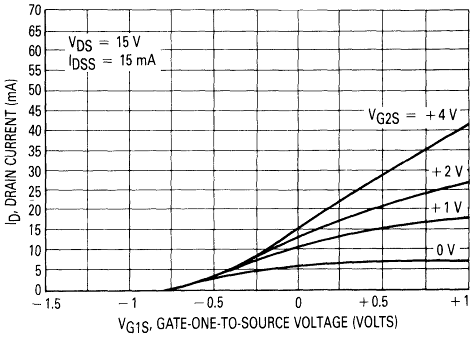


Figure 5. Drain Current versus Gate-One-to-Source Voltage

SMALL-SIGNAL COMMON-SOURCE PARAMETER

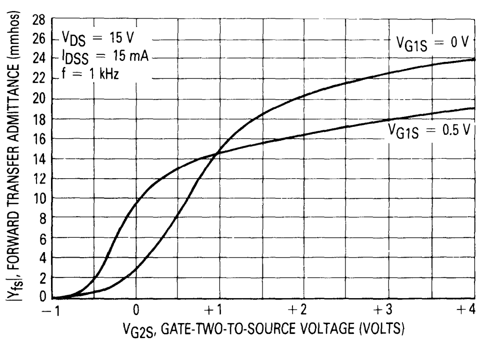


Figure 6. Forward Transfer Admittance versus Gate-Two-to-Source Voltage

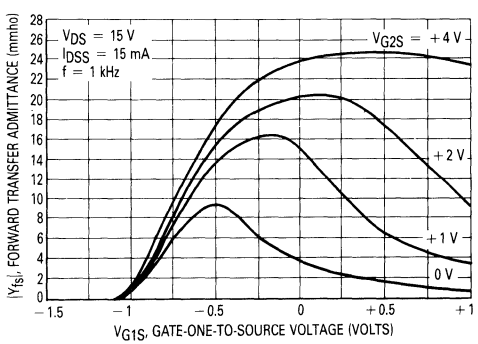


Figure 7. Forward Transfer Admittance versus Gate-One-to-Source Voltage

TYPICAL CHARACTERISTICS (continued)

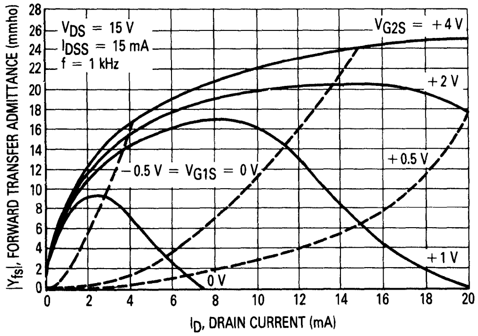


Figure 8. Forward Transfer Admittance versus Drain Current

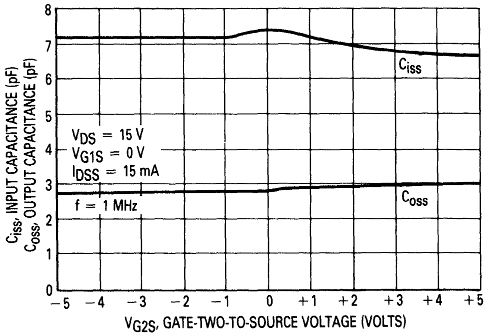


Figure 9. Input and Output Capacitance versus Gate-Two-to-Source Voltage

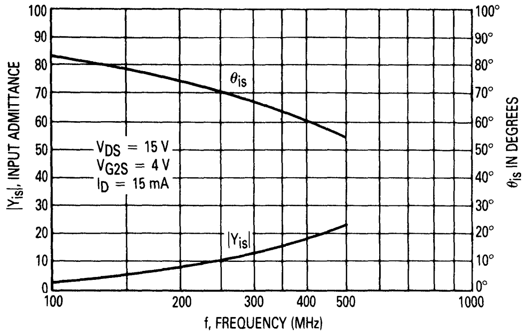


Figure 10. Small-Signal Gate-One Input Admittance versus Frequency

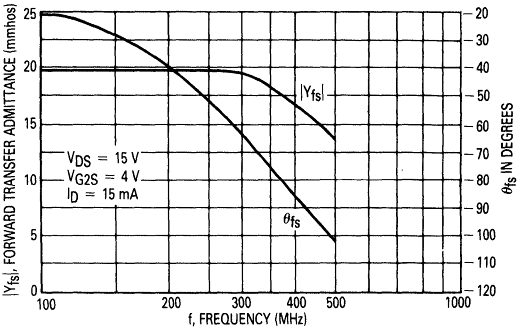


Figure 11. Small-Signal Forward Transfer Admittance versus Frequency

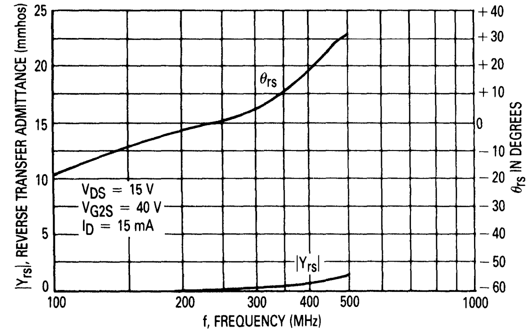


Figure 12. Small-Signal Gate-One Reverse Transfer Admittance versus Frequency

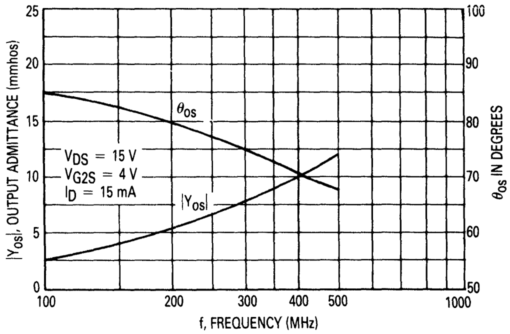


Figure 13. Small-Signal Gate-One Output Admittance versus Frequency

TYPICAL CHARACTERISTICS (continued)

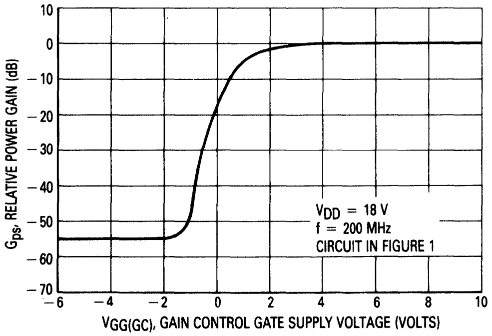


Figure 14. Relative Small-Signal Power Gain versus Gain Control Gate Supply Voltage MFE211

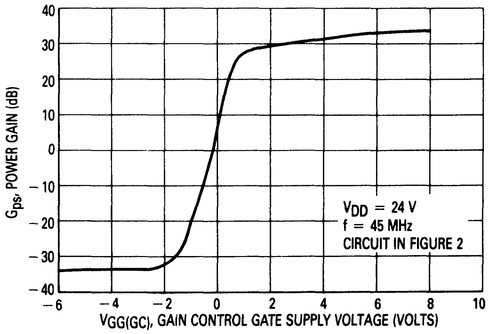


Figure 15. Small-Signal Common-Source Insertion Power Gain versus Gain Control Gate Supply Voltage

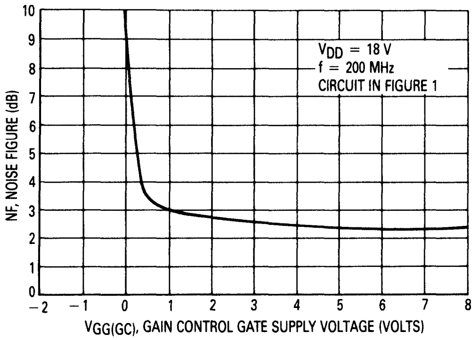


Figure 16. Common Source Spot Noise Figure versus Gain Control Gate Supply Voltage

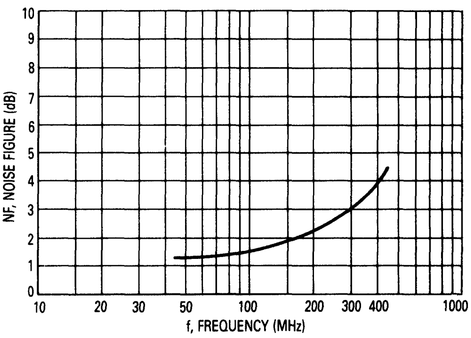
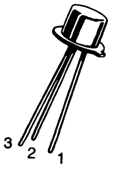
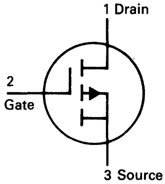


Figure 17. Optimum Spot Noise Figure versus Frequency

MFE823

CASE 22-03, STYLE 11
TO-18 (TO-206AA)





MOSFET

P-CHANNEL — ENHANCEMENT

Refer to 2N4352 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	±10	Vdc
Drain Current	I_D	30	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 1.71	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +175	°C

THERMAL CHARACTERISTICS

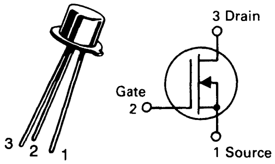
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	584	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	250	°C/W

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage ($I_D = -10\ \mu Adc$, $V_{GS} = 0$ Vdc)	$V_{(BR)DSX}$	−25	—	Vdc
Zero-Gate-Voltage Drain Current ($V_{DS} = -10$ Vdc, $V_{GS} = 0$)	I_{DSS}	—	−20	nAdc
Gate Reverse Current ($V_{GS} = -10$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	1.0	pAdc
ON CHARACTERISTICS				
Gate Threshold Voltage ($V_{DS} = -10$ Vdc, $I_D = -10\ \mu Adc$)	$V_{GS(Th)}$	−2.0	−6.0	Vdc
On-State Drain Current ($V_{DS} = -10$ Vdc, $V_{GS} = -10$ Vdc)	$I_{D(on)}$	−3.0	—	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = -10$ Vdc, $I_D = -2.0$ mAdc, f = 1.0 kHz)	$\|y_{fs}\|$	1000	—	µmhos
Input Capacitance ($V_{DS} = -10$ Vdc, $V_{GS} = -10$ Vdc, f = 1.0 MHz)	C_{iss}	—	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = -10$ Vdc, $V_{GS} = -10$ Vdc, f = 1.0 MHz)	C_{rss}	—	1.5	pF

MFE825

CASE 22-03, STYLE 2
TO-18 (TO-206AA)



MOSFET

N-CHANNEL — DEPLETION

Refer to 2N3796 for graphs.

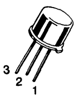
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	20	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Drain Current	I_D	25	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	200 1.6	mW mW/°C
Junction Temperature Range	T_J	150	°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

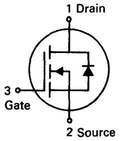
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage ($I_D = 1.0\ \mu A$, $V_{GS} = -8.0$ V)	$V_{(BR)DSX}$	20	—	Vdc
Gate Reverse Current ($V_{GS} = -10$ V, $V_{DS} = 0$ V)	I_{GSS}	—	−1.0	pA
Gate Source Voltage ($I_D = 1.0\ \mu A$, $V_{DS} = 2.0$ V)	V_{GS}	0	−2.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current ($V_{DS} = 10$ V, $V_{GS} = 0$)	I_{DSS}	1.0	25	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = 10$ V, $V_{GS} = 0$, f = 1.0 kHz)	$\vert y_{fs}\vert$	500	—	μmhos

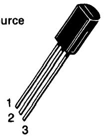
MFE910
MPF910



CASE 79-04, STYLE 6
TO-39 (TO-205AD)



MPF910
CASE 29-03, STYLE 22
TO-92 (TO-226AE)



TMOS
SWITCHING

N-CHANNEL — ENHANCEMENT

Refer to 2N6659 for additional graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	60	Vdc
Gate-Source Voltage	V_{GS}	±15	Vdc
Drain Current — Continuous(1) Pulsed(2)	I_D I_{DM}	0.5 1.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C MPF910	P_D	1.0 8.0	Watts mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C MFE910	P_D	6.25 50	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 40 V, V_{GS} = 0)	I_{DSS}	—	0.1	10	μAdc
Gate Reverse Current (V_{GS} = 10 V, V_{DS} = 0)	I_{GSS}	—	0.01	10	nAdc
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSS}$	60	90	—	Vdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.3	1.5	2.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 500 mA)	$V_{DS(on)}$	—	—	2.5	Vdc
On-State Drain Current (V_{DS} = 25 V, V_{GS} = 10 V)	$I_{D(on)}$	500	—	—	mA
Forward Transconductance (V_{DS} = 15 V, I_D = 500 mA)	g_{fs}	100	—	—	mmhos

FIGURE 1 — $V_{GS(th)}$ NORMALIZED versus TEMPERATURE

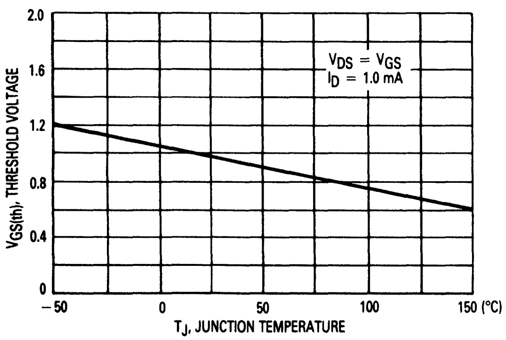


FIGURE 2 — ON-REGION CHARACTERISTICS

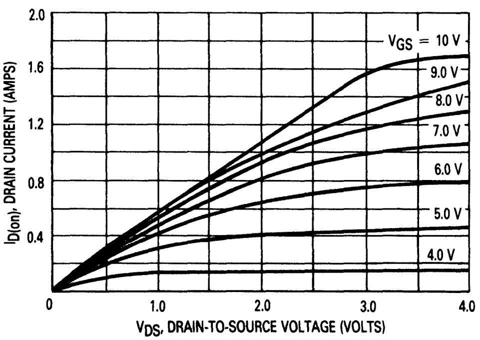


FIGURE 3 — OUTPUT CHARACTERISTICS

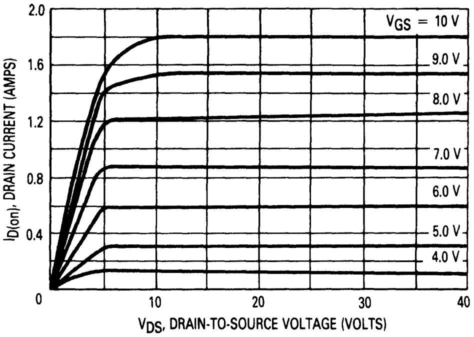
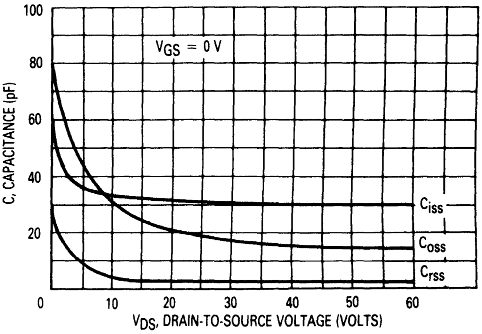
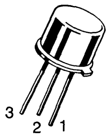


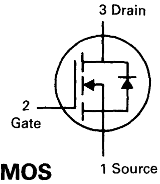
FIGURE 4 — CAPACITANCE versus DRAIN-TO-SOURCE VOLTAGE



MFE930
MFE960
MFE990

CASE 79-04, STYLE 6
TO-39 (TO-205AD)





TMOS SWITCHING

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	MFE930	MFE960	MFE990	Unit
Drain-Source Voltage	V_{DS}	35	60	90	Vdc
Drain-Gate Voltage	V_{DG}	35	60	90	Vdc
Gate-Source Voltage	V_{GS}	±30			Vdc
Drain Current					Adc
Continuous(1)	I_D	2.0			
Pulsed(2)	I_{DM}	3.0			
Total Device Dissipation	P_D				
@ $T_C = 25°C$		6.25			Watts
Derate above 25°C		50			mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to 150			°C

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10\ \mu A$)	MFE930	$V_{(BR)DSX}$	35	—	—	Vdc
	MFE960		60	—	—	
	MFE990		90	—	—	
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)		I_{GSS}	—	—	50	nAdc
ON CHARACTERISTICS*						
Zero-Gate-Voltage Drain Current (V_{DS} = Maximum Rating, $V_{GS} = 0$)		I_{DSS}	—	—	10	μAdc
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1.0$ mA)		$V_{GS(Th)}$	1.0	—	3.5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V) ($I_D = 0.5$ A)	MFE930	$V_{DS(on)}$	—	0.4	0.7	Vdc
	MFE960		—	0.6	0.8	
	MFE990		—	0.6	1.2	
($I_D = 1.0$ A)	MFE930		—	0.9	1.4	
	MFE960		—	1.2	1.7	
	MFE990		—	1.2	2.4	
($I_D = 2.0$ A)	MFE930		—	2.2	3.0	
	MFE960		—	2.8	3.5	
	MFE990		—	2.8	4.8	
Static Drain-Source On Resistance ($V_{GS} = 10$ Vdc, $I_D = 1.0$ Adc)	MFE930	$r_{DS(on)}$	—	0.9	1.4	Ohms
	MFE960		—	1.2	1.7	
	MFE990		—	1.2	2.0	
On-State Drain Current ($V_{DS} = 25$ V, $V_{GS} = 10$ V)		$I_{D(on)}$	1.0	2.0	—	Amps
SMALL-SIGNAL CHARACTERISTICS						
Input Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	60	70	pF
Reverse Transfer Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{rss}	—	13	18	pF
Output Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{oss}	—	49	60	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Forward Transconductance (V_{DS} = 25 V, I_D = 0.5 A)	g_{fs}	200	380	—	mmhos
SWITCHING CHARACTERISTICS*					
Turn-On Time (See Figure 1)	t_{on}	—	7.0	15	ns
Turn-Off Time (See Figure 1)	t_{off}	—	7.0	15	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

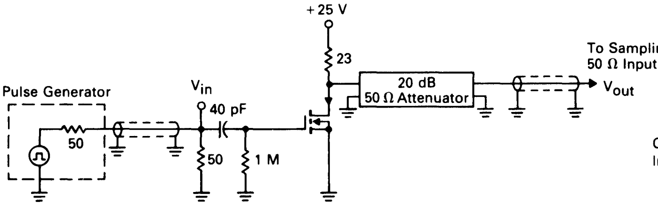


FIGURE 2 — SWITCHING WAVEFORMS

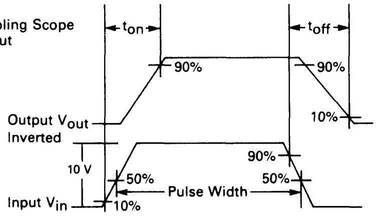


FIGURE 3 — ON VOLTAGE versus TEMPERATURE,

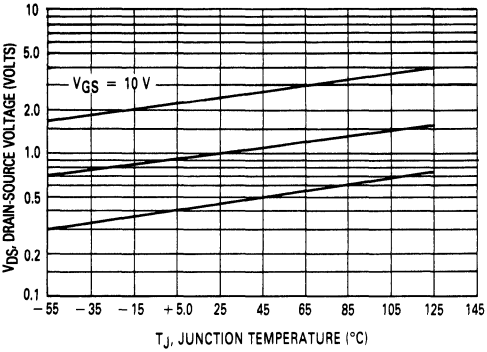


FIGURE 4 — CAPACITANCE VARIATION

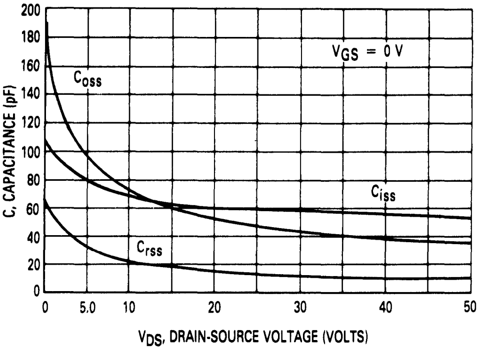


FIGURE 5 — TRANSFER CHARACTERISTIC

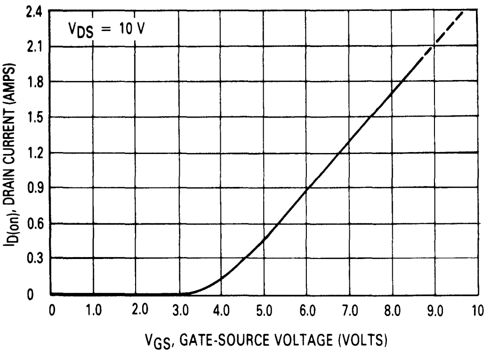


FIGURE 6 — OUTPUT CHARACTERISTIC

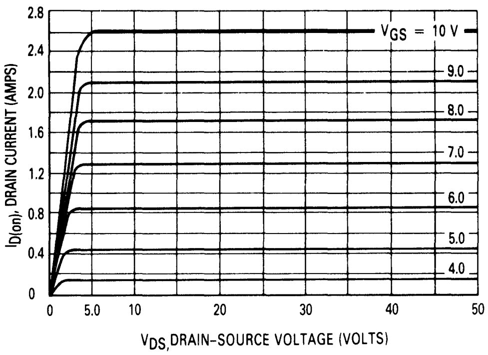
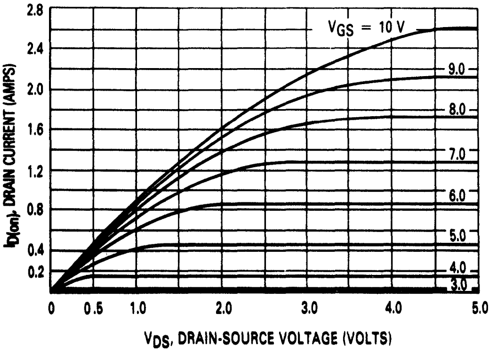
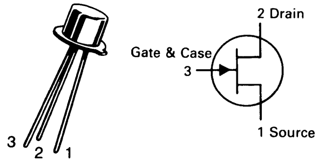


FIGURE 7 — SATURATION CHARACTERISTIC



MFE2004
thru
MFE2006

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFET CHOPPERS

N-CHANNEL — DEPLETION

Refer to 2N4091 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	I_{GF}	10	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10	Watts mW/°C
Junction Temperature Range	T_J	−65 to +175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 150°C)		I_{GSS}	— —	0.2 0.4	nAdc μAdc
Drain Cutoff Current (V_{DS} = 20 Vdc, V_{GS} = 12 Vdc) (V_{DS} = 20 Vdc, V_{GS} = 12 Vdc, T_A = 150°C)		$I_{D(off)}$	— —	0.2 0.4	nAdc μAdc
Gate Source Voltage (V_{DS} = 20 Vdc, I_D = 50 μAdc)	MFE2004 MFE2005 MFE2006	V_{GS}	1.0 2.0 5.0	6.0 8.0 10	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current* (V_{DS} = 20 Vdc, V_{GS} = 0)	MFE2004 MFE2005 MFE2006	I_{DSS}*	8.0 15 30	— — —	mAdc
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)		$V_{GS(f)}$	—	1.0	Vdc
Drain-Source On-Voltage (I_D = 3.0 mAdc, V_{GS} = 0) (I_D = 6.0 mAdc, V_{GS} = 0) (I_D = 10 mAdc, V_{GS} = 0)	MFE2004 MFE2005 MFE2006	$V_{DS(on)}$	— — —	0.4 0.4 0.4	Vdc
Static Drain-Source On Resistance (I_D = 1.0 mAdc, V_{GS} = 0)	MFE2004 MFE2005 MFE2006	$r_{DS(on)}$	— — —	80 50 30	Ohms
SMALL-SIGNAL CHARACTERISTICS					
Static Drain-Source "ON" Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	MFE2004 MFE2005 MFE2006	$r_{ds(on)}$	— — —	80 50 30	Ohms
Input Capacitance (V_{DS} = 0, V_{GS} = −12 Vdc, f = 1.0 MHz)		C_{iss}	—	16	pF

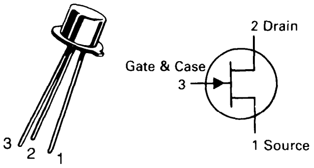
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
Reverse Transfer Capacitance		C_{rss}			pF
(V_{DS} = 0, V_{GS} = 6.0 Vdc, f = 1.0 MHz)	MFE2004		—	5.0	
(V_{DS} = 0, V_{GS} = 8.0 Vdc, f = 1.0 MHz)	MFE2005		—	5.0	
(V_{DS} = 0, V_{GS} = 12 Vdc, f = 1.0 MHz)	MFE2006		—	5.0	
SWITCHING CHARACTERISTICS					
Turn-On Delay Time		$t_{d(on)}$			ns
(V_{DD} = 3.0 Vdc, I_D = 3.0 mAdc, V_{GS} = 0)	MFE2004		—	20	
(V_{DD} = 3.0 Vdc, I_D = 6.0 mAdc, V_{GS} = 0)	MFE2005		—	15	
(V_{DD} = 3.0 Vdc, I_D = 10 mAdc, V_{GS} = 0)	MFE2006		—	10	
Rise Time		t_r			ns
(V_{DD} = 3.0 Vdc, I_D = 3.0 mAdc, V_{GS} = 0)	MFE2004		—	40	
(V_{DD} = 3.0 Vdc, I_D = 6.0 mAdc, V_{GS} = 0)	MFE2005		—	20	
(V_{DD} = 3.0 Vdc, I_D = 10 mAdc, V_{GS} = 0)	MFE2006		—	10	
Turn-Off Time		t_{off}			ns
(V_{DD} = 3.0 Vdc, I_D = 3.0 mAdc, $V_{GS(off)}$ = 6.0 Vdc)	MFE2004		—	80	
(V_{DD} = 3.0 Vdc, I_D = 6.0 mAdc, $V_{GS(off)}$ = 8.0 Vdc)	MFE2005		—	60	
(V_{DD} = 3.0 Vdc, I_D = 10 mAdc, $V_{GS(off)}$ = 12 Vdc)	MFE2006		—	40	

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

MFE2010
thru
MFE2012

CASE 22-03, STYLE 4
TO-18 (TO-206AA)



JFET CHOPPERS

N-CHANNEL — DEPLETION

Refer to J107 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Forward Gate Current	I_{GF}	50	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.8 10	Watt mW/°C
Junction Temperature Range	T_J	−65 to +175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	25	—	Vdc
Gate Reverse Current		I_{GSS}			
(V_{GS} = 15 Vdc, V_{DS} = 0)			—	3.0	nAdc
(V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 150°C)			—	6.0	μAdc
Drain Cutoff Current		$I_{D(off)}$			
(V_{DS} = 15 Vdc, V_{GS} = 12 Vdc)			—	3.0	nAdc
(V_{DS} = 15 Vdc, V_{GS} = 12 Vdc, T_A = 150°C)			—	6.0	μAdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current*		I_{DSS}*			mAdc
(V_{DS} = 20 Vdc, V_{GS} = 0)	MFE2010		15	—	
	MFE2011		40	—	
	MFE2012		100	—	
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)		$V_{GS(f)}$	—	1.0	Vdc
Gate-Source Voltage		V_{GS}			Vdc
(V_{DS} = 15 Vdc, I_D = 1.0 μAdc)	MFE2010		−0.5	−10	
	MFE2011		−1.0	−10	
	MFE2012		−3.0	−10	
Drain-Source On-Voltage		$V_{DS(on)}$			Vdc
(I_D = 8.0 mAdc, V_{GS} = 0)	MFE2010		—	0.75	
(I_D = 15 mAdc, V_{GS} = 0)	MFE2011		—	0.75	
(I_D = 30 mAdc, V_{GS} = 0)	MFE2012		—	0.75	
Static Drain-Source On Resistance		$r_{DS(on)}$			Ohms
(I_D = 1.0 mAdc, V_{GS} = 0)	MFE2010		—	25	
	MFE2011		—	15	
	MFE2012		—	10	
SMALL-SIGNAL CHARACTERISTICS					
Static Drain-Source "ON" Resistance		$r_{ds(on)}$			Ohms
(V_{GS} = 0, I_D = 0, f = 1.0 kHz)	MFE2010		—	25	
	MFE2011		—	15	
	MFE2012		—	10	
Input Capacitance (V_{DS} = 0, V_{GS} = 10 Vdc, f = 1.0 MHz)		C_{iss}	—	50	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 12 Vdc, f = 1.0 MHz)		C_{rss}	—	20	pF

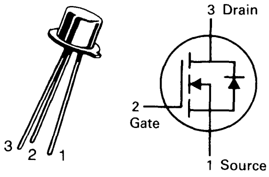
ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS					
Turn-On Delay Time		$t_{d(on)}$	—	10	ns
Rise Time		t_r	—	6.0	ns
Turn-Off Delay Time		$t_{d(off)}$			ns
(V_{DD} = 15 Vdc, I_D = 8.0 mAdc)	MFE2010		—	35	
(V_{DD} = 15 Vdc, I_D = 15 mAdc)	MFE2011		—	20	
(V_{DD} = 15 Vdc, I_D = 30 mAdc)	MFE2012		—	12	
Fall Time		t_f			ns
(V_{DD} = 15 Vdc, I_D = 8.0 mAdc)	MFE2010		—	75	
(V_{DD} = 15 Vdc, I_D = 15 mAdc)	MFE2011		—	45	
(V_{DD} = 15 Vdc, I_D = 30 mAdc)	MFE2012		—	25	

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 3.0%.

MFE9200

CASE 22-03, STYLE 12
TO-18 (TO-206AA)



TMOS SWITCHING FET

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current Continuous (1) Pulsed (2)	 I_D I_{DM}	 400 800	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.8 14.4	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10\ \mu A$)	$V_{(BR)DSX}$	200	—	—	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	0.01	50	nAdc
ON CHARACTERISTICS*					
Zero-Gate-Voltage Drain Current ($V_{DS} = 200$ V, $V_{GS} = 0$)	I_{DSS}	—	0.1	10	μAdc
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1.0$ mA)	$V_{GS(Th)}$	1.0	—	4.0	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V) ($I_D = 100$ mA) ($I_D = 250$ mA) ($I_D = 500$ mA)	$V_{DS(on)}$	 — — —	 0.45 1.20 3.0	 0.6 1.60 —	Vdc
Static Drain-Source On Resistance ($V_{GS} = 10$ Vdc) ($I_D = 100$ mA) ($I_D = 250$ mA) ($I_D = 500$ mA)	$r_{DS(on)}$	 — — —	 4.5 4.8 6.0	 6.0 6.4 —	Ohms
On-State Drain Current ($V_{DS} = 25$ V, $V_{GS} = 10$ V)	$I_{D(on)}$	400	700	—	mA
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	72	90	pF
Reverse Transfer Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{rss}	—	—	10	pF
Output Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{oss}	—	—	30	pF
Forward Transconductance ($V_{DS} = 25$ V, $I_D = 250$ mA)	g_{fs}	200	400	—	mmhos
SWITCHING CHARACTERISTICS					
Turn-On Time See Figure 1	t_{on}	—	6.0	15	ns
Turn-Off Time See Figure 1	t_{off}	—	6.0	15	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

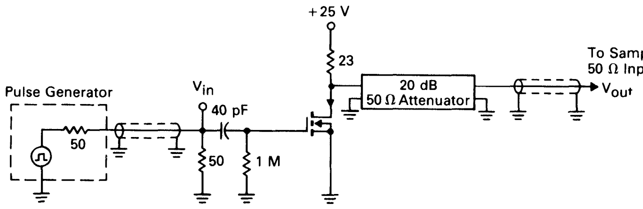


FIGURE 2 — SWITCHING WAVEFORMS

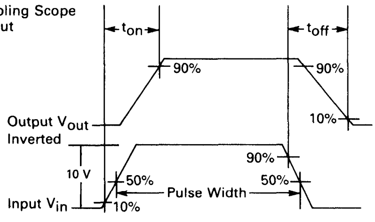


FIGURE 3 — ON VOLTAGE versus TEMPERATURE

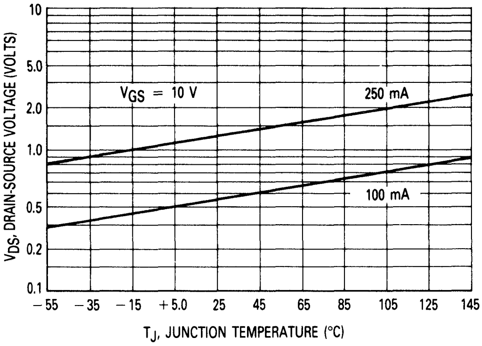


FIGURE 4 — CAPACITANCE VARIATION

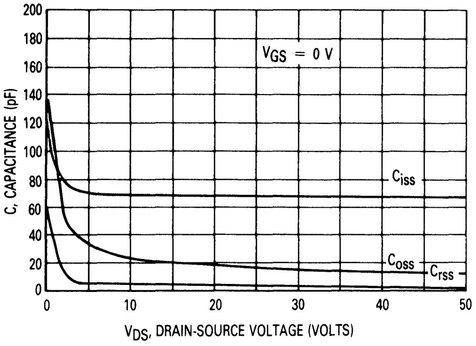


FIGURE 5 — TRANSFER CHARACTERISTIC

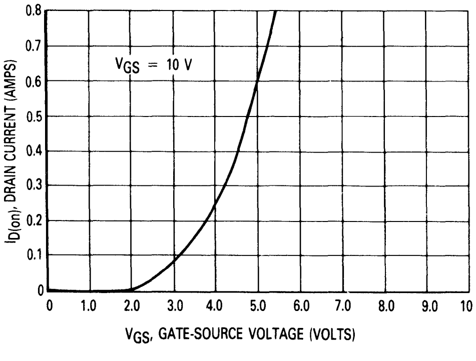


FIGURE 6 — OUTPUT CHARACTERISTIC

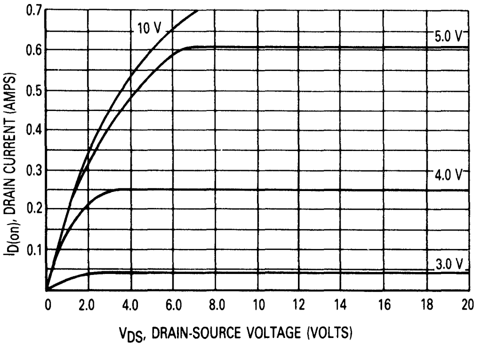
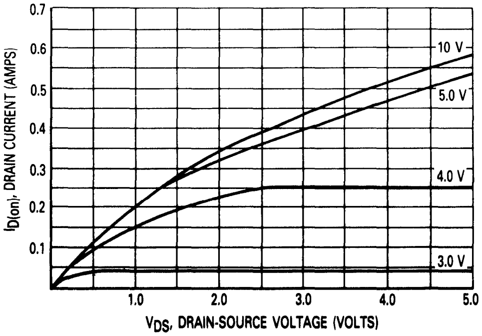
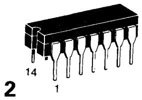


FIGURE 7 — SATURATION CHARACTERISTIC

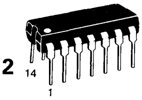


QUAD DUAL-IN-LINE N-CHANNEL ENHANCEMENT MODE SILICON GATE TMOS FIELD EFFECT TRANSISTORS

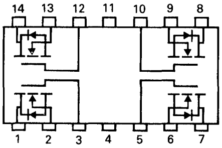
MFQ1000C, P



MFQ1000C
CASE 632-08, STYLE 2



MFQ1000P
CASE 646-06, STYLE 2



QUAD
DUAL-IN-LINE TMOS
N-CHANNEL — ENHANCEMENT

These TMOS Power FETs are designed for high current, high speed power switching applications such as switching power supplies, CMOS logic, microprocessor or TTL-to-high current interface and line drivers.

- Fast Switching Speed — $t_{on} = t_{off} = 10$ ns Max
- Low Drive Requirement, $V_{GS(th)} = 2.5$ V Max
- Inherent Current Sharing Capability Permits Easy Paralleling of Many Devices
- Plastic and Ceramic Packages

MAXIMUM RATINGS

Rating	Symbol	Value				Unit
Drain-Source Voltage	V_{DSS}	60				Vdc
Drain-Gate Voltage	V_{DGO}	60				Vdc
Forward Gate-Source Voltage	V_{GSF}	15				Vdc
Reverse Gate-Source Voltage	V_{GSR}	0.3				Vdc
Drain Current — Continuous — Pulsed	 I_D I_{DM}	 0.3 1.0				Adc
Drain-Source Diode Current — Continuous — Pulsed	 I_{DS} I_{DMS}	 0.5 1.0				Amps
		Each Transistor		All Four Transistors		
		C	P	C	P	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 1.0 8.0	 0.5 4.0	 2.0 16	 1.2 9.6	 Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 2.0 16	 1.0 8.0	 4.0 32	 3.0 23	 Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−40 to +125				°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 100$ μA)	$V_{(BR)DSS}$	60	—	—	Vdc
Zero Gate Voltage Drain Current ($V_{DS} = 40$, $V_{GS} = 0$)	I_{DSS}	—	—	10	μAdc
Gate-Body Leakage Current ($V_{GS} = 10$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage ($V_{DS} = V_{GS}$, $I_D = 1.0$ mA)	$V_{GS(th)}$	—	—	2.5	Vdc
Drain-Source On-Voltage (Note 1) ($V_{GS} = 5.0$ V, $I_D = 0.3$ A) ($V_{GS} = 10$ V, $I_D = 0.5$ A)	$V_{DS(on)}$	— —	— —	1.5 1.65	Vdc
Static Drain-Source On-Resistance ($V_{GS} = 10$ Vdc, $I_D = 300$ mA)	$r_{DS(on)}$	—	—	5.5	Ohms
On-State Drain Current (Note 1) ($V_{DS} = 25$ V, $V_{GS} = 5.0$ V) ($V_{DS} = 25$ V, $V_{GS} = 10$ V)	$I_{D(on)}$	0.2 0.5	— —	— —	Amps
Forward Transconductance (Note 1) ($V_{DS} = 15$ V, $I_D = 0.5$ A)	g_{fs}	100	—	—	mΩ
DYNAMIC CHARACTERISTICS					
Input Capacitance (Note 2) ($V_{DS} = 25$ V, f = 1.0 MHz)	C_{iss}	—	48	—	pF
Output Capacitance (Note 2) ($V_{DS} = 25$ V, f = 1.0 MHz)	C_{oss}	—	16	—	pF
Reverse Transfer Capacitance (Note 2) ($V_{DS} = 25$ V, f = 1.0 MHz)	C_{rss}	—	2.0	—	pF
SWITCHING CHARACTERISTICS					
Turn-On Time (Note 2) ($I_D = 0.3$ A, $R_L = 23$ Ω, $R_S = 50$ Ω)	t_{on}	—	—	10	ns
Turn-Off Time (Note 2)	t_{off}	—	—	10	ns

NOTES: 1. Pulse Test — 80 μs pulse, % duty cycle.
2. Sample Test.

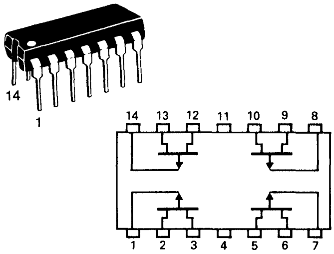
QUAD DUAL-IN-LINE
P-CHANNEL JUNCTION FIELD-EFFECT TRANSISTORS

. . . depletion mode (Type A) junction field-effect transistors designed for use in general-purpose amplifier applications.

- High Gate-Source Breakdown Voltage — $V_{(BR)GSS}$ = 40 Vdc (Min)
- Low Noise Figure — NF = 1.0 dB (Typ) @ f = 100 Hz
- Low Reverse Transfer Capacitance —C_{rss} = 2.0 pF (Max)
- Refer to 2N5460 Data Sheet for Performance Graphs

MFQ5460P

CASE 646-06, STYLE 5



QUAD DUAL-IN-LINE JFETs

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
Drain-Source Voltage	V_{DS}	40		Vdc
Drain-Gate Voltage	V_{DG}	40		Vdc
Reverse Gate-Source Voltage	V_{GSR}	40		Vdc
Drain Current	I_D	20		mAdc
Forward Gate Current	I_{GF}	10		mAdc
		Each Transistor	**Total Device**	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	 0.5 2.86	 1.5 8.58	 Watts mW/°C

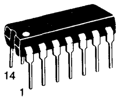
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	40	—	—	Vdc
Gate-Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 1.0 μAdc)	$V_{GS(off)}$	0.75	—	6.0	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 — —	 — —	 5.0 1.0	 nAdc μAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	1.0	—	5.0	mAdc
Gate-Source Voltage (V_{DS} = 15 Vdc, I_D = 0.1 mAdc)	V_{GS}	0.5	—	4.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transadmittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	1000	—	4000	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	—	75	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.0	2.0	pF
Common-Source Noise Figure (V_{DS} = 15 Vdc, V_{GS} = 0, R_G = 1.0 MΩ, f = 100 Hz, BW = 1.0 Hz)	NF	—	1.0	—	dB
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, f = 100 Hz, BW = 1.0 Hz)	e_n	—	60	—	$nV/\sqrt{Hz}$

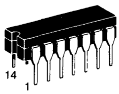
QUAD DUAL-IN-LINE N-CHANNEL ENHANCEMENT MODE SILICON GATE TMOS FIELD EFFECT TRANSISTORS

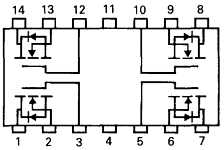
MFQ6660C, P

MFQ6660C
CASE 632-08, STYLE 2



MFQ6660P
CASE 646-06, STYLE 2





QUAD DUAL-IN-LINE TMOS

N-CHANNEL — ENHANCEMENT

These TMOS Power FETs are designed for high current, high speed power switching applications such as switching power supplies, CMOS logic, microprocessor or TTL-to-high current interface and line drivers.

- Fast Switching Speed — $t_{on} = t_{off} = 5.0$ ns Max
- Low On-Resistance — 3.0 Ohms Max
- Low Drive Requirement, $V_{GS(th)} = 2.0$ V Max
- Inherent Current Sharing Capability Permits Easy Paralleling of Many Devices
- Plastic and Ceramic Packages

MAXIMUM RATINGS

Rating	Symbol	Value				Unit
Drain-Source Voltage	V_{DSS}	60				Vdc
Drain-Gate Voltage	V_{DGO}	60				Vdc
Gate-Source Voltage	V_{GS}	±30				Vdc
Drain Current — Continuous (Note 1) — Pulsed (Note 2)	 I_D I_{DM}	 2.0 3.0				Adc
		Each Transistor		All Four Transistors		
		C	P	C	P	
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 1.0 8.0	 0.5 4.0	 2.0 16	 1.2 9.6	 Watts mW/°C
Total Power Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	 2.0 16	 1.0 8.0	 4.0 32	 3.0 23	 Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−50 to +150				°C

NOTES: (1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10$ μA)	$V_{(BR)DSS}$	60	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = Maximum Rating, $V_{GS} = 0$)	I_{DSS}	—	—	10	μAdc
Gate-Body Leakage Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS (See Note)					
Gate Threshold Voltage ($I_D = 1.0$ mA, $V_{DS} = V_{GS}$)	$V_{GS(th)}$	—	—	2.0	Vdc
Drain-Source On-Voltage ($I_D = 0.3$ A, $V_{GS} = 5.0$ V) ($I_D = 1.0$ A, $V_{GS} = 10$ V)	$V_{DS(on)}$	— —	0.9 —	1.5 3.0	Vdc
Static Drain-Source On-Resistance ($V_{GS} = 10$ Vdc, $I_D = 1.0$ Adc)	$r_{DS(on)}$	—	—	3.0	Ohms
On-State Drain Current ($V_{DS} = 25$ V, $V_{GS} = 10$ V)	$I_{D(on)}$	1.0	2.0	—	Amps
Forward Transconductance ($V_{DS} = 25$ V, $I_D = 0.5$ A)	g_{fs}	170	—	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	30	50	pF
Output Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{oss}	—	20	40	pF
Reverse Transfer Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)	C_{rss}	—	3.6	10	pF
SWITCHING CHARACTERISTICS (See Note)					
Turn-On Time (See Figure 1)	t_{on}	—	—	5.0	ns
Turn-Off Time (See Figure 1)	t_{off}	—	—	5.0	ns

NOTE: Pulse Test — Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

RESISTIVE SWITCHING

FIGURE 1 — SWITCHING TEST CIRCUIT

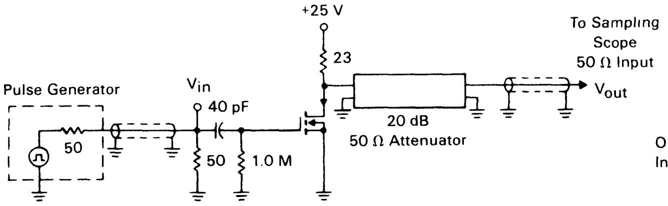
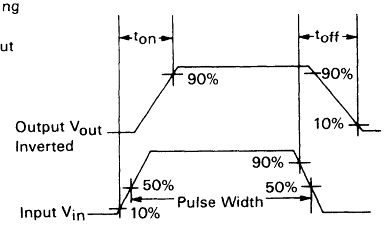


FIGURE 2 — SWITCHING WAVEFORMS



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage	V_{DGS}	60	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current — Continuous Pulsed	I_D I_{DM}	0.5 0.8	Adc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

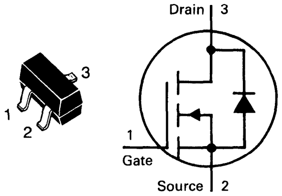
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF170L = 6Z

MMBF170L

CASE 318-03, STYLE 21
SOT-23 (TO-236AB)



TMOS FET
TRANSISTOR

N-CHANNEL

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSS}$	60	—	Vdc
Gate-Body Leakage Current, Forward (V_{GSF} = 15 Vdc, V_{DS} = 0)	I_{GSS}	—	10	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.8	3.0	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 200 mA)	$r_{DS(on)}$	—	5.0	Ohm
On-State Drain Current (V_{DS} = 25 V, V_{GS} = 0)	$I_{D(off)}$	—	0.5	μA
DYNAMIC CHARACTERISTICS				
Input Capacitance (V_{DS} = 10 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	60	pF
SWITCHING CHARACTERISTICS*				
Turn-On Delay Time (V_{DD} = 25 V, I_D = 500 mA, R_{gen} = 50 Ohms) Figure 1	$t_{d(on)}$	—	10	ns
Turn-Off Delay Time	$t_{d(off)}$	—	10	

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

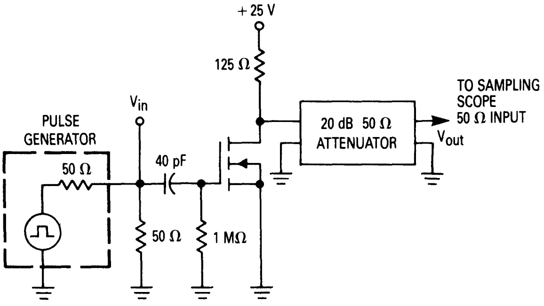
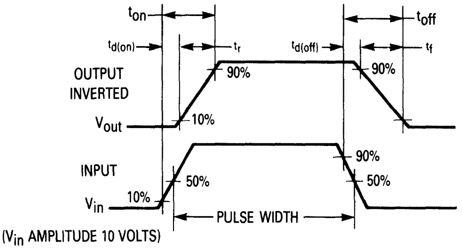


Figure 1. Switching Test Circuit

SWITCHING WAVEFORM

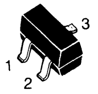


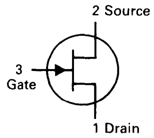
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	$I_{G(f)}$	50	mAdc

MMBF4391L thru MMBF4393L

CASE 318-03, STYLE 10 SOT-23 (TO-236AB)





JFET SWITCHING TRANSISTORS

N-CHANNEL

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

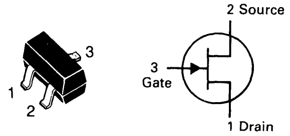
MMBF4391L = 6J; MMBF4392L = 6K; MMBF4393L = 6G

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)		$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 25°C) (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 100°C)		I_{GSS}	— —	1.0 0.20	nAdc μAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	MMBF4391L MMBF4392L MMBF4393L	$V_{GS(off)}$	−4.0 −2.0 −0.5	−10 −5.0 −3.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain (V_{DS} = 15 V, V_{GS} = 0)	MMBF4391L MMBF4392L MMBF4393L	I_{DSS}	50 25 5.0	150 75 30	mAdc
Drain Current (V_{DS} = 15 Vdc, V_{GS} = 12 Vdc) (V_{DS} = 15, V_{GS} = 12 Vdc, T_A = 100°C)		I_D	— —	1.0 1.0	nAdc μAdc
Drain-Source On-Voltage (I_D = 12 mAdc, V_{GS} = 0) (I_D = 6.0 mAdc, V_{GS} = 0) (I_D = 3.0 mAdc, V_{GS} = 0)	MMBF4391L MMBF4392L MMBF4393L	$V_{DS(on)}$	— — —	0.4 0.4 0.4	Vdc
Static Drain-Source On Resistance (I_D = 1.0 mAdc, V_{GS} = 0)	MMBF4391L MMBF4392L MMBF4393L	$r_{DS(on)}$	— — —	30 60 100	Ohms
SMALL-SIGNAL CHARACTERISTICS					
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	14	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = 12 Vdc, f = 1.0 MHz)		C_{rss}	—	3.5	pF

MMBF4416L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET
VHF/UHF AMPLIFIER TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF4416L = 6A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current (V_{GS} = 20 Vdc, V_{DS} = 0) (V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 150°C)	I_{GSS}	— —	1.0 200	nAdc nAdc
Gate Source Cutoff Voltage (I_D = 1.0 nAdc, V_{DS} = 15 Vdc)	$V_{GS(off)}$	—	−6.0	Vdc
Gate Source Voltage (I_D = 0.5 mAdc, V_{DS} = 15 Vdc)	V_{GS}	−1.0	−5.5	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain (V_{GS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	5.0	15	μAdc
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)	$V_{GS(f)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert Y_{fs} \rvert$	4500	7500	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	4.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	0.8	pF
Output Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, $R_g \approx 1000\ \Omega$, f = 100 MHz) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, $R_g \approx 1000\ \Omega$, f = 400 MHz)	NF	— —	2.0 4.0	dB
Common Source Power Gain (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, f = 100 MHz) (V_{DS} = 15 Vdc, I_D = 5.0 mAdc, f = 400 MHz)	G_{ps}	18 10	— —	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Reverse Gate-Source Voltage	$V_{GS(r)}$	30	Vdc
Forward Gate Current	$I_{G(f)}$	50	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

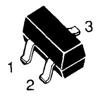
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

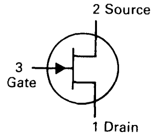
DEVICE MARKING

MMBF4860L = 6F

MMBF4860L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)





JFET SWITCHING TRANSISTOR

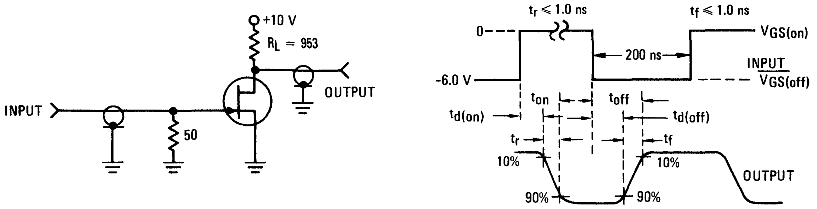
N-CHANNEL

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu Adc, V_{DS} = 0$)	$V_{(BR)GSS}$	30	—	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$) ($V_{GS} = 15$ Vdc, $V_{DS} = 0$, $T_A = 150°C$)	I_{GSS}	 — —	 0.5 2.0	 nAdc μAdc
Gate Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $I_D = 0.5$ nAdc)	$V_{GS(off)}$	−2.0	−6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain(1) ($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	I_{DSS}	20	100	mAdc
Drain Cutoff Current ($V_{DS} = 15$ Vdc, $V_{GS} = 10$ Vdc) ($V_{DS} = 15$ Vdc, $V_{GS} = 10$ Vdc, $T_A = 150°C$)	$I_{D(off)}$	 — —	 0.25 0.5	 nAdc μAdc
Drain-Source On-Voltage ($I_D = 10$ mAdc, $V_{GS} = 0$)	$V_{DS(on)}$	—	0.5	Vdc
Static Drain-Source On Resistance ($V_{GS} = 0$, $I_D = 0$, f = 1.0 kHz)	$r_{DS(on)}$	—	40	Ohms
Input Capacitance ($V_{DS} = 0$, $V_{GS} = 10$ Vdc, f = 1.0 MHz)	C_{iss}	—	18	pF
Reverse Transfer Capacitance ($V_{DS} = 0$, $V_{GS} = 10$ Vdc, f = 1.0 MHz)	C_{rss}	—	8.0	pF
SWITCHING CHARACTERISTICS				
Delay Time ($V_{DD} = 10$ Vdc, $I_{D(on)} = 20$ mAdc) ($V_{G(on)} = 0$, $V_{GS(off)} = 10$ Vdc)	t_d	—	6.0	ns
Rise Time ($V_{DD} = 10$ Vdc, $I_{D(on)} = 10$ mAdc) ($V_{GS(on)} = 0$, $V_{GS(off)} = 6.0$ Vdc) (Figure 1)	t_r	—	4.0	ns
Turn-Off Time ($V_{DD} = 10$ Vdc, $I_{D(on)} = 5.0$ mAdc) ($V_{GS(on)} = 0$, $V_{GS(off)} = 4.0$ Vdc) (Figure 1)	t_{off}	—	50	ns

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



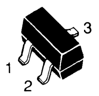
TEST CIRCUIT

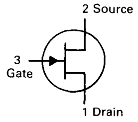
VOLTAGE WAVEFORMS

NOTES: 1. The input waveforms are supplied by a generator with the following characteristics:
Z_{out} = 50 ohms, Duty Cycle ≈ 2.0%
2. Waveforms are monitored on an oscilloscope with the following characteristics:
$t_r \leq 0.75$ ns, $R_{in} \geq 1.0$ megohm, $C_{in} \leq 2.5$ pF.

MMBF5457L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)





JFET
GENERAL PURPOSE TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	$V_{GS(r)}$	25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF5457L = 6D

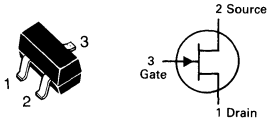
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	25	—	—	Vdc
Gate Reverse Current (V_{GS} = 15 Vdc, V_{DS} = 0) (V_{GS} = 15 Vdc, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 — —	 — —	 1.0 200	nAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 10 nAdc)	$V_{GS(off)}$	0.5	—	−6.0	Vdc
Gate Source Voltage (V_{DS} = 15 Vdc, I_D = 100 μAdc)	V_{GS}	—	−2.5	—	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain(1) (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	1.0	—	5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance(1) (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	1000	—	5000	μmhos
Reverse Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{rs}\|$	—	10	50	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	4.5	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.5	3.0	pF

(1) Pulse test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

MMBF5459L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET
TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	$V_{GS(r)}$	−25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF5459L = 6L

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = −10 μA, V_{DS} = 0)	$V_{(BR)GSS}$	25	—	Vdc
Gate 1 Leakage Current (V_{GS} = −15 V, V_{DS} = 0)	I_{G1SS}	—	1.0	nA
Gate 2 Leakage Current (V_{GS} = −15 V, V_{DS} = 0, T_A = 100°C)	I_{G2SS}	—	200	nA
Gate Source Cutoff Voltage (V_{DS} = 15 V, I_D = 10 nA)	$V_{GS(off)}$	−2.0	−8.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain (V_{DS} = 15 V, V_{GS} = 0)	I_{DSS}	4.0	16	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	2000	6000	μmhos
Output Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{os}\|$	—	50	μmhos
Input Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	3.0	pF

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	40	Vdc
Reverse Gate-Source Voltage	V_{GSR}	40	Vdc
Forward Gate Current	I_{GF}	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

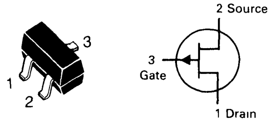
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF5460L = 6E

MMBF5460L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET GENERAL PURPOSE TRANSISTOR

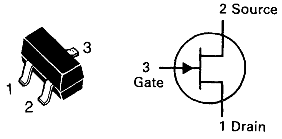
P-CHANNEL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 10 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	40	—	—	Vdc
Gate Reverse Current	I_{GSS}				
(V_{GS} = 20 Vdc, V_{DS} = 0)		—	—	5.0	nAdc
(V_{GS} = 20 Vdc, V_{DS} = 0, T_A = 100°C)		—	—	1.0	μAdc
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 1.0 μAdc)	$V_{GS(off)}$	0.75	—	6.0	Vdc
Gate Source Voltage (V_{DS} = 15 Vdc, I_D = 0.1 mAdc)	V_{GS}	0.5	—	4.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain (V_{DS} = 15 Vdc, V_{GS} = 0)	I_{DSS}	−1.0	—	−5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|Y_{fs}\|$	1000	—	4000	μmhos
Output Admittance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 kHz)	$\|y_{os}\|$	—	—	75	μmhos
Input Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	7.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 Vdc, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.0	2.0	pF
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 15 Vdc, V_{GS} = 0, R_G = 1.0 MΩ, f = 100 Hz, BW = 1.0 Hz)	$\bar{e}_n$	—	20	—	nV/√Hz

MMBF5484L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	$V_{GS(r)}$	25	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Continuous Device Dissipation at or Below T_C = 25°C Linear Derating Factor	P_D	 200 2.8	 mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF5484L = 6B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage (I_G = −1.0 μA, V_{DS} = 0)	$V_{(BR)GSS}$	−25	—	Vdc
Gate Reverse Current (V_{GS} = −20 V, V_{DS} = 0) (V_{GS} = −20 V, V_{DS} = 0, T_A = 100°C)	I_{GSS}	 — —	 −1.0 −0.2	 nA μA
Gate Source Cutoff Voltage (V_{DS} = 15 V, I_D = 10 nA)	$V_{GS(off)}$	−0.3	−3.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain (V_{DS} = 15 V, V_{GS} = 0)	I_{DSS}	1.0	5.0	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	$\lvert Y_{fs}\rvert$	3000	6000	μmhos
Output Admittance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 kHz)	$\lvert Y_{os}\rvert$	—	50	μmhos
Input Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	1.0	pF
Output Capacitance (V_{DS} = 15 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure (V_{DS} = 15 V, I_D = 1.0 mA, YG′ = 1.0 mmhos) (R_G = 1.0 kΩ, f = 100 MHz) (V_{DS} = 15 V, V_{GS} = 0, YG′ = 1.0 μmho) (R_G = 1.0 MΩ, f = 1.0 kHz)	NF	 — —	 3.0 2.5	dB
Common Source Power Gain (V_{DS} = 15 Vdc, I_D = 1.0 mAdc, f = 100 MHz)	G_{ps}	16	25	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	$V_{GS(r)}$	25	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

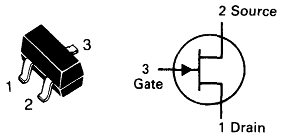
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBF5486L = 6H

MMBF5486L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET TRANSISTOR

N-CHANNEL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($V_{DS} = 0$, $I_G = -1.0$ μA)	$V_{(BR)GSS}$	−25	—	Vdc
Gate 1 Leakage Current ($V_{GS} = -20$ V, $V_{DS} = 0$)	I_{G1SS}	—	−1.0	nA
Gate 2 Leakage Current ($V_{GS} = -20$ V, $V_{DS} = 0$, $T_A = 100°C$)	I_{G2SS}	—	−0.2	μA
Gate Source Cutoff Voltage ($V_{DS} = 15$ V, $I_D = 10$ nA)	$V_{GS(off)}$	−2.0	−6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain ($V_{GS} = 0$, $V_{DS} = 15$ V)	I_{DSS}	8.0	20	mA
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	4000	8000	μmhos
Input Admittance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 400 MHz)	$Re(y_{is})$	—	1000	μmhos
Output Admittance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	75	μmhos
Output Conductance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 400 MHz)	$Re(y_{os})$	—	100	μmhos
Forward Transconductance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 400 MHz)	$Re(y_{fs})$	3500	—	μmhos
Input Capacitance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 1.0 MHz)	C_{rss}	—	1.0	pF
Output Capacitance ($V_{GS} = 0$, $V_{DS} = 15$ V, f = 1.0 MHz)	C_{oss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure ($V_{DS} = 15$ V, $I_D = 4.0$ mA, f = 100 MHz, $Y_G = 1.0$ μmhos) ($V_{DS} = 15$ V, $I_D = 4.0$ mA, $R_G = 1.0$ kΩ, f = 400 MHz, $Y_G = 1.0$ μmhos) ($V_{GS} = 0$, $V_{DS} = 15$ V, $R_G = 1.0$ mΩ, f = 1.0 kHz, $Y_G = 1.0$ μmhos)	NF	 — — —	 2.0 4.0 2.5	dB
Common Source Power Gain ($V_{DS} = 15$ V, $I_D = 4.0$ mA, f = 100 MHz) ($V_{DS} = 15$ V, $I_D = 4.0$ mA, f = 400 MHz)	G_{ps}	 18 10	 30 20	dB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

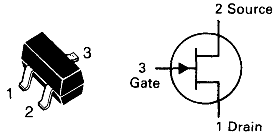
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBFJ310L = 6T

MMBFJ310L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET
VHF/UHF AMPLIFIER
TRANSISTOR

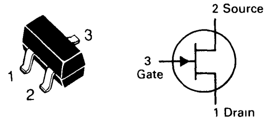
N-CHANNEL

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = −1.0 μAdc, V_{DS} = 0)	$V_{(BR)GSS}$	−25	—	—	Vdc
Gate Reverse Current (V_{GS} = −15 V) (V_{GS} = −15 V, T_A = 125°C)	I_{GSS}	 — —	 — —	 −1.0 −1.0	 nAdc μAdc
Gate Source Cutoff Voltage (V_{DS} = 10 Vdc, I_D = 1.0 nAdc)	$V_{GS(off)}$	−2.0	—	−6.5	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain (V_{DS} = 10 Vdc, V_{GS} = 0)	I_{DSS}	24	—	60	mAdc
Gate-Source Forward Voltage (I_G = 1.0 mAdc, V_{DS} = 0)	$V_{GS(f)}$	—	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	$\|Y_{fs}\|$	8.0	—	18	mmhos
Output Admittance (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 1.0 kHz)	$\|Y_{os}\|$	—	—	250	μmhos
Input Capacitance (V_{GS} = −10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)	C_{iss}	—	—	5.0	pF
Reverse Transfer Capacitance (V_{GS} = −10 Vdc, V_{DS} = 0 Vdc, f = 1.0 MHz)	C_{rss}	—	—	2.5	pF
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 10 Vdc, I_D = 10 mAdc, f = 100 Hz)	$\bar{e}_n$	—	10	—	$nV/\sqrt{Hz}$

MMBFU310L

CASE 318-03, STYLE 10
SOT-23 (TO-236AB)



JFET
TRANSISTOR

N-CHANNEL

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Gate Current	I_G	10	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

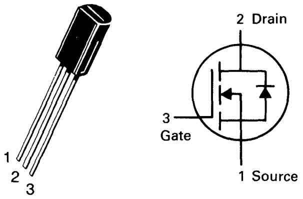
MMBFU310L = 6C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu A$, $V_{DS} = 0$)	$V_{(BR)GSS}$	−25	—	Vdc
Gate 1 Leakage Current ($V_{GS} = -15$ V, $V_{DS} = 0$)	I_{G1SS}	–	−150	pA
Gate 2 Leakage Current ($V_{GS} = -15$ V, $V_{DS} = 0$, $T_A = 125°C$)	I_{G2SS}	—	−150	nA
Gate Source Cutoff Voltage ($V_{DS} = 10$ V, $I_D = 1.0$ nA)	$V_{GS(off)}$	−2.5	−6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain ($V_{DS} = 10$ V, $V_{GS} = 0$)	I_{DSS}	24	60	mA
Gate-Source Forward Voltage ($I_G = 10$ mA, $V_{DS} = 0$)	$V_{GS(f)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 1.0 kHz)	$\lvert Y_{fs} \rvert$	10	18	mmhos
Output Admittance ($V_{DS} = 10$ V, $I_D = 10$ mA, f = 1.0 kHz)	$\lvert Y_{os} \rvert$	—	250	µmhos
Input Capacitance ($V_{GS} = -10$ V, $V_{DS} = 10$ V, f = 1.0 MHz)	C_{iss}	—	5.0	pF
Reverse Transfer Capacitance ($V_{GS} = -10$ V, $V_{DS} = 10$ V, f = 1.0 MHz)	C_{rss}	—	2.5	pF

MPF89

CASE 29-03, STYLE 7
TO-92 (TO-226AE)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	200	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain Current — Continuous (1) — Pulsed (2)	I_D I_{DM}	400 800	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.6 4.8	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to 150	°C
Thermal Resistance Junction to Ambient	θ_{JA}	208	°C/W

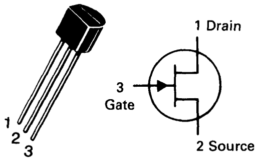
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 0.5 mA)	$V_{(BR)DSS}$	200	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 200 V, V_{GS} = 0)	I_{DSS}	—	0.1	60	μAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	0.01	100	nAdc
ON CHARACTERISTICS*					
Gate Threshold Voltage (I_D = 1.0 mA, V_{DS} = V_{GS})	$V_{GS(th)}$	1.0	—	2.7	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V) (I_D = 100 mA) (I_D = 300 mA) (I_D = 500 mA)	$V_{DS(on)}$	 — — —	 0.45 1.2 3.0	 0.6 1.8 —	Vdc
On-State Drain Current (V_{DS} = 25 V, V_{GS} = 10 V)	$I_{D(on)}$	500	700	—	mA
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc) (I_D = 150 mA) (I_D = 300 mA) (I_D = 500 mA)	$r_{DS(on)}$	 — — —	 4.5 — 6.0	 6.0 6.0 —	Ohms
Forward Transconductance (V_{DS} = 25 V, I_D = 300 mA)	g_{fs}	140	400	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	72	—	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	15	—	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.8	—	pF
SWITCHING CHARACTERISTICS*					
Turn-On Time (See Figure 1)	t_{on}	—	6.0	—	ns
Turn-Off Time (See Figure 1)	t_{off}	—	12	—	ns

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPF102

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
VHF AMPLIFIER

N-CHANNEL — DEPLETION

Refer to 2N4416 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Gate-Source Voltage	V_{GS}	−25	Vdc
Gate Current	I_G	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	200 2	mW mW/°C
Junction Temperature Range	T_J	125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

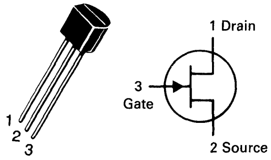
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = -10\ \mu Adc$, $V_{DS} = 0$)	$V_{(BR)GSS}$	−25	—	Vdc
Gate Reverse Current	I_{GSS}			
($V_{GS} = -15$ Vdc, $V_{DS} = 0$)		—	−2.0	nAdc
($V_{GS} = -15$ Vdc, $V_{DS} = 0$, $T_A = 100°C$)		—	−2.0	μAdc
Gate Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $I_D = 2.0$ nAdc)	$V_{GS(off)}$	—	−8.0	Vdc
Gate Source Voltage ($V_{DS} = 15$ Vdc, $I_D = 0.2$ mAdc)	V_{GS}	−0.5	−7.5	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current* ($V_{DS} = 15$ Vdc, $V_{GS} = 0$ Vdc)	I_{DSS}	2.0	20	mAdc
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance*	$\|y_{fs}\|$			μmhos
($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)		2000	7500	
($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 100 MHz)		1600	—	
Input Admittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 100 MHz)	$Re(y_{is})$	—	800	μmhos
Output Conductance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 100 MHz)	$Re(y_{os})$	—	200	μmhos
Input Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)	C_{iss}	—	7.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)	C_{rss}	—	3.0	pF

*Pulse Test: Pulse Width ≤ 630 ms; Duty Cycle ≤ 10%.

MPF820

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
RF AMPLIFIER

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	25	Vdc
Reverse Gate-Source Voltage	V_{GSR}	25	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = 10\ \mu Adc, V_{DS} = 0$)	$V_{(BR)GSS}$	25	—	—	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)	I_{GSS}	—	—	5.0	nAdc
Gate Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $I_D = 200\ \mu Adc$)	$V_{GS(off)}$	—	—	−5.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain ($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	I_{DSS}	10	—	—	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	$\lvert y_{fs} \rvert$	—	20	—	mmhos
Input Capacitance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 1.0 MHz)	C_{iss}	—	15	—	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 1.0 MHz)	C_{rss}	—	3.5	—	pF
Common-Gate Input Conductance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 100 MHz)	g_{ig}	—	16	—	mmhos
Common-Gate Output Conductance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 100 MHz)	G_{og}	—	—	16	μmhos
Common-Gate Forward Transadmittance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 100 MHz)	y_{fg}	—	18	—	mmhos
Common-Gate Reverse Transadmittance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 100 MHz)	y_{rg}	—	—	130	μmhos
Output Capacitance ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, f = 1.0 kHz)	C_{oss}	—	3.5	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, See Figure 5)	NF	—	—	4.0	dB
Small-Signal Power Gain ($V_{DS} = 15$ Vdc, $I_D = 10$ mAdc, See Figure 5)	G_{pg}	—	11	—	dB

FIGURE 1 – NOISE FIGURE

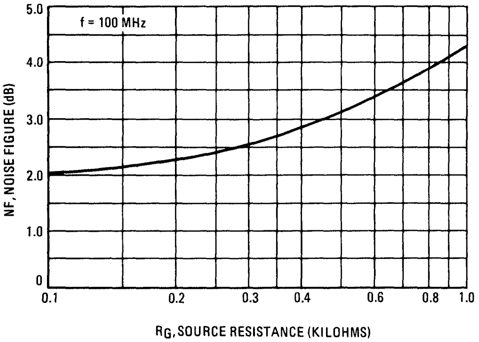


FIGURE 2 – FORWARD TRANSADMITTANCE

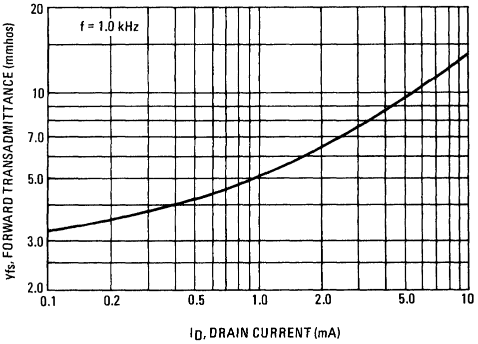


FIGURE 3 – INPUT CAPACITANCE

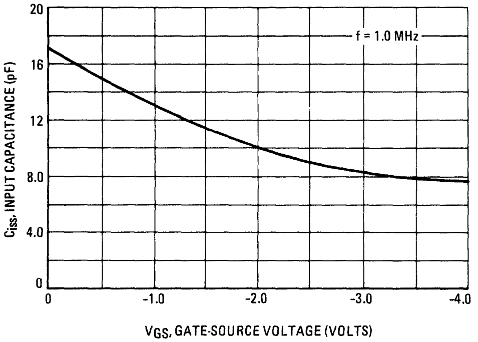


FIGURE 4 – OUTPUT AND REVERSE TRANSFER CAPACITANCE

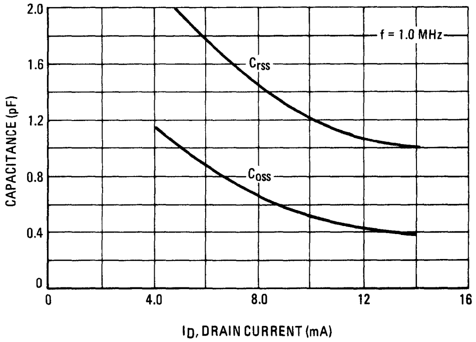
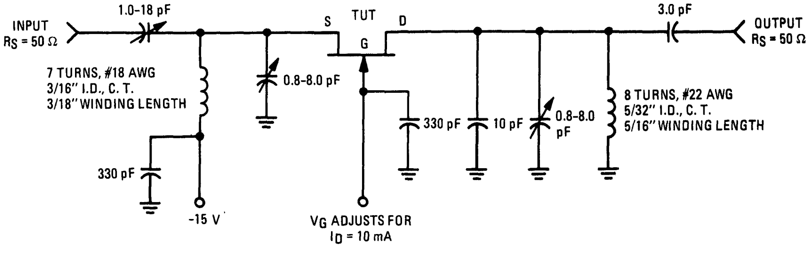


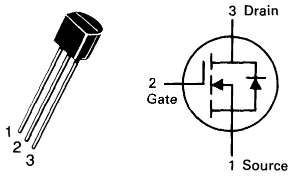
FIGURE 5 – 100 MHz TEST CIRCUIT



MPF910 For Specifications, See MFE910 Data.

MPF930
MPF960
MPF990

CASE 29-03, STYLE 22
TO-92 (TO-226AE)



TMOS
SWITCHING

N-CHANNEL — ENHANCEMENT

Refer to MFE930 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPF930	MPF960	MPF990	Unit
Drain-Source Voltage	V_{DS}	35	60	90	Vdc
Drain-Gate Voltage	V_{DG}	35	60	90	Vdc
Gate-Source Voltage	V_{GS}	±30			Vdc
Drain Current Continuous (1) Pulsed (2)	 I_D I_{DM}	 2.0 3.0			Adc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	 1.0 8.0			 Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to 150			°C
Thermal Resistance	θ_{JA}	125			°C/W

(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

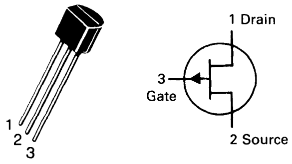
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Drain-Source Breakdown Voltage ($V_{GS} = 0$, $I_D = 10\ \mu A$)	MPF930 MPF960 MPF990	$V_{(BR)DSX}$	35 60 90	— — —	— — —	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$)		I_{GSS}	—	—	50	nAdc
ON CHARACTERISTICS*						
Zero-Gate-Voltage Drain Current (V_{DS} = Maximum Rating, $V_{GS} = 0$)		I_{DSS}	—	—	10	μAdc
Gate Threshold Voltage ($I_D = 1.0$ mA, $V_{DS} = V_{GS}$)		$V_{GS(Th)}$	1.0	—	3.5	Vdc
Drain-Source On-Voltage ($V_{GS} = 10$ V) ($I_D = 0.5$ A)	MPF930 MPF960 MPF990	$V_{DS(on)}$	— — —	0.4 0.6 0.6	0.7 0.8 1.2	Vdc
($I_D = 1.0$ A)	MPF930 MPF960 MPF990		— — —	0.9 1.2 1.2	1.4 1.7 2.4	
($I_D = 2.0$ A)	MPF930 MPF960 MPF990		— — —	2.2 2.8 2.8	3.0 3.5 4.8	
Static Drain-Source On Resistance ($V_{GS} = 10$ Vdc, $I_D = 1.0$ Adc)	MPF930 MPF960 MPF990	$r_{DS(on)}$	— — —	0.9 1.2 1.2	1.4 1.7 2.0	Ohms
On-State Drain Current ($V_{DS} = 25$ V, $V_{GS} = 10$ V)		$I_{D(on)}$	1.0	2.0	—	Amps
SMALL-SIGNAL CHARACTERISTICS						
Input Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	60	70	pF
Reverse Transfer Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{rss}	—	13	18	pF
Output Capacitance ($V_{DS} = 25$ V, $V_{GS} = 0$, f = 1.0 MHz)		C_{oss}	—	49	60	pF
Forward Transconductance ($V_{DS} = 25$ V, $I_D = 0.5$ A)		g_{fs}	200	380	—	mmhos
SWITCHING CHARACTERISTICS						
Turn-On Time		t_{on}	—	7.0	15	ns
Turn-Off Time		t_{off}	—	7.0	15	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MPF970
MPF971

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
SWITCHING

P-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	30	Vdc
Forward Gate Current	$I_{G(f)}$	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +150	°C
Operating Temperature Range	$T_{channel}$	−65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu Adc$, $V_{DS} = 0$)		$V_{(BR)GSS}$	30	—	—	Vdc
Gate Reverse Current ($V_{GS} = 15$ Vdc, $V_{DS} = 0$) ($V_{GS} = 15$ Vdc, $V_{DS} = 0$, $T_A = 150°C$)		I_{GSS}	 — —	 — —	 1.0 1.0	 nAdc μAdc
Drain-Cutoff Current ($V_{DS} = 15$ Vdc, $V_{GS} = 12$ Vdc) ($V_{DS} = 15$ Vdc, $V_{GS} = 12$ Vdc, $T_A = 150°C$) ($V_{DS} = 15$ Vdc, $V_{GS} = 7.0$ Vdc) ($V_{DS} = 15$ Vdc, $V_{GS} = 7.0$ Vdc, $T_A = 150°C$)	 MPF970 MPF970 MPF971 MPF971	$I_{D(off)}$	 — — — —	 — — — —	 10 10 10 10	 nAdc μAdc nAdc μAdc
Gate Source Cutoff Voltage ($V_{DS} = 15$ Vdc, $I_D = 10$ nAdc)	 MPF970 MPF971	$V_{GS(off)}$	 5.0 1.0	 — —	 12 7.0	Vdc
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1) ($V_{DS} = 20$ Vdc, $V_{GS} = 0$)	 MPF970 MPF971	I_{DSS}	 −15 −2.0	 — —	 −100 −50	mAdc
Drain-Source On-Voltage ($I_D = 10$ mAdc, $V_{GS} = 0$) ($I_D = 1.5$ mAdc, $V_{GS} = 0$)		$V_{DS(on)}$	 — —	 — —	 1.5 1.5	Vdc
Static Drain-Source On Resistance ($I_D = 1.0$ mAdc, $V_{GS} = 0$)	 MPF970 MPF971	$r_{DS(on)}$	 — —	 — —	 100 250	Ohms
SMALL-SIGNAL CHARACTERISTICS						
Drain-Source "ON" Resistance ($V_{GS} = 0$, $I_D = 0$, f = 1.0 kHz)	 MPF970 MPF971	$r_{ds(on)}$	 — —	 — —	 100 250	Ohms
Input Capacitance ($V_{GS} = 12$ Vdc, $V_{DS} = 0$, f = 1.0 MHz) ($V_{GS} = 7.0$ Vdc, $V_{DS} = 0$, f = 1.0 MHz)	 MPF970 MPF971	C_{iss}	 — —	 — —	 12 12	pF
Reverse Transfer Capacitance ($V_{GS} = 12$ Vdc, $V_{DS} = 0$, f = 1.0 MHz) ($V_{GS} = 7.0$ Vdc, $V_{DS} = 0$, f = 1.0 MHz)	 MPF970 MPF971	C_{rss}	 — —	 — —	 5.0 5.0	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
SWITCHING CHARACTERISTICS (See Figure 6, R_K = 0) (1)						
Rise Time		t_r				ns
($I_{D(on)}$ = 10 mAdc, $V_{GS(off)}$ = 12 Vdc)	MPF970		—	2.0	5.0	
($I_{D(on)}$ = 1.5 mAdc, $V_{GS(off)}$ = 7.0 Vdc)	MPF971		—	3.0	5.0	
Fall Time		t_f				ns
($I_{D(on)}$ = 10 mAdc, $V_{GS(off)}$ = 12 Vdc)	MPF970		—	9.0	15	
($I_{D(on)}$ = 1.5 mAdc, $V_{GS(off)}$ = 7.0 Vdc)	MPF971		—	68	80	
Turn-On Time		t_{on}				ns
($I_{D(on)}$ = 10 mAdc, $V_{GS(off)}$ = 12 Vdc)	MPF970		—	3.5	8.0	
($I_{D(on)}$ = 1.5 mAdc, $V_{GS(off)}$ = 7.0 Vdc)	MPF971		—	5.0	10	
Turn-Off Time		t_{off}				ns
($I_{D(on)}$ = 10 mAdc, $V_{GS(off)}$ = 12 Vdc)	MPF970		—	13	25	
($I_{D(on)}$ = 1.5 mAdc, $V_{GS(off)}$ = 7.0 Vdc)	MPF971		—	88	120	

(1) Pulse Test: Pulse Width ≤ 100 μs, Duty Cycle ≤ 1.0%.

FIGURE 1 – EFFECT OF I_{DSS} ON DRAIN-SOURCE RESISTANCE AND GATE-SOURCE VOLTAGE

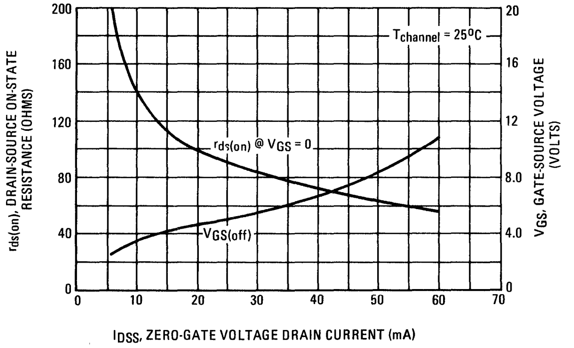


FIGURE 2 – TURN-ON DELAY TIME

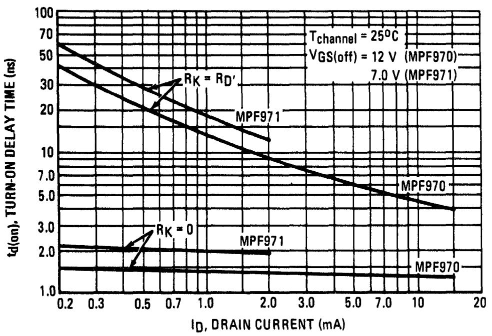


FIGURE 3 – RISE TIME

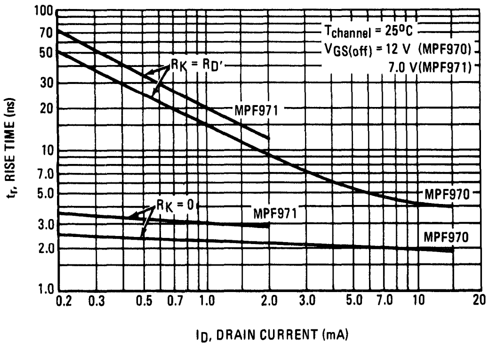


FIGURE 4 – TURN-OFF DELAY TIME

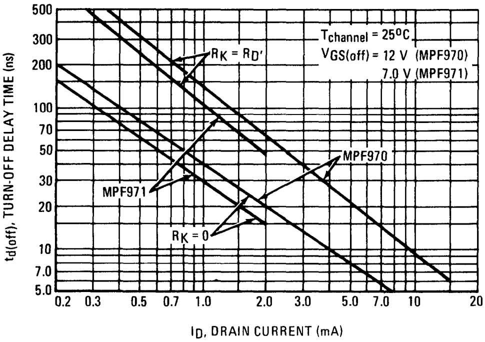


FIGURE 5 – FALL TIME

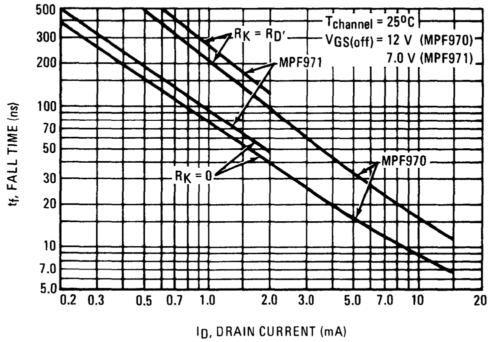
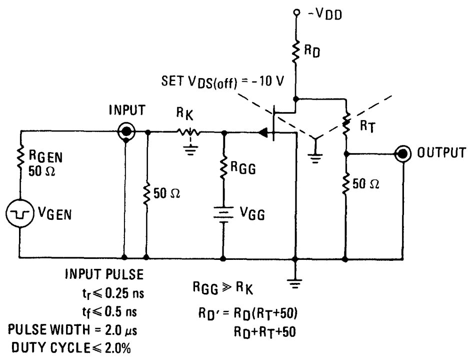


FIGURE 6 – SWITCHING TIME TEST CIRCUIT



NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 6. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($+V_{GG}$). The Drain-Source Voltage (V_{DS}) is slightly lower than Drain Supply Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate-Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn-on interval, Gate-Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain-Source Resistance (r_{ds}). During the turn-off, this charge flow is reversed.

Predicting turn-on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn-on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) R_K is equal to R_D, which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

FIGURE 7 – TYPICAL FORWARD TRANSFER ADMITTANCE

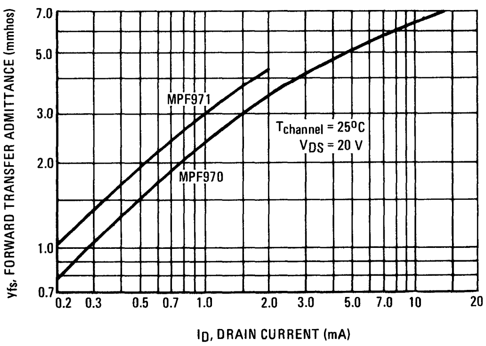


FIGURE 8 – TYPICAL CAPACITANCE

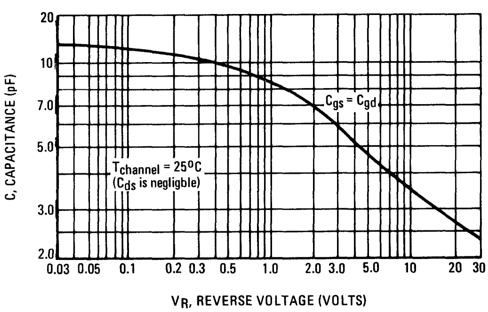


FIGURE 9 — EFFECT OF GATE-SOURCE VOLTAGE ON DRAIN-SOURCE RESISTANCE

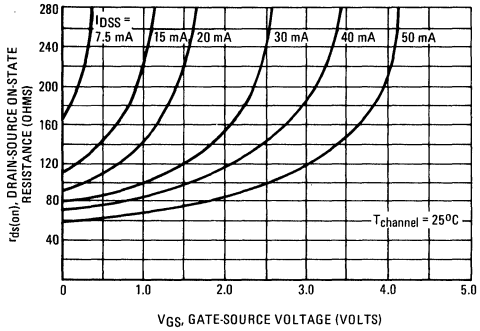


FIGURE 10 — EFFECT OF TEMPERATURE ON DRAIN-SOURCE ON-STATE RESISTANCE

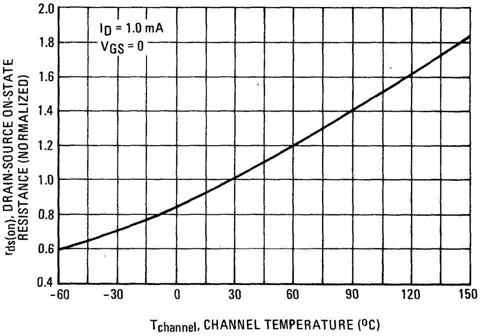
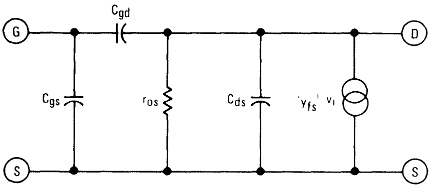


FIGURE 11 — LOW FREQUENCY CIRCUIT MODEL



$y_{is} = j\omega C_{iss}$
$y_{os} = 1/r_{oss} + j\omega C_{oss}$
$y_{fs} = |y_{fs}|$
$y_{rs} = -j\omega C_{rss}$

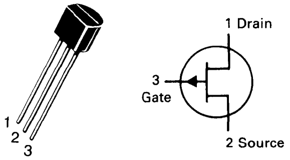
$C_{iss} = C_{gd} + C_{gs}$
$C_{rss} = C_{gd}$
$C_{oss} = C_{gd} + C_{ds}, C_{ds} \approx 0$

MPF990

For Specifications, See MPF930

MPF3330

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
LOW FREQUENCY, LOW NOISE

P-CHANNEL — DEPLETION

Refer to 2N5460 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Gate Voltage	V_{DG}	20	Vdc
Gate-Source Voltage	V_{GS}	20	Vdc
Reverse Gate-Source Voltage	V_{GSR}	20	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	310 2.82	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

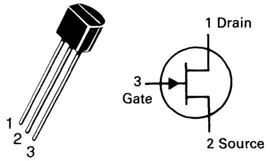
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Gate-Source Breakdown Voltage ($I_G = 10\ \mu A$)	$V_{(BR)GSS}$	20	—	Vdc
Gate Reverse Current ($V_{GS} = 10$ V)	I_{GSS}	—	10	nA
Gate Source Cutoff Voltage ($V_{DS} = -15$ V, $I_D = 10\ \mu A$)	$V_{GS(off)}$	—	6.0	Vdc
ON CHARACTERISTICS				
Zero-Gate-Voltage Drain Current ($V_{DS} = -10$ V)	I_{DSS}*	−2.0	−6.0	mA
Drain-Source Resistance ($I_D = 100\ \mu A$, $V_{GS} = 0$)	r_{DS}	—	800	Ω
SMALL-SIGNAL CHARACTERISTICS				
Forward Transfer Admittance ($V_{DS} = -10$ V, $I_D = 2.0$ mA, f = 1.0 kHz)	$\lvert y_{fs} \rvert$*	1500	3000	μmhos
Output Admittance ($V_{DS} = -10$ V, $I_D = 2.0$ mA, f = 1.0 kHz)	$\lvert y_{os} \rvert$	—	40	μmhos
Input Capacitance ($V_{DS} = -10$ Volts, $V_{GS} = 1.0$ Volt, f = 1.0 MHz)	C_{iss}	—	20	pF
FUNCTIONAL CHARACTERISTICS				
Noise Figure ($V_{DS} = -5.0$ V, $I_D = 1.0$ mA, $R_G = 1.0$ MΩ)	NF	—	3.0	dB

*Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

MPF3821
MPF3822

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
GENERAL PURPOSE

N-CHANNEL — DEPLETION

Refer to 2N4220 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	50	Vdc
Drain-Gate Voltage	V_{DG}	50	Vdc
Gate-Source Voltage	V_{GS}	−50	Vdc
Drain Current	I_D	10	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	310 2.0	mW mW/°C
Junction Temperature Range	T_J	125	°C
Storage Temperature Range	T_{stg}	−65 to 150	°C

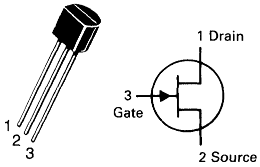
ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -1.0\ \mu$Adc, $V_{DS} = 0$)		$V_{(BR)GSS}$	−50	—	Vdc
Gate Reverse Current ($V_{GS} = -30$ Vdc, $V_{DS} = 0$) ($V_{GS} = -30$ Vdc, $V_{DS} = 0$, $T_A = 150°C$)		I_{GSS}	— —	−0.1 −100	nAdc
Gate Source Cutoff Voltage ($I_D = 0.5$ nAdc, $V_{DS} = 15$ Vdc)	MPF3821 MPF3822	$V_{GS(off)}$	— —	−4.0 −6.0	Vdc
Gate Source Voltage ($I_D = 50\ \mu$Adc, $V_{DS} = 15$ Vdc) ($I_D = 200\ \mu$Adc, $V_{DS} = 15$ Vdc)	MPF3821 MPF3822	V_{GS}	−0.5 −1.0	−2.0 −4.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1) ($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	MPF3821 MPF3822	I_{DSS}	0.5 2.0	2.5 10	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)(1)	MPF3821 MPF3822	$\lvert y_{fs} \rvert$	1500 3000	4500 6500	μmhos
($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 100 MHz)	MPF3821 MPF3822		1500 3000	— —	
Output Admittance(1) ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 kHz)	MPF3821 MPF3822	$\lvert y_{os} \rvert$	— —	10 20	μmhos
Input Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{iss}	—	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 1.0 MHz)		C_{rss}	—	3.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, $R_S = 1.0$ megohm, f = 10 Hz, Noise Bandwidth = 5.0 Hz)		NF	—	5.0	dB
Equivalent Input Noise Voltage ($V_{DS} = 15$ Vdc, $V_{GS} = 0$, f = 10 Hz, Noise Bandwidth = 5.0 Hz)		e_n	—	200	nv/Hz$^{1/2}$

(1) Pulse Test: Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

MPF3970
MPF3972

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	40	Vdc
Drain-Gate Voltage	V_{DG}	40	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−40	Vdc
Forward Gate Current	I_{GF}	50	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.82	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μA, V_{GS} = 0)		$V_{(BR)GSS}$	40	—	Vdc
Drain-to-Gate Leakage (V_{DG} = 20 V, I_S = 0)		I_{DGO}	—	250	pA
Gate Reverse Current (V_{GS} = 20 V, V_{DS} = 0)		I_{GSS}	—	250	pA
Gate Source Cutoff Voltage (V_{DS} = −20 V, I_D = 1.0 nA)	MPF3970 MPF3972	$V_{GS(off)}$	−4.0 −0.5	−10 −3.0	Vdc
Drain Source Voltage (V_{GS} = 0) (I_D = 20 mA) (I_D = 5.0 mA)	MPF3970 MPF3972	V_{DS}	— —	1.0 2.0	Vdc
Drain Cutoff Current (V_{DS} = 20 V, V_{GS} = −12 V)		$I_{D(off)}$	—	250	pA
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 20 V, V_{GS} = 0)	MPF3970 MPF3972	I_{DSS}	50 5.0	150 30	mA
Drain-Source "ON" Resistance (I_D = 1.0 mA, V_{GS} = 0)	MPF3970 MPF3972	$r_{DS(on)}$	— —	30 100	Ω
Input Capacitance (V_{DS} = 20 V, V_{GS} = 0, f = 1.0 MHz)		C_{iss}	—	25	pF
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = −12 V, f = 1.0 MHz)		C_{rss}	—	6.0	pF
FUNCTIONAL CHARACTERISTICS					
Drain-Gate Leakage (V_{DG} = 20 V, I_S = 0, T_A = 150°C)		I_{DGO}	—	500	nA
Drain Cutoff Current (V_{DS} = 20 V, V_{GS} = −12 V, T_A = 150°C)		$I_{D(off)}$	—	500	nA

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

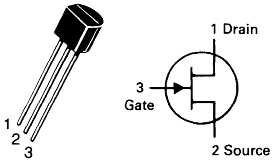
Characteristic	Symbol	Min	Max	Unit
Drain-Source "ON" Resistance (I_D = 0, V_{GS} = 0, f = 1.0 kHz) MPF3970 MPF3972	$r_{ds(on)}$	— —	30 100	Ω

SWITCHING CHARACTERISTICS

Characteristic	Symbol	Min	Max	Unit
Switching Characteristics (MPF3970 Only) (V_{DD} = 10 V, V_{GS} = 0, $I_{D(on)}$ = 20 mA, $V_{GS(off)}$ = 10 V)	$t_{d(on)}$ t_r t_{off}	— — —	10 10 30	ns
Switching Characteristics (MPF3972 Only) (V_{DD} = 10 V, V_{GS} = 0, $I_{D(on)}$ = 5.0 mA, $V_{GS(off)}$ = 3.0 V)	$t_{d(on)}$ t_r t_{off}	— — —	40 40 100	ns

MPF4221
MPF4222A

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
LOW FREQUENCY

N-CHANNEL — DEPLETION

Refer to 2N4220 for graphs.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	30	Vdc
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	310 2.82	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

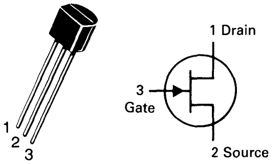
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -10\ \mu A$, $V_{DS} = 0$ V)		$V_{(BR)GSS}$	−30	—	Vdc
Gate Reverse Current ($V_{GS} = -15$ V, $V_{DS} = 0$ V)		I_{GSS}	—	−100	pA
Gate Source Cutoff Voltage ($V_{DS} = 15$ V, $I_D = 0.1$ nA)	MPF4221 MPF4222A	$V_{GS(off)}$	— —	−6.0 −8.0	Vdc
Gate Source Voltage ($V_{DS} = 15$ V, $I_D = 200\ \mu A$) ($V_{DS} = 15$ V, $I_D = 500\ \mu A$)	MPF4221 MPF4222A	V_{GS}	−1.0 −2.0	−5.0 −6.0	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current (V_{DS} = 15 Volts, $V_{GS} = 0$ V)	MPF4221 MPF4222A	I_{DSS}*	+2.0 +5.0	+6.0 +15	mA
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 15$ V, f = 1.0 kHz, $V_{GS} = 0$ V)	MPF4221 MPF4222A	$\lvert y_{fs} \rvert$*	2000 2500	5000 6000	µmhos
Output Admittance ($V_{DS} = 15$ V, f = 1.0 kHz, $V_{GS} = 0$ V)	MPF4221 MPF4222A	$\lvert y_{os} \rvert$	— —	20 40	µmhos
Input Capacitance ($V_{DS} = 15$ V, f = 1.0 MHz)		C_{iss}	—	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ V, f = 1.0 MHz)		C_{rss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 15$ V, f = 100 Hz, $R_G = 1.0\ M\Omega$)		NF	—	2.5	dB

*Pulse Width ≤ 100 ms, Duty Cycle ≤ 10%.

MPF4223
MPF4224

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET HIGH FREQUENCY AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

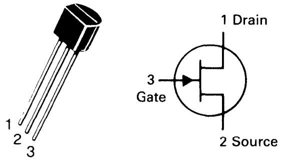
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Drain Current	I_D	20	mA
Gate Current	I_G	10	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	300 2.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage ($I_G = -10\ \mu A$)		$V_{(BR)GSS}$	−30	—	Vdc
Gate 1 Leakage Current ($V_{G1S} = -20$ V)	MPF4223 MPF4224	I_{G1SS}	— —	0.25 0.50	nA
Gate Source Cutoff Voltage ($I_D = 0.25$ nA, $V_{DS} = 15$ V) ($I_D = 0.5$ nA, $V_{DS} = 15$ V)	MPF4223 MPF4224	$V_{GS(off)}$	−0.1 −0.1	−8.0 −8.0	Vdc
Gate Source Voltage ($I_D = 0.3$ mA, $V_{DS} = 15$ V) ($I_D = 0.2$ mA, $V_{DS} = 15$ V)	MPF4223 MPF4224	V_{GS}	−1.0 −1.0	−7.0 −7.5	Vdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current ($V_{DS} = 15$ V)	MPF4223 MPF4224	I_{DSS}	3.0 2.0	18 20	mA
SMALL-SIGNAL CHARACTERISTICS					
Forward Transfer Admittance ($V_{DS} = 15$ V, $V_{GS} = 0$ V, f = 1.0 kHz)	MPF4223 MPF4224	$\lvert y_{fs} \rvert$	3000 2000	7000 7500	μmhos
Output Conductance ($V_{DS} = 15$ V, $V_{GS} = 0$ V, f = 200 MHz)		$Re(y_{os})$	—	200	μmhos
Input Capacitance ($V_{DS} = 15$ V, $V_{GS} = 0$ V, f = 1.0 MHz)		C_{iss}	—	6.0	pF
Reverse Transfer Capacitance ($V_{DS} = 15$ V, $V_{GS} = 0$ V, f = 1.0 MHz)		C_{rss}	—	2.0	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure ($V_{DS} = 15$ V, $V_{GS} = 0$ V, $R_G = 1.0$ kΩ, f = 200 MHz)	MPF4223 (Only)	NF	—	5.0	dB
Common Source Power Gain ($V_{DS} = 15$ V, $V_{GS} = 0$ V, f = 200 MHz)	MPF4223 (Only)	G_{ps}	10	—	dB

MPF4391
thru
MPF4393

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFETs
SWITCHING

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	30	Vdc
Drain-Gate Voltage	V_{DG}	30	Vdc
Gate-Source Voltage	V_{GS}	30	Vdc
Forward Gate Current	$I_{G(f)}$	50	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	360 2.4	mW mW/°C
Operating and Storage Channel Temperature Range	$T_{channel}$, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage ($I_G = 1.0\ \mu Adc$, $V_{DS} = 0$)		$V_{(BR)GSS}$	30	—	—	Vdc
Gate Reverse Current		I_{GSS}				
($V_{GS} = 15$ Vdc, $V_{DS} = 0$)			—	—	1.0	nAdc
($V_{GS} = 15$ Vdc, $V_{DS} = 0$, $T_A = 100°C$)			—	—	0.2	μAdc
Drain-Cutoff Current		$I_{D(off)}$				
($V_{DS} = 15$ Vdc, $V_{GS} = 12$ Vdc)			—	—	1.0	nAdc
($V_{DS} = 15$ Vdc, $V_{GS} = 12$ Vdc, $T_A = 100°C$)			—	—	0.1	μAdc
Gate Source Voltage		V_{GS}				Vdc
($V_{DS} = 15$ Vdc, $I_D = 10$ nAdc)	MPF4391		−4.0	—	−10	
	MPF4392		−2.0	—	−5.0	
	MPF4393		−0.5	—	−3.0	
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1)		I_{DSS}				mAdc
($V_{DS} = 15$ Vdc, $V_{GS} = 0$)	MPF4391		60	—	130	
	MPF4392		25	—	75	
	MPF4393		5.0	—	30	
Drain-Source On-Voltage		$V_{DS(on)}$				Vdc
($I_D = 12$ mAdc, $V_{GS} = 0$)	MPF4391		—	—	0.4	
($I_D = 6.0$ mAdc, $V_{GS} = 0$)	MPF4392		—	—	0.4	
($I_D = 3.0$ mAdc, $V_{GS} = 0$)	MPF4393		—	—	0.4	
Static Drain-Source On Resistance		$r_{DS(on)}$				Ohms
($I_D = 1.0$ mAdc, $V_{GS} = 0$)	MPF4391		—	—	30	
	MPF4392		—	—	60	
	MPF4393		—	—	100	
SMALL-SIGNAL CHARACTERISTICS						
Forward Transfer Admittance		$\|y_{fs}\|$				mmhos
($V_{DS} = 15$ Vdc, $I_D = 60$ mAdc, f = 1.0 kHz)	MPF4391		—	20	—	
($V_{DS} = 15$ Vdc, $I_D = 25$ mAdc, f = 1.0 kHz)	MPF4392		—	17	—	
($V_{DS} = 15$ Vdc, $I_D = 5.0$ mAdc, f = 1.0 kHz)	MPF4393		—	12	—	
Drain-Source "ON" Resistance		$r_{ds(on)}$				Ohms
($V_{GS} = 0$, $I_D = 0$, f = 1.0 kHz)	MPF4391		—	—	30	
	MPF4392		—	—	60	
	MPF4393		—	—	100	
Input Capacitance ($V_{GS} = 15$ Vdc, $V_{DS} = 0$, f = 1.0 MHz)		C_{iss}	—	6.0	10	pF

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Transfer Capacitance		C_{rss}				pF
(V_{GS} = 12 Vdc, V_{DS} = 0, f = 1.0 MHz)			—	2.5	3.5	
(V_{DS} = 15 Vdc, I_D = 10 mAdc, f = 1.0 MHz)			—	3.2	—	
SWITCHING CHARACTERISTICS						
Rise Time (See Figure 2)		t_r				ns
($I_{D(on)}$ = 12 mAdc)	MPF4391		—	1.2	5.0	
($I_{D(on)}$ = 6.0 mAdc)	MPF4392		—	2.0	5.0	
($I_{D(on)}$ = 3.0 mAdc)	MPF4393		—	2.5	5.0	
Fall Time (See Figure 4)		t_f				ns
($V_{GS(off)}$ = 12 Vdc)	MPF4391		—	7.0	15	
($V_{GS(off)}$ = 7.0 Vdc)	MPF4392		—	15	20	
($V_{GS(off)}$ = 5.0 Vdc)	MPF4393		—	29	35	
Turn-On Time (See Figures 1 and 2)		t_{on}				ns
($I_{D(on)}$ = 12 mAdc)	MPF4391		—	3.0	15	
($I_{D(on)}$ = 6.0 mAdc)	MPF4392		—	4.0	15	
($I_{D(on)}$ = 3.0 mAdc)	MPF4393		—	6.5	15	
Turn-Off Time (See Figures 3 and 4)		t_{off}				ns
($V_{GS(off)}$ = 12 Vdc)	MPF4391		—	10	20	
($V_{GS(off)}$ = 7.0 Vdc)	MPF4392		—	20	35	
($V_{GS(off)}$ = 5.0 Vdc)	MPF4393		—	37	55	

(1) Pulse Test: Pulse Width ≤ 100 μs, Duty Cycle ≤ 1.0%.

TYPICAL SWITCHING CHARACTERISTICS

FIGURE 1 — TURN-ON DELAY TIME

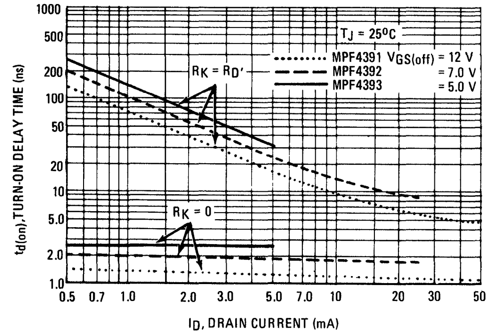


FIGURE 2 — RISE TIME

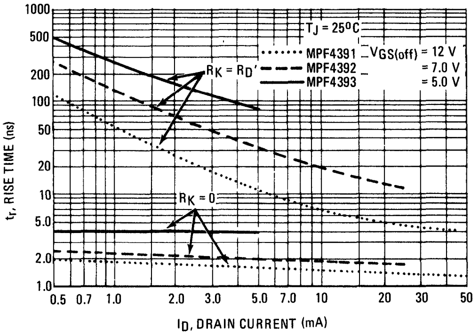


FIGURE 3 — TURN-OFF DELAY TIME

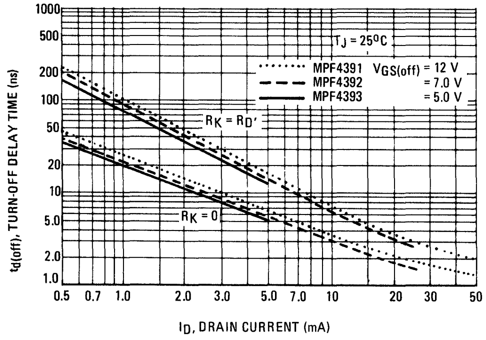


FIGURE 4 — FALL TIME

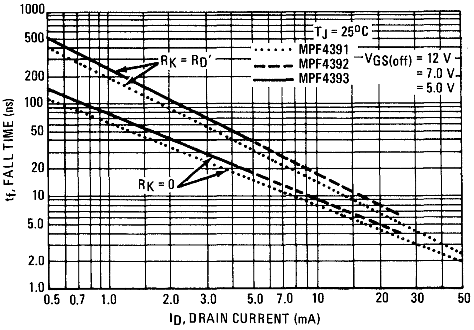
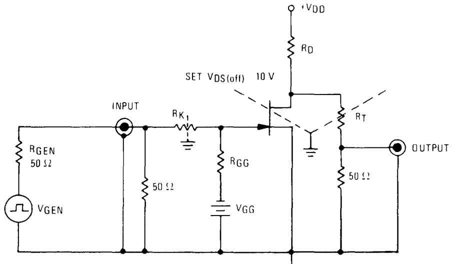


FIGURE 5 – SWITCHING TIME TEST CIRCUIT



INPUT PULSE
t_r 0.25 ns
t_f ≈ 0.5 ns
PULSE WIDTH ≈ 2.0 μs
DUTY CYCLE ≤ 2.0 %

$R_{GG} \gg R_K$

$R_D' = \frac{R_D(R_T+50)}{R_D+R_T+50}$

NOTE 1

The switching characteristics shown above were measured using a test circuit similar to Figure 5. At the beginning of the switching interval, the gate voltage is at Gate Supply Voltage ($-V_{GG}$). The Drain-Source Voltage (V_{DS}) is slightly lower than Drain Supply, Voltage (V_{DD}) due to the voltage divider. Thus Reverse Transfer Capacitance (C_{rss}) or Gate-Drain Capacitance (C_{gd}) is charged to $V_{GG} + V_{DS}$.

During the turn-on interval, Gate-Source Capacitance (C_{gs}) discharges through the series combination of R_{Gen} and R_K. C_{gd} must discharge to $V_{DS(on)}$ through R_G and R_K in series with the parallel combination of effective load impedance (R'_D) and Drain-Source Resistance (r_{ds}). During the turn-off, this charge flow is reversed.

Predicting turn-on time is somewhat difficult as the channel resistance r_{ds} is a function of the gate-source voltage. While C_{gs} discharges, V_{GS} approaches zero and r_{ds} decreases. Since C_{gd} discharges through r_{ds}, turn-on time is non-linear. During turn-off, the situation is reversed with r_{ds} increasing as C_{gd} charges.

The above switching curves show two impedance conditions; 1) R_K is equal to R_D' which simulates the switching behavior of cascaded stages where the driving source impedance is normally the load impedance of the previous stage, and 2) $R_K = 0$ (low impedance) the driving source impedance is that of the generator.

FIGURE 6 – TYPICAL FORWARD TRANSFER ADMITTANCE

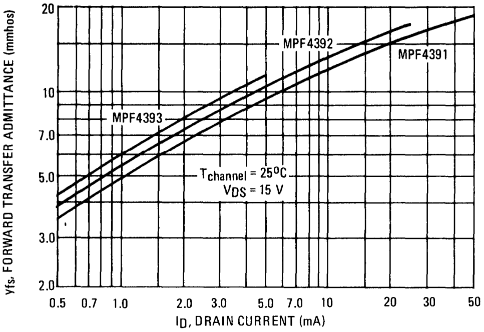


FIGURE 7 – TYPICAL CAPACITANCE

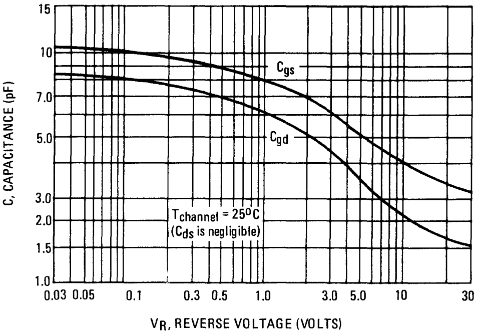


FIGURE 8 – EFFECT OF GATE-SOURCE VOLTAGE ON DRAIN-SOURCE RESISTANCE

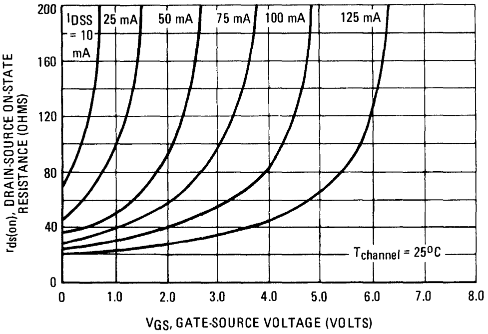


FIGURE 9 – EFFECT OF TEMPERATURE ON DRAIN–SOURCE ON-STATE RESISTANCE

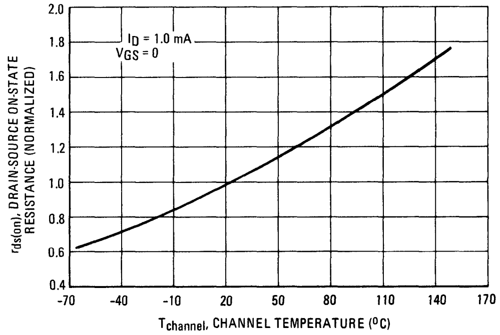
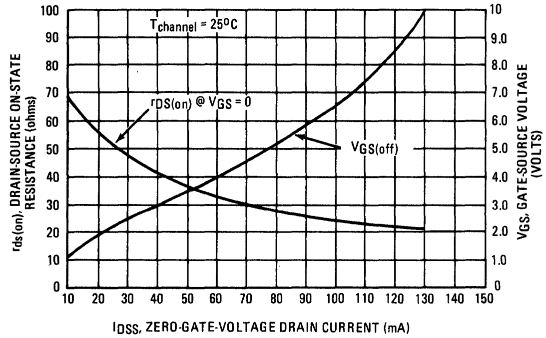


FIGURE 10 – EFFECT OF IDSS ON DRAIN-SOURCE RESISTANCE AND GATE-SOURCE VOLTAGE



NOTE 2

The Zero-Gate-Voltage Drain Current (I_{DSS}), is the principle determinant of other J-FET characteristics. Figure 10 shows the relationship of Gate-Source Off Voltage ($V_{GS(off)}$) and Drain-Source On Resistance ($r_{ds(on)}$) to I_{DSS}. Most of the devices will be within ±10% of the values shown in Figure 10. This data will be useful in predicting the characteristic variations for a given part number.

For example:

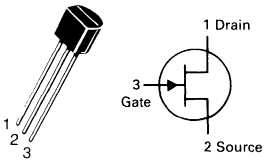
Unknown

$r_{ds(on)}$ and V_{GS} range for an MPF4392

The electrical characteristics table indicates that an MPF4392 has an I_{DSS} range of 25 to 75 mA. Figure 10, shows $r_{ds(on)}$ = 52 Ohms for I_{DSS} = 25 mA and 30 Ohms for I_{DSS} = 75 mA. The corresponding V_{GS} values are 2.2 volts and 4.8 volts.

MPF4856, A
thru
MPF4861, A

CASE 29-04, STYLE 5
TO-92 (TO-226AA)



JFET
SWITCHING

N-CHANNEL — DEPLETION

Refer to 2N4856 for graphs.

MAXIMUM RATINGS

Rating	Symbol	MPF4856,A MPF4857,A MPF4858,A	MPF4859,A MPF4860,A MPF4861,A	Unit
Drain-Source Voltage	V_{DS}	+40	+30	Vdc
Drain-Gate Voltage	V_{DG}	+40	+30	Vdc
Reverse Gate-Source Voltage	V_{GSR}	−40	−30	Vdc
Forward Gate Current	I_{GF}	50		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	360 2.4		mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Gate-Source Breakdown Voltage (I_G = 1.0 μAdc, V_{DS} = 0)	MPF4856,A, MPF4857,A, MPF4858,A	$V_{(BR)GSS}$	−40	—	Vdc
	MPF4859,A, MPF4860,A, MPF4861,A		−30	—	
Gate Reverse Current (V_{GS} = −20 Vdc, V_{DS} = 0)	MPF4856,A, MPF4857,A, MPF4858,A	I_{GSS}	—	0.25	nAdc
(V_{GS} = −15 Vdc, V_{DS} = 0)	MPF4859,A, MPF4860,A, MPF4861,A		—	0.25	
(V_{GS} = −20 Vdc, V_{DS} = 0, T_A = 150°C)	MPF4856,A, MPF4857,A, MPF4858,A		—	0.5	μAdc
(V_{GS} = −15 Vdc, V_{DS} = 0, T_A = 150°C)	MPF4859,A, MPF4860,A, MPF4861,A		—	0.5	
Gate Source Cutoff Voltage (V_{DS} = 15 Vdc, I_D = 0.5 nAdc)	MPF4856,A, MPF4859,A	$V_{GS(off)}$	−4.0	−10	Vdc
	MPF4857,A, MPF4860,A		−2.0	−6.0	
	MPF4858,A, MPF4861,A		−0.8	−4.0	
Drain Cutoff Current (V_{DS} = 15 Vdc, V_{GS} = −10 Vdc)		$I_{D(off)}$	—	0.25	nAdc
(V_{DS} = 15 Vdc, V_{GS} = −10 Vdc, T_A = 150°C)			—	0.5	μAdc
ON CHARACTERISTICS					
Zero-Gate-Voltage Drain Current(1) (V_{DS} = 15 Vdc, V_{GS} = 0)	MPF4856,A, MPF4859,A	I_{DSS}	50	—	mAdc
	MPF4857,A, MPF4860,A		20	100	
	MPF4858,A, MPF4861,A		8.0	80	
Drain-Source On-Voltage (I_D = 20 mAdc, V_{GS} = 0)	MPF4856,A, MPF4859,A	$V_{DS(on)}$	—	0.75	Vdc
(I_D = 10 mAdc, V_{GS} = 0)	MPF4857,A, MPF4860,A		—	0.5	
(I_D = 5.0 mAdc, V_{GS} = 0)	MPF4858,A, MPF4861,A		—	0.5	
SMALL-SIGNAL CHARACTERISTICS					
Drain-Source "ON" Resistance (V_{GS} = 0, I_D = 0, f = 1.0 kHz)	MPF4856,A, MPF4859,A	$r_{ds(on)}$	—	25	Ohms
	MPF4857,A, MPF4860,A		—	40	
	MPF4858,A, MPF4861,A		—	60	
Input Capacitance (V_{DS} = 0, V_{GS} = −10 Vdc, f = 1.0 MHz)	MPF4856 thru MPF4861	C_{iss}	—	18	pF
	MPF4856A thru MPF4861A		—	10	
Reverse Transfer Capacitance (V_{DS} = 0, V_{GS} = −10 Vdc, f = 1.0 MHz)	MPF4856 thru MPF4861	C_{rss}	—	8.0	pF
	MPF4856A, MPF4859A		—	4.0	
	MPF4857A, MPF4858A, MPF4860A, MPF4861A		—	3.5	

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

Characteristic			Symbol	Min	Max	Unit
SWITCHING CHARACTERISTICS						
Turn-On Delay Time	Conditions for MPF4856,A, MPF4859,A:	MPF4856, MPF4859	$t_{d(on)}$	—	6.0	ns
		MPF4856A, MPF4859A		—	5.0	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 20 mAdc,	MPF4857, MPF4860		—	6.0	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −10 Vdc)	MPF4857A, MPF4860A		—	6.0	
		MPF4858, MPF4861		—	10	
		MPF4858A, MPF4861A		—	8.0	
Rise Time	Conditions for MPF4857,A, MPF4860,A:	MPF4856,A, MPF4859,A	t_r	—	3.0	ns
		MPF4857,A, MPF4860,A		—	4.0	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 10 mAdc,	MPF4858, MPF4861		—	10	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −6.0 Vdc)	MPF4858A, MPF4861A		—	8.0	
Turn-Off Time		MPF4856, MPF4859	t_{off}	—	25	ns
	Conditions for MPF4858,A, MPF4861,A:	MPF4856A, MPF4859A		—	20	
		MPF4857, MPF4860		—	50	
	(V_{DD} = 10 Vdc, $I_{D(on)}$ = 5.0 mAdc,	MPF4857A, MPF4860A		—	40	
	$V_{GS(on)}$ = 0, $V_{GS(off)}$ = −4.0 Vdc)	MPF4858, MPF4861		—	100	
		MPF4858A; MPF4861A		—	80	

(1) Pulse Test: Pulse Width = 100 ms, Duty Cycle ≤ 10%.

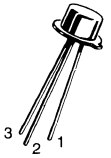
(2) The $I_{D(on)}$ values are nominal; exact values vary slightly with transistor parameters.

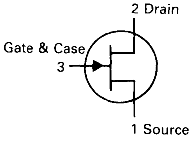
MPF6659 thru MPF6661

For Specifications, See 2N6659 Data.

U308 thru U310

CASE 27-02, STYLE 4
TO-52 (TO-206AC)





JFET
VHF/UHF AMPLIFIERS

N-CHANNEL — DEPLETION

MAXIMUM RATINGS

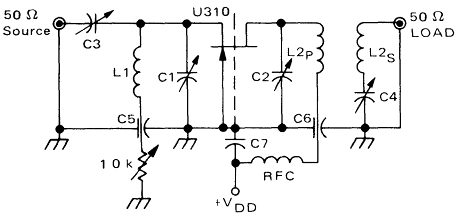
Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DS}	25	Vdc
Gate-Source Voltage	V_{GS}	25	Vdc
Gate Current	I_G	20	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	500 4.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Gate-Source Breakdown Voltage (I_G = 1.0 μA, V_{DS} = 0)		$V_{(BR)GSS}$	−25	—	—	V
Gate Reverse Current (V_{GS} = −15 V) (V_{GS} = 0, T_A = 125°C)		I_{GSS}	 — —	 — —	 −150 −150	 pA nA
Gate Source Cutoff Voltage (V_{DS} = 10 V, I_D = 1.0 nA)	 U308 U309 U310	$V_{GS(off)}$	 −1.0 −1.0 −2.5	 — — —	 −6.0 −4.0 −6.0	V
ON CHARACTERISTICS						
Zero-Gate-Voltage Drain Current(1) (V_{DS} = 10 V, V_{GS} = 0)	 U308 U309 U310	I_{DSS}	 12 12 24	 — — —	 60 30 60	mA
Gate-Source Forward Voltage (I_G = 10 mA, V_{DS} = 0)		$V_{GS(f)}$	—	—	1.0	V
SWITCHING CHARACTERISTICS						
Common-Gate Forward Transconductance(1) (V_{DS} = 10 V, I_D = 10 mA, f = 1.0 kHz)	 U308 U309 U310	g_{fg}	 10 10 10	 — — —	 20 20 18	mmhos
Common-Gate Output Conductance (V_{DS} = 10 V, I_D = 10 mA, f = 1.0 kHz)		g_{og}	—	—	250	μmhos
Drain-Gate Capacitance (V_{GS} = −10 V, V_{DS} = 10 V, f = 1.0 MHz)		C_{gd}	—	—	2.5	pF
Gate-Source Capacitance (V_{GS} = −10 V, V_{DS} = 10 V, f = 1.0 MHz)		C_{gs}	—	—	5.0	pF
Equivalent Short-Circuit Input Noise Voltage (V_{DS} = 10 V, I_D = 10 mA, f = 100 Hz)		$\bar{e}_n$	—	10	—	nV$\sqrt{Hz}$

(1) Pulse test duration = 2.0 ms.
(2) See Figures 10 and 11 for Noise Figure and Power Gain information.

FIGURE 1 – 450 MHz COMMON-GATE AMPLIFIER TEST CIRCUIT



C1 = C2 = 0.8 – 10 pF. JFD #MVM010W.
C3 = C4 = 8-35 pF Erie #539-002D.
C5 = C6 = 5000 pF Erie (2443-000)
C7 = 1000 pF. Allen Bradley #FA5C
RFC = 0.33 μH Miller #9230-30.
L1 = One Turn #16 Cu, 1/4" I.D. (Air Core)
$L2_P$ = One Turn #16 Cu, 1/4" I.D (Air Core).
$L2_S$ = One Turn #16 Cu, 1/4" I.D. (Air Core).

FIGURE 2 – DRAIN CURRENT and TRANSFER CHARACTERISTICS versus GATE-SOURCE VOLTAGE

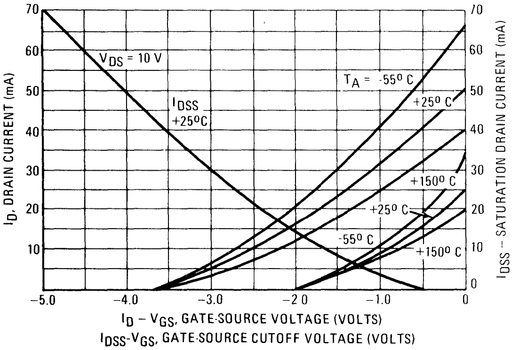


FIGURE 3 – FORWARD TRANSCONDUCTANCE versus GATE-SOURCE VOLTAGE

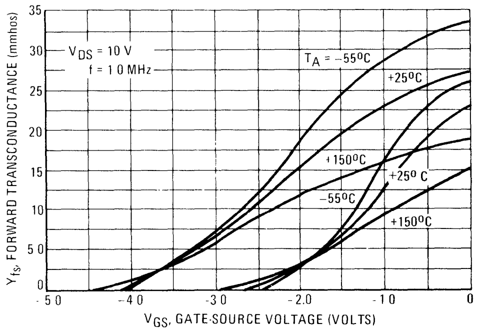


FIGURE 4 – COMMON-SOURCE OUTPUT ADMITTANCE and FORWARD TRANSCONDUCTANCE versus DRAIN CURRENT

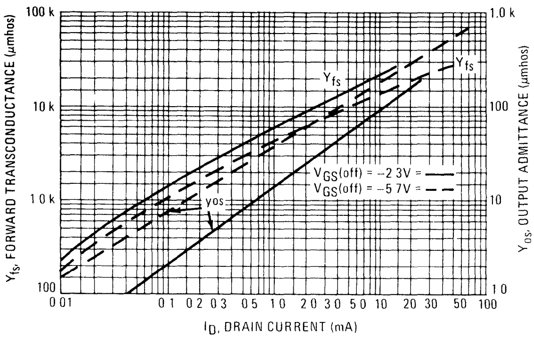


FIGURE 5 – ON RESISTANCE and JUNCTION CAPACITANCE versus GATE-SOURCE VOLTAGE

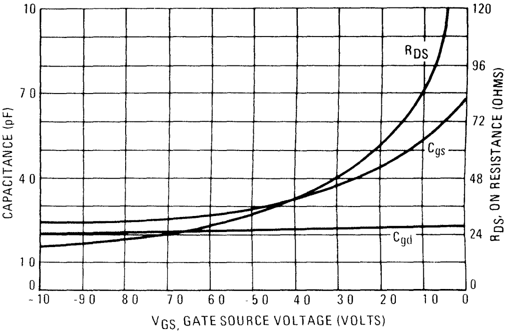


FIGURE 6 – COMMON-GATE Y PARAMETER MAGNITUDE versus FREQUENCY

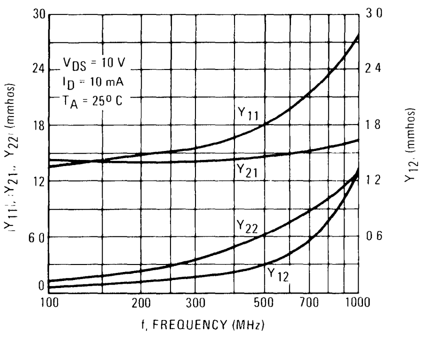


FIGURE 7 – COMMON-GATE S PARAMETER MAGNITUDE versus FREQUENCY

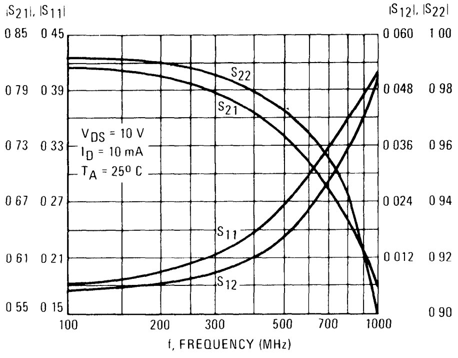


FIGURE 8 – COMMON-GATE Y PARAMETER PHASE-ANGLE versus FREQUENCY

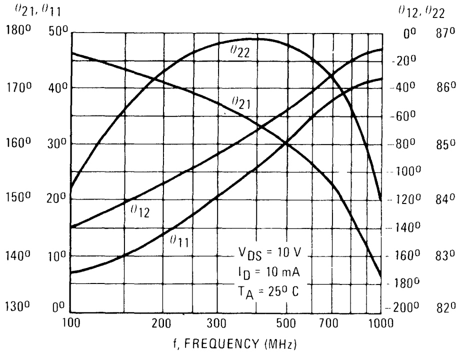


FIGURE 9 – S PARAMETER PHASE-ANGLE versus FREQUENCY

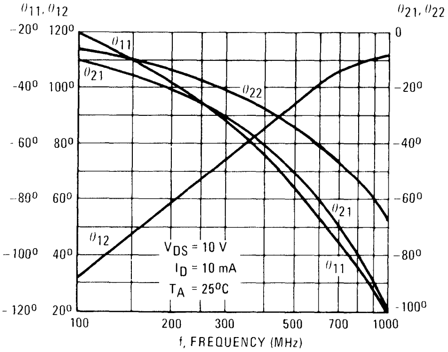


FIGURE 10 – NOISE FIGURE and POWER GAIN versus DRAIN CURRENT

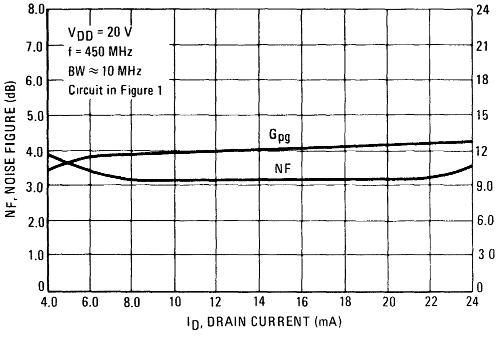


FIGURE 11 – NOISE FIGURE and POWER GAIN versus FREQUENCY

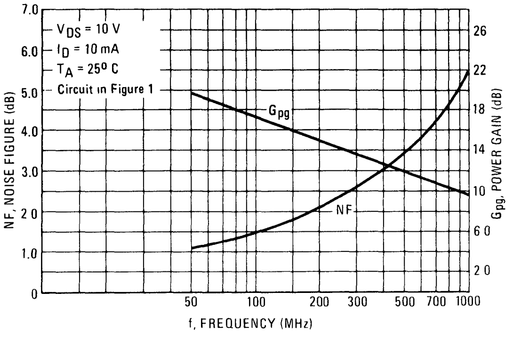
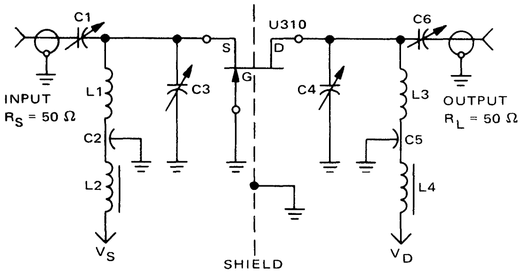


FIGURE 12 – 450 MHz IMD EVALUATION AMPLIFIER



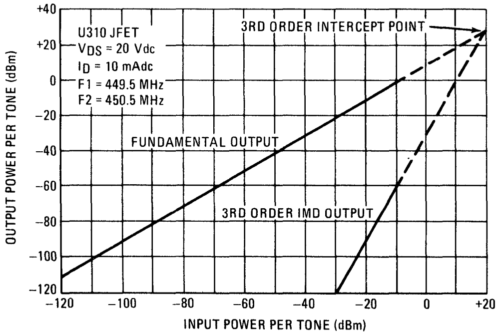
B_W (3dB) – 36.5 MHz
I_D – 10 mAdc
V_{DS} – 20 Vdc
Device case grounded
IM test tones – f1 = 449.5 MHz, f2 = 450.5 MHz

C1 = 1-10 pf Johanson Air variable trimmer.
C2, C5 = 100 pf feed thru button capacitor.
C3, C4, C6 = 0.5-6 pf Johanson Air variable trimmer

L1 = 1/8" x 1/32" x 1-5/8" copper bar
L2, L4 = Ferroxcube Vk200 choke
L3 = 1/8" x 1/32" x 1-7/8" copper bar.

Amplifier power gain and IMD products are a function of the load impedance. For the amplifier design shown above with C4 and C6 adjusted to reflect a load to the drain resulting in a nominal power gain of 9 dB, the 3rd order intercept point (IP) value is 29 dBm. Adjusting C4, C6 to provide larger load values will result in higher gain, smaller bandwidth and lower IP values. For example, a nominal gain of 13 dB can be achieved with an intercept point of 19 dBm.

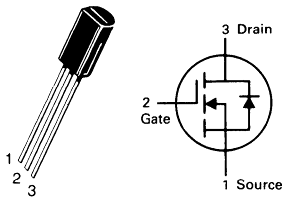
FIGURE 13 – TWO TONE 3RD ORDER INTERCEPT POINT



Example of intercept point plot use:
Assume two in-band signals of –20 dBm at the amplifier input. They will result in a 3rd order IMD signal at the output of –90 dBm. Also, each signal level at the output will be –11 dBm, showing an amplifier gain of 9.0 dB and an intermodulation ratio (IMR) capability of 79 dB. The gain and IMR values apply only for signal levels below compression.

VN10LM

CASE 29-03, STYLE 22
TO-92 (TO-226AE)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Gate-Source Voltage	V_{GS}	±30	Vdc
Drain Current — Continuous(1) Pulsed(2)	I_D I_{DM}	0.3 1.0	Adc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 8.0	Watts mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−40 to +150	°C

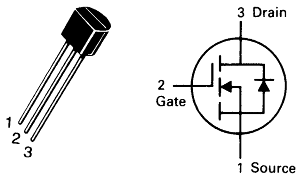
(1) The Power Dissipation of the package may result in a lower continuous drain current.
(2) Pulse Width ≤ 300 μs, Duty Cycle.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSS}$	60	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 45 V, V_{GS} = 0)	I_{DSS}	—	0.1	10	μAdc
Gate-Body Leakage Current (V_{GS} = −15 V, V_{DS} = 0)	$I_{GSS}{}^1$	—	—	100	nAdc
Gate-Body Leakage Current (V_{GS} = 15 V, V_{DS} = 0)	$I_{GSS}{}^2$	—	—	−100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.8	—	2.5	Vdc
On-State Drain Current (V_{DS} = 15 V, V_{GS} = 10 V)	$I_{D(on)}$	750	—	—	mA
Forward Transconductance (V_{DS} = 15 V, I_D = 500 mA)	g_{fs}	200	—	—	mmhos
Drain-Source On-Voltage (V_{GS} = 5.0 V, I_D = 200 mA)	$V_{DS(on)}{}^1$	—	—	1.5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 500 mA)	$V_{DS(on)}{}^2$	—	—	2.5	Vdc
Drain-Source On-Resistance (V_{GS} = 5.0 V, I_D = 200 mA)	$r_{DS(on)}{}^1$	—	—	7.5	Ω
Drain-Source On-Resistance (V_{GS} = 10 V, I_D = 500 mA)	$r_{DS(on)}{}^2$	—	—	5.0	Ω
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	—	60	pF
Output Capacitance (V_{DS} = 25 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	—	25	pF
Reverse Transfer Capacitance (V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{rss}	—	—	5.0	pF
Turn-On Time (V_{DS} = 15 V, R_L = 23 Ω, R_G = 50 Ω, V_{in} = 20 V)	t_{on}	—	—	10	ns
Turn-Off Time (V_{DS} = 15 V, R_L = 23 Ω, R_G = 50 Ω, V_{in} = 20 V)	t_{off}	—	—	10	ns

VN0610LL

CASE 29-04, STYLE 22
TO-92 (TO-226AA)



TMOS FET TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	60	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current			mAdc
Continuous	I_D	190	
Pulsed	I_{DM}	1000	
Total Power Dissipation @ T_A = 25°C	P_D	400	mW
Derate above 25°C		3.2	mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16″ from case for 10 seconds	T_L	300	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSS}$	60	—	Vdc
Zero Gate Voltage Drain Current	I_{DSS}			μAdc
(V_{DS} = 48 V, V_{GS} = 0)		—	10	
(V_{DS} = 48 V, V_{GS} = 0, T_J = 125°C)		—	500	
Gate-Body Leakage Current, Forward (V_{GSF} = 30 Vdc, V_{DS} = 0)	I_{GSSF}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.8	2.5	Vdc
Static Drain-Source On-Resistance	$r_{DS(on)}$			Ohm
(V_{GS} = 10 Vdc, I_D = 500 mA)		—	5.0	
(V_{GS} = 10 Vdc, I_D = 500 mA, T_C = 125°C)		—	9.0	
Drain-Source On-Voltage	$V_{DS(on)}$			Vdc
(V_{GS} = 5.0 V, I_D = 200 mA)		—	1.5	
(V_{GS} = 10 V, I_D = 500 mA)		—	2.5	
On-State Drain Current (V_{GS} = 10 V, $V_{DS} \geq 2.0\ V_{DS(on)}$)	$I_{D(on)}$	750	—	mA
Forward Transconductance ($V_{DS} \geq 2.0\ V_{DS(on)}$, I_D = 500 mA)	g_{fs}	100	—	μmhos
DYNAMIC CHARACTERISTICS				
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	60	pF
Output Capacitance	C_{oss}	—	25	
Reverse Transfer Capacitance	C_{rss}	—	5.0	
SWITCHING CHARACTERISTICS*				
Turn-On Delay Time (V_{DD} = 15 V, I_D = 600 mA R_{gen} = 25 ohms, R_L = 23 ohms)	t_{on}	—	10	ns
Turn-Off Delay Time	t_{off}	—	10	

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

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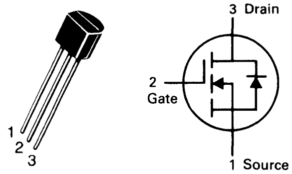
CASE 29-04, STYLE 22
TO-92 (TO-226AA)



TMOS FET
TRANSISTOR

N-CHANNEL — ENHANCEMENT

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	60	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	60	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current Continuous Pulsed	 I_D I_{DM}	 150 1000	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 3.2	mW mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance Junction to Ambient	$R_{\theta JA}$	312.5	°C/W
Maximum Lead Temperature for Soldering Purposes, 1/16″ from case for 10 seconds	T_L	300	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 μA)	$V_{(BR)DSS}$	60	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 48 V, V_{GS} = 0) (V_{DS} = 48 V, V_{GS} = 0, T_J = 125°C)	I_{DSS}	 — —	 10 500	μAdc
Gate-Body Leakage Current, Forward (V_{GSF} = 30 Vdc, V_{DS} = 0)	I_{GSSF}	—	−100	nAdc
ON CHARACTERISTICS*				
Gate Threshold Voltage (V_{DS} = V_{GS}, I_D = 1.0 mA)	$V_{GS(th)}$	0.6	2.5	Vdc
Static Drain-Source On-Resistance (V_{GS} = 10 Vdc, I_D = 0.5 Adc) (V_{GS} = 10 Vdc, I_D = 0.5 V, T_C = 125°C)	$r_{DS(on)}$	 — —	 7.5 13.5	Ohm
Drain-Source On-Voltage (V_{GS} = 5.0 V, I_D = 200 mA) (V_{GS} = 10 V, I_D = 500 mA)	$V_{DS(on)}$	 — —	 1.5 3.75	Vdc
On-State Drain Current (V_{GS} = 10 Vdc, $V_{DS} \geqslant 2.0\ V_{DS(on)}$)	$I_{D(on)}$	750	—	mA
Forward Transconductance (V_{DS} = 10 V, I_D = 500 mA)	g_{fs}	100	—	μmhos
DYNAMIC CHARACTERISTICS				
Input Capacitance (V_{DS} = 25 V, V_{GS} = 0 f = 1.0 MHz)	C_{iss}	—	60	pF
Output Capacitance	C_{oss}	—	25	
Reverse Transfer Capacitance	C_{rss}	—	5.0	
SWITCHING CHARACTERISTICS*				
Turn-On Delay Time (V_{DD} = 15 V, I_D = 600 mA R_{gen} = 25 ohms, R_L = 23 ohms)	t_{on}	—	10	ns
Turn-Off Delay Time	t_{off}	—	10	

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

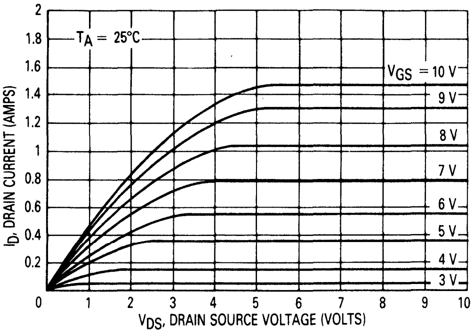


Figure 1. Ohmic Region

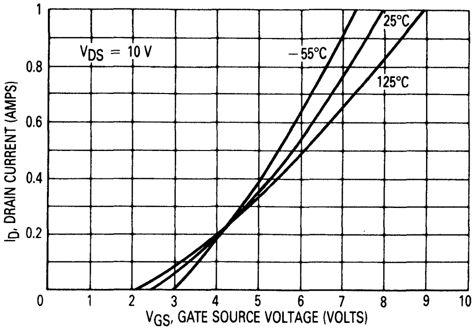


Figure 2. Transfer Characteristics

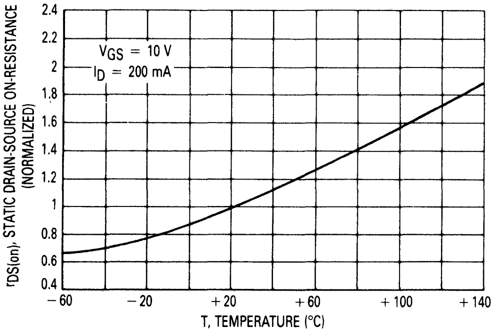


Figure 3. Temperature versus Static Drain-Source On-Resistance

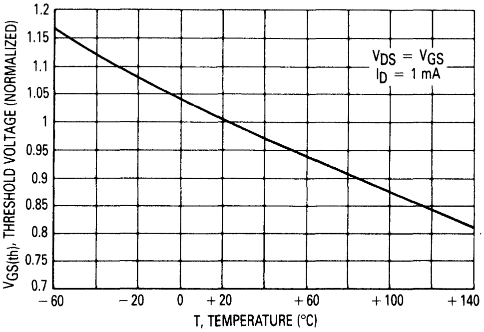
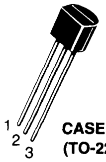
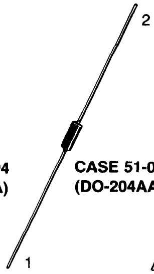


Figure 4. Temperature versus Gate Threshold Voltage

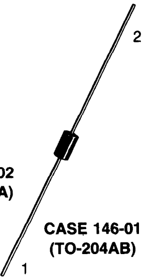
Small-Signal Tuning, Switching and Zener Diodes



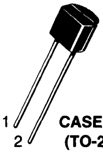
CASE 29-04
(TO-226AA)



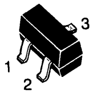
CASE 51-02
(DO-204AA)



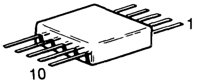
CASE 146-01
(TO-204AB)



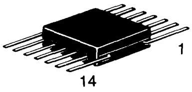
CASE 182-02
(TO-226AC)



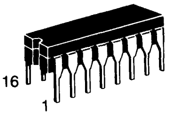
CASE 318-03
SOT-23 (TO-236AB)



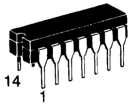
CASE 606-04
TO-91



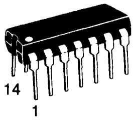
CASE 607-05



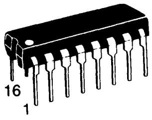
CASE 620-09



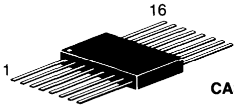
CASE 632-08
(TO-116)



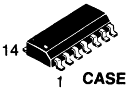
CASE 646-06



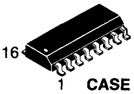
CASE 648-08



CASE 650-05



CASE 751A-02
SO-14

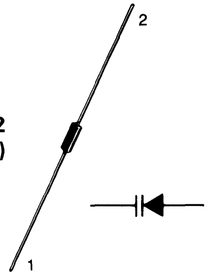


CASE 751B-03
SO-16

Motorola's dual, quad, and multiple transistors and diodes have been implemented with discrete chips that have proven to be the most popular for all-around performance at low cost.

Packaging options include plastic and ceramic DIP's, ceramic flat pak, axial lead and surface mount packages.

1N5139, A
thru
1N5148, A



CASE 51-02
(DO-204AA)

6.8–47 pF EPICAP
VOLTAGE-VARIABLE
CAPACITANCE DIODES

SILICON EPICAP DIODES

. . . designed for electronic tuning and harmonic-generation applications, and providing solid-state reliability to replace mechanical tuning methods.

- Guaranteed High-Frequency Q
- Guaranteed Wide Tuning Range
- Guaranteed Temperature Coefficient
- Standard 10% Capacitance Tolerance
- Complete Typical Design Curves

MAXIMUM RATINGS (T_C = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	60	Volts
Forward Current	I_F	250	mA
RF Power Input*	P_{in}	5.0	Watts
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.67	mW mW/°C
Device Dissipation @ T_C = 25°C Derate above 25°C	P_C	2.0 13.3	Watts mW/°C
Junction Temperature	T_J	+175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

*The RF power input rating assumes that an adequate heatsink is provided.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	60	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 55 Vdc, T_A = 25°C) (V_R = 55 Vdc, T_A = 150°C)	I_R	— —	— —	0.02 20	μAdc
Series Inductance (f = 250 MHz, L ≈ 1/16″)	L_S	—	5.0	—	nH
Case Capacitance (f = 1.0 MHz, L ≈ 1/16″)	C_C	—	0.25	—	pF
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	200	300	ppm/°C

	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	α V_R = 4.0 Vdc, f = 1.0 MHz		TR, Tuning Ratio C_4/C_{60} f = 1.0 MHz	
Device	**Min**	**Typ**	**Max**	**Min**	**Min**	**Typ**	**Min**	**Typ**
1N5139	6.1	6.8	7.5	350	0.37	0.4	2.7	2.9
1N5139A	6.5	6.8	7.1	350	0.37	0.4	2.7	2.9
1N5140	9.0	10	11	300	0.38	0.41	2.8	3.0
1N5140A	9.5	10	10.5	300	0.38	0.41	2.8	3.0
1N5141	10.8	12	13.2	300	0.38	0.41	2.8	3.0
1N5141A	11.4	12	12.6	300	0.38	0.41	2.8	3.0
1N5142	13.5	15	16.5	250	0.38	0.41	2.8	3.0
1N5142A	14.3	15	15.7	250	0.38	0.41	2.8	3.0
1N5143	16.2	18	19.8	250	0.38	0.41	2.8	3.0
1N5143A	17.1	18	18.9	250	0.38	0.41	2.8	3.0
1N5144	19.8	22	24.2	200	0.43	0.45	3.2	3.4
1N5144A	20.9	22	23.1	200	0.43	0.45	3.2	3.4
1N5145	24.3	27	29.7	200	0.43	0.45	3.2	3.4
1N5145A	25.7	27	28.3	200	0.43	0.45	3.2	3.4
1N5146	29.7	33	36.3	200	0.43	0.45	3.2	3.4
1N5146A	31.4	33	34.6	200	0.43	0.45	3.2	3.4
1N5147	36.1	39	42.9	200	0.43	0.45	3.2	3.4
1N5147A	37.1	39	40.9	200	0.43	0.45	3.2	3.4
1N5148	42.3	47	51.7	200	0.43	0.45	3.2	3.4
1N5148A	44.7	47	49.3	200	0.43	0.45	3.2	3.4

PARAMETER TEST METHODS

1. L_S, SERIES INDUCTANCE
L_S is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter). L = lead length.

2. C_C, CASE CAPACITANCE
C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

3. C_T, DIODE CAPACITANCE
($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

4. TR, TUNING RATIO
TR is the ratio of C_T measured at 4.0 Vdc divided by C_T measured at 60 Vdc.

5. Q, FIGURE OF MERIT
Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

(Boonton Electronics Model 33AS8).

6. α, DIODE CAPACITANCE REVERSE VOLTAGE SLOPE
The diode capacitance, C_T (as measured at $V_R = 4.0$ Vdc, f = 1.0 MHz) is compared to C_T (as measured at $V_R = 60$ Vdc, f = 1.0 MHz) by the following equation which defines α.

$$\alpha = \frac{\log C_T(4) - \log C_T(60)}{\log 60 - \log 4}$$

Note that a C_T versus V_R law is assumed as shown in the following equation where C_C is included.

$$C_T = \frac{K}{V\alpha}$$

7. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT

TC_C is guaranteed by comparing C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = -65°C$ with C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = +85°C$ in the following equation which defines TC_C:

$$TC_C = \left|\frac{C_T(+85°C) - C_T(-65°C)}{85 + 65}\right| \cdot \frac{10^6}{C_T(25°C)}$$

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE

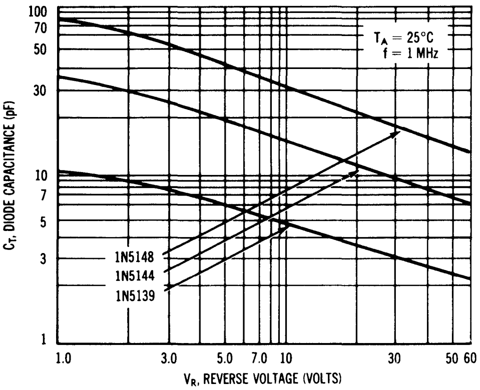


FIGURE 2 — FIGURE OF MERIT versus REVERSE VOLTAGE

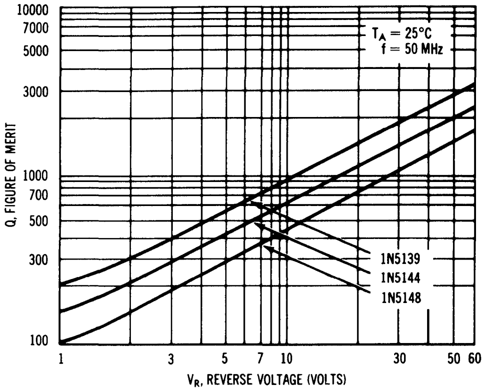


FIGURE 3 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE

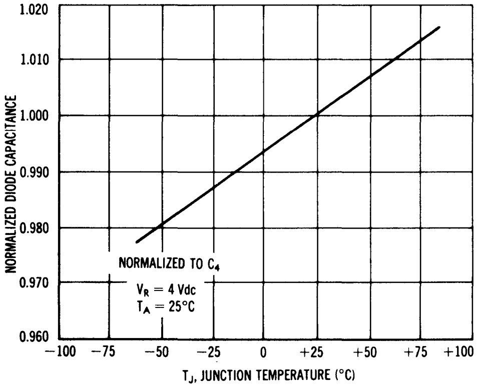


FIGURE 4 — NORMALIZED FIGURE OF MERIT versus JUNCTION TEMPERATURE

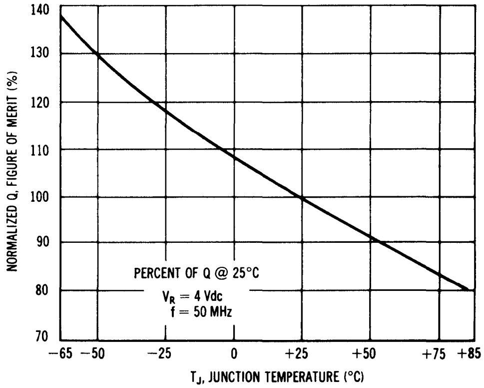


FIGURE 5 — REVERSE CURRENT versus REVERSE BIAS VOLTAGE

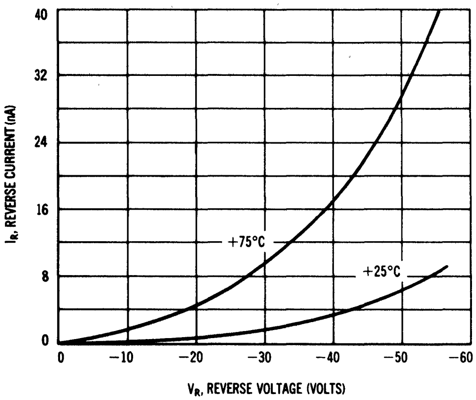
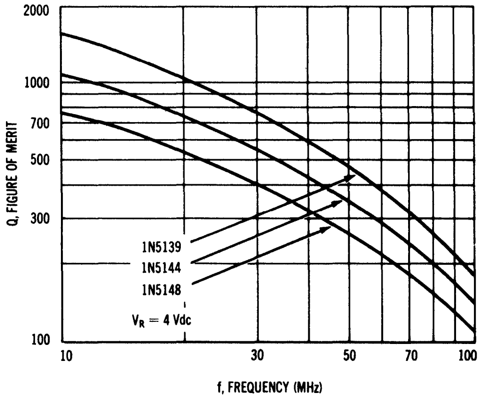
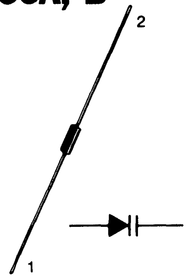


FIGURE 6 — FIGURE OF MERIT versus FREQUENCY



1N5441A, B
thru
1N5456A, B

CASE 51-02
(DO-204AA)



6.8–100 pF
30 VOLTS
VOLTAGE-VARIABLE
CAPACITANCE DIODES

SILICON EPICAP DIODES

. . . epitaxial passivated abrupt junction tuning diodes designed for electronic tuning, FM, AFC and harmonic-generation applications in AM through UHF ranges, providing solid-state reliability to replace mechanical tuning methods.

- Excellent Q Factor at High Frequencies
- Guaranteed Capacitance Change — 2.0 to 30 V
- Guaranteed Temperature Coefficient
- Capacitance Tolerance — 10% and 5.0%
- Complete Typical Design Curves

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.67	mW mW/°C
Operating Junction Temperature Range	T_J	+175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C) (V_R = 25 Vdc, T_A = 150°C)	I_R	— —	— —	0.02 20	μAdc
Series Inductance (f = 250 MHz, lead length ≈ 1/16″)	L_S	—	4.0	10	nH
Case Capacitance (f = 1.0 MHz, lead length ≈ 1/16″)	C_C	0.1	0.17	0.25	pF
Diode Capacitance Temperature Coefficient (Note 6) (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	300	400	ppm/°C

Device	C_T, Diode Capacitance (1) V_R = 4.0 Vdc, f = 1.0 MHz pF			TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		Q, Figure of Merit V_R = 4.0 Vdc f = 50 MHz
	Min (Nom −10%)	Nom	Max (Nom +10%)	Min	Max	Min
1N5441A	6.1	6.8	7.5	2.5	3.1	450
1N5442A	7.4	8.2	9.0	2.5	3.1	450
1N5443A	9.0	10	11	2.6	3.1	400
1N5444A	10.8	12	13.2	2.6	3.1	400
1N5445A	13.5	15	16.5	2.6	3.1	400
1N5446A	16.2	18	19.8	2.6	3.1	350
1N5447A	18	20	22	2.6	3.1	350
1N5448A	19.8	22	24.2	2.6	3.2	350
1N5449A	24.3	27	29.7	2.6	3.2	350
1N5450A	29.7	33	36.3	2.6	3.2	350
1N5451A	35.1	39	42.9	2.6	3.2	300
1N5452A	42.3	47	51.7	2.6	3.2	250
1N5453A	50.4	56	61.6	2.6	3.3	200
1N5454A	61.2	68	74.8	2.7	3.3	175
1N5455A	73.8	82	90.2	2.7	3.3	175
1N5456A	90	100	110	2.7	3.3	175

(1) To order devices with C_T Nom ±5.0% add Suffix B.
*Indicates JEDEC Registered Data.

PARAMETER TEST METHODS

1. L_S, SERIES INDUCTANCE
L_S is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter or equivalent).

2. C_C, CASE CAPACITANCE
C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

3. C_T, DIODE CAPACITANCE
($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

4. TR, TUNING RATIO
TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

5. Q, FIGURE OF MERIT
Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

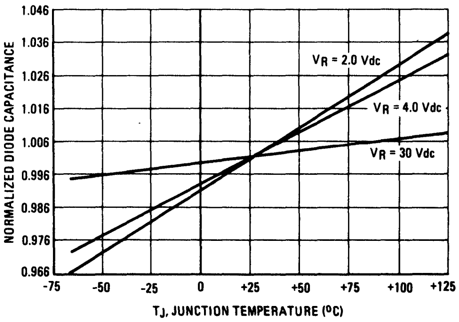
(Boonton Electronics Model 33AS8 or equivalent).

6. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT
TC_C is guaranteed by comparing C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = -65°C$ with C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = +85°C$ in the following equation, which defines TC_C:

$$TC_C = \left| \frac{C_T(+85°C) - C_T(-65°C)}{85 + 65} \right| \cdot \frac{10^6}{C_T(25°C)}$$

Accuracy limited by C_T measurement to ±0.1 pF.

FIGURE 1 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE



TYPICAL DEVICE PERFORMANCE

FIGURE 2 — DIODE CAPACITANCE versus REVERSE VOLTAGE

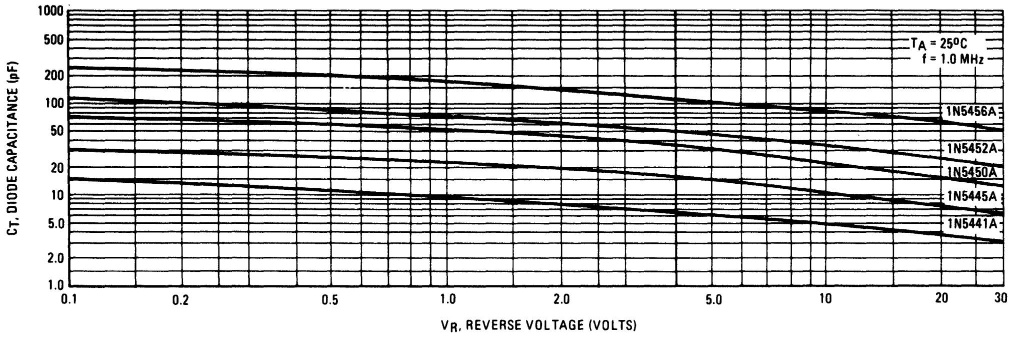


FIGURE 3 — FIGURE OF MERIT versus REVERSE VOLTAGE

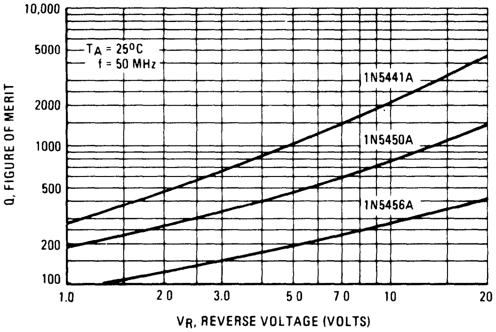


FIGURE 4 — FIGURE OF MERIT versus FREQUENCY

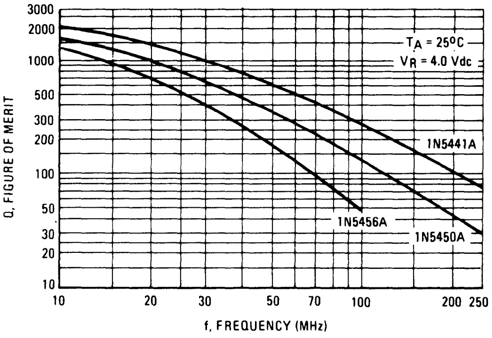


FIGURE 5 — REVERSE CURRENT versus REVERSE BIAS VOLTAGE

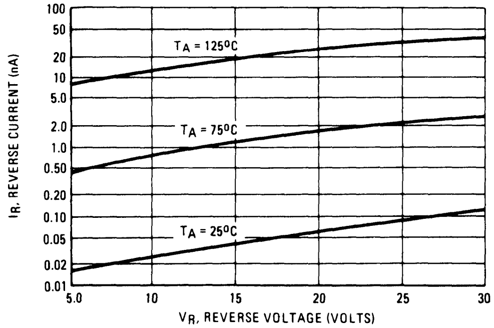
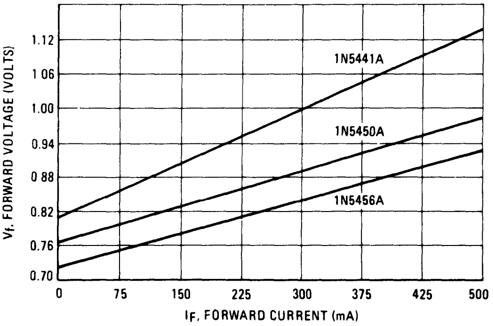
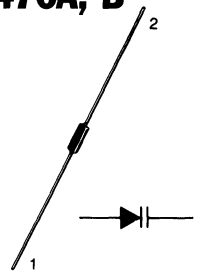


FIGURE 6 — FORWARD VOLTAGE versus FORWARD CURRENT



1N5461A, B
thru
1N5476A, B

CASE 51-02
(DO-204AA)



6.8–100 pF
30 VOLTS
VOLTAGE-VARIABLE
CAPACITANCE DIODES

SILICON EPICAP DIODES

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- High Q at High Frequencies
- Guaranteed High Capacitance Tuning Range
- Excellent Unit-to-Unit Uniformity
- Guaranteed Temperature Coefficient
- Capacitance Tolerance — 10% and 5.0%
- Complete Typical Design Curves

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Volts
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.67	mW mW/°C
Operating Junction Temperature Range	T_J	+175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C) (V_R = 25 Vdc, T_A = 150°C)	I_R	— —	— —	0.02 20	μAdc
Series Inductance (f = 250 MHz, lead length ≈ 1/16″)	L_S	—	4.0	10	nH
Case Capacitance (f = 1.0 MHz, lead length ≈ 1/16″)	C_C	0.1	0.17	0.25	pF
Diode Capacitance Temperature Coefficient (Note 6) (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	300	400	ppm/°C

Device	C_T, Diode Capacitance (1) V_R = 4.0 Vdc, f = 1.0 MHz pF			TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		Q, Figure of Merit V_R = 4.0 Vdc f = 50 MHz
	Min (Nom −10%)	Nom	Max (Nom +10%)	Min	Max	Min
1N5461A	6.1	6.8	7.5	2.7	3.1	600
1N5462A	7.4	8.2	9.0	2.8	3.1	600
1N5463A	9.0	10	11	2.8	3.1	550
1N5464A	10.8	12	13.2	2.8	3.1	550
1N5465A	13.5	15	16.5	2.8	3.1	550
1N5466A	16.2	18	19.8	2.9	3.1	500
1N5467A	18	20	22	2.9	3.1	500
1N5468A	19.8	22	24.2	2.9	3.2	500
1N5469A	24.3	27	29.7	2.9	3.2	500
1N5470A	29.7	33	36.3	2.9	3.2	500
1N5471A	35.1	39	42.9	2.9	3.2	450
1N5472A	42.3	47	51.7	2.9	3.2	400
1N5473A	50.4	56	61.6	2.9	3.3	300
1N5474A	61.2	68	74.8	2.9	3.3	250
1N5475A	73.8	82	90.2	2.9	3.3	225
1N5476A	90	100	110	2.9	3.3	200

(1) To order devices with C_T Nom ±5.0% add Suffix B.
*Indicates JEDEC Registered Data.

PARAMETER TEST METHODS

1. L_S, SERIES INDUCTANCE
L_S is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter or equivalent).

2. C_C, CASE CAPACITANCE
C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

3. C_T, DIODE CAPACITANCE
($C_T = C_C + C_J$). C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

4. TR, TUNING RATIO
TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

5. Q, FIGURE OF MERIT
Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

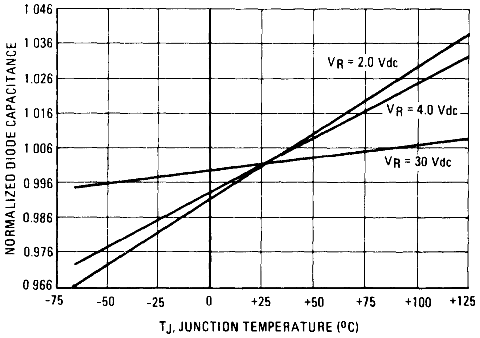
(Boonton Electronics Model 33AS8 or equivalent).

6. TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT
TC_C is guaranteed by comparing C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = -65°C$ with C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = +85°C$ in the following equation, which defines TC_C:

$$TC_C = \left|\frac{C_T(+85°C) - C_T(-65°C)}{85 + 65}\right| \cdot \frac{10^6}{C_T(25°C)}$$

Accuracy limited by C_T measurement to ±0.1 pF.

FIGURE 1 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE



TYPICAL DEVICE PERFORMANCE

FIGURE 2 — DIODE CAPACITANCE versus REVERSE VOLTAGE

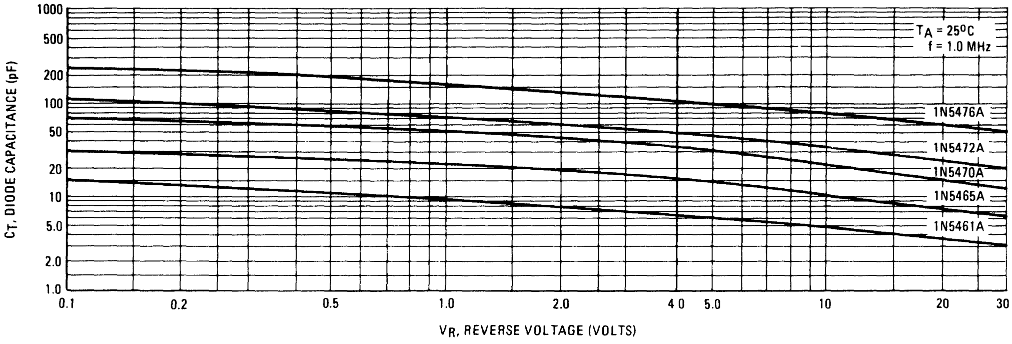


FIGURE 3 — FIGURE OF MERIT versus REVERSE VOLTAGE

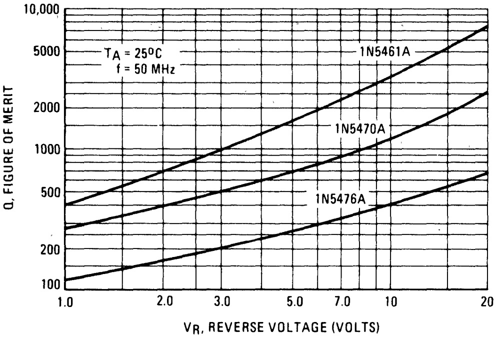


FIGURE 4 — FIGURE OF MERIT versus FREQUENCY

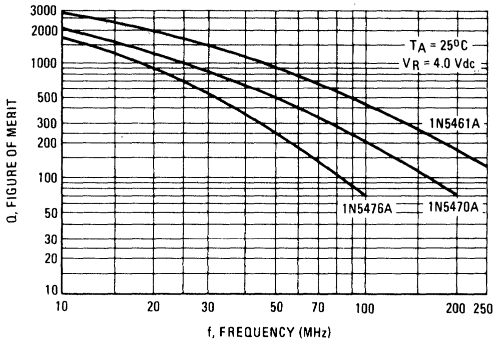


FIGURE 5 — REVERSE CURRENT versus REVERSE BIAS VOLTAGE

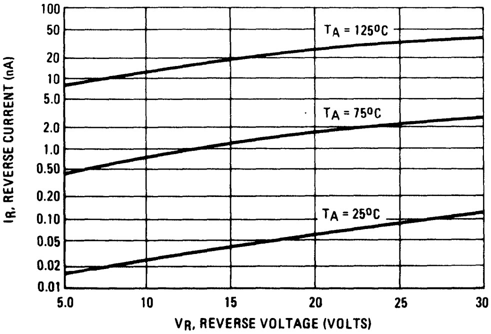
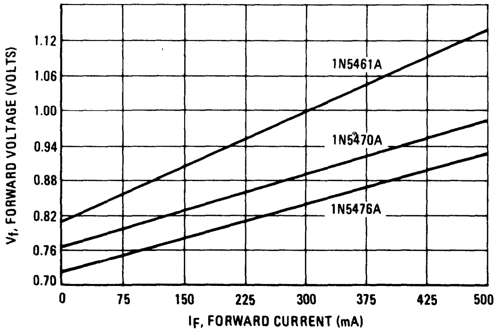
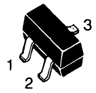


FIGURE 6 — FORWARD VOLTAGE versus FORWARD CURRENT



BAL99L

CASE 318-03 STYLE 17
SOT-23 (TO-236AB)



SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	70	Vdc
Peak Forward Current	I_F	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MBAL99L = TFX

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 70 V) (V_R = 25 V, T_J = 150°C) (V_R = 70 V, T_J = 150°C)	I_R	 — — —	 2.5 30 50	μA
Reverse Breakdown Voltage (I_R = 100 μA)	$V_{(BR)}$	70	—	V
Forward Voltage (I_F = 1.0 mA) (I_F = 10 mA) (I_F = 50 mA) (I_F = 150 mA)	V_F	 — — — —	 715 855 1000 1250	mV
Recovery Current (I_F = 10 mA, V_R = 5.0 V, R_L = 500 Ω)	Q_S	—	45	pC
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Reverse Recovery Time (I_F = I_R = 10 mA, R_L = 100 Ω, measured at I_R = 1.0 mA)	t_{rr}	—	6.0	ns
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns)	V_{FR}	—	1.75	V

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	75	Vdc
Peak Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mA

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

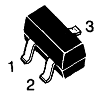
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

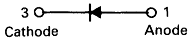
DEVICE MARKING

MBAS16L = A6X

BAS16L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)



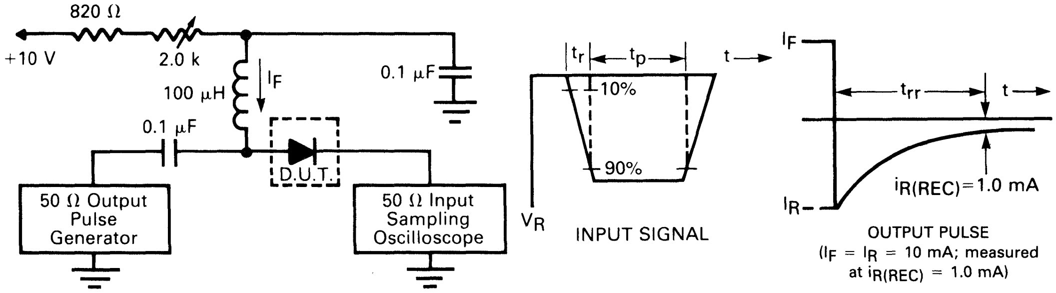


SWITCHING DIODE

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Voltage Leakage Current (V_R = 75 V) (V_R = 75 V, T_J = 150°C) (V_R = 25 V, T_J = 150°C)	I_R	 — — —	 1.0 50 30	µA
Reverse Breakdown Voltage (I_{BR} = 100 µA)	$V_{(BR)}$	75	—	V
Forward Voltage (I_F = 1.0 mA) (I_F = 10 mA) (I_F = 50 mA) (I_F = 150 mA)	V_F	 — — — —	 715 855 1000 1250	mV
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns)	V_{FR}	—	1.75	V
Reverse Recovery Time (I_F = I_R = 10 mA, R_L = 50 Ω)	t_{rr}	—	6.0	ns
Stored Charge (I_F = 10 mA to V_R = 5.0 V, R_L = 500 Ω)	Q_S	—	45	pC

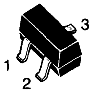
FIGURE 1 — Recovery Time Equivalent Test Circuit

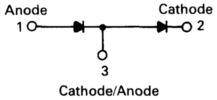


Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

BAV99L

CASE 318-03, STYLE 11
SOT-23 (TO-236AB)





DUAL SERIES
SWITCHING DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	150	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

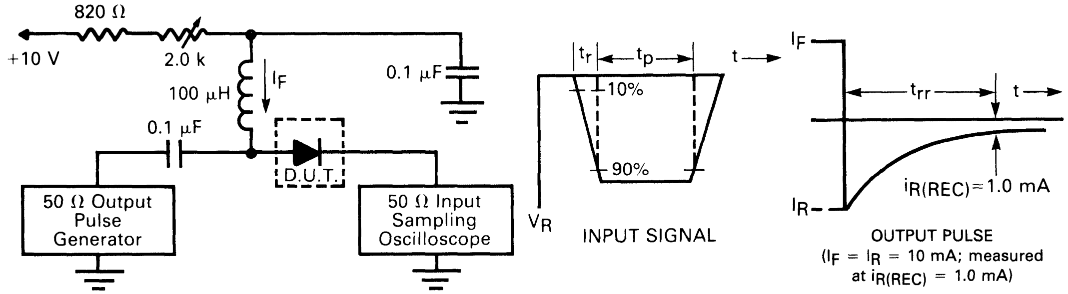
DEVICE MARKING

BAV99L = A7

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μA)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 70 Vdc) (V_R = 25 Vdc, T_J = 150°C) (V_R = 70 Vdc, T_J = 150°C)	I_R	— — —	2.5 30 50	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 150 mAdc)	V_F	— — — —	715 855 1000 1250	mVdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	6.0	ns
Forward Recovery Voltage (I_F = 10 mA, t_r = 20 ns)	V_{FR}	—	1.75	V

FIGURE 1 — Recovery Time Equivalent Test Circuit



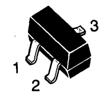
INPUT SIGNAL

OUTPUT PULSE
(I_F = I_R = 10 mA; measured at $i_{R(REC)}$ = 1.0 mA)

Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

BZX84C4V7L
thru
BZX84C33L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)



ZENER DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Voltage Range	$V_{Z(nom)}$	4.7 to 33	Vdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Forward Voltage (I_F = 10 mAdc)	BZX84C Series	V_F	—	0.9	Vdc
Reverse Voltage Leakage Current		I_R			μAdc
(V_R = 2.0 Vdc)	BZX84C4V7L		—	3.0	
	BZX84C5V1L		—	2.0	
	BZX84C5V6L		—	1.0	
(V_R = 4.0 Vdc)	BZX84C6V2L		—	3.0	
	BZX84C6V8L		—	2.0	
(V_R = 5.0 Vdc)	BZX84C7V5L		—	1.0	
	BZX84C8V2L		—	0.7	
(V_R = 6.0 Vdc)	BZX84C9V1L		—	0.5	
(V_R = 7.0 Vdc)	BZX84C10L		—	0.2	
(V_R = 8.0 Vdc)	BZX84C11L, C12L, C13L		—	0.1	
(V_R = 0.70 V_Z)	BZX84C15L to BZX84C33L		—	0.05	

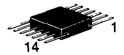
ZENER VOLTAGE

Device	Marking	I_{Z3}(mA)	V_{Z3}(V)		Z_{ZT1}(Ω)	Z_{ZT2}(Ω)	Z_{ZT3}(Ω)	$\Delta V_Z/\Delta T$(nV/k)	
			Min	Max				Min	Max
BZX84C4V7L	Z1	20	4.5	5.4	80	500	15	−3.5	0.2
BZX84C5V1L	Z2	20	5.0	5.9	60	480	15	−2.7	1.2
BZX84C5V6L	Z3	20	5.2	6.3	40	400	10	−2.0	2.5
BZX84C6V2L	Z4	20	5.8	6.8	10	150	6	0.4	3.7
BZX84C6V8L	Z5	20	6.4	7.4	15	80	6	1.2	4.5
BZX84C7V5L	Z6	20	7.0	8.0	15	80	6	2.5	5.3
BZX84C8V2L	Z7	20	7.7	8.8	15	80	6	3.2	6.2
BZX84C9V1L	Z8	20	8.5	9.7	15	100	8	3.8	7.0
BZX84C10L	Z9	20	9.4	10.7	20	150	10	4.5	8.0
BZX84C11L	Y1	20	10.4	11.8	20	150	10	5.4	9.0
BZX84C12L	Y2	20	11.4	12.9	25	150	10	6.0	10
BZX84C13L	Y3	20	12.5	14.2	30	170	15	7.0	11
BZX84C15L	Y4	20	13.9	15.7	30	200	20	9.2	13
BZX84C16L	Y5	20	15.4	17.2	40	200	20	10.4	14
BZX84C18L	Y6	20	16.9	19.2	45	225	20	12.4	16
BZX84C20L	Y7	20	18.9	21.4	55	225	20	14.4	18
BZX84C22L	Y8	20	20.9	23.4	55	250	25	16.4	20
BZX84C24L	Y9	20	22.9	25.7	70	250	25	18.4	22
BZX84C27L	Y10	10	25.2	29.3	80	300	45	21.4	25.3
BZX84C30L	Y11	10	28.1	32.4	80	300	50	24.4	29.4
BZX84C33L	Y12	10	31.1	35.4	80	325	55	27.4	33.4

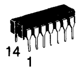
Device	Marking	I_{Z1}(mA)	V_{Z1}(V)		I_{Z1}(mA)	V_{Z2}(V)	
			Min	Max		Min	Max
BZX84C4V7L	Z1	5	4.4	5.0	1	3.7	4.7
BZX84C5V1L	Z2	5	4.8	5.4	1	4.2	5.3
BZX84C5V6L	Z3	5	5.2	6.0	1	4.8	6.0
BZX84C6V2L	Z4	5	5.8	6.6	1	5.6	6.6
BZX84C6V8L	Z5	5	6.4	7.2	1	6.3	7.2
BZX84C7V5L	Z6	5	7.0	7.9	1	6.9	7.9
BZX84C8V2L	Z7	5	7.7	8.7	1	7.6	8.7
BZX84C9V1L	Z8	5	8.5	9.6	1	8.4	9.6
BZX84C10L	Z9	5	9.4	10.6	1	9.3	10.6
BZX84C11L	Y1	5	10.4	11.6	1	10.2	11.6
BZX84C12L	Y2	5	11.4	12.7	1	11.2	12.7
BZX84C13L	Y3	5	12.4	14.1	1	12.3	14
BZX84C15L	Y4	5	13.8	15.6	1	13.7	15.5
BZX84C16L	Y5	5	15.3	17.1	1	15.2	17
BZX84C18L	Y6	5	16.8	19.1	1	16.7	19
BZX84C20L	Y7	5	18.8	21.2	1	18.7	21.1
BZX84C22L	Y8	5	20.8	23.3	1	20.7	23.2
BZX84C24L	Y9	5	22.8	25.6	1	22.7	25.5
BZX84C27L	Y10	2	25.1	28.9	0.5	25	28.9
BZX84C30L	Y11	2	28	32	0.5	27.8	32
BZX84C33L	Y12	2	31	35	0.5	30.8	35

MAD130, MAD1103
MAD1107, MAD1108

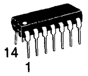
MAD1103F
CASE 606-04



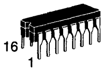
MAD1107F
CASE 607-05



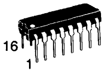
MAD130C
MAD1103C, MAD1107C
CASE 632-08



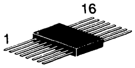
MAD130P
MAD1103P, MAD1107P
CASE 646-06



MAD1108C
CASE 620-09



MAD1108P
CASE 648-08



MAD1108F
CASE 650-05

MONOLITHIC DIODE ARRAYS

MAXIMUM RATINGS (@ 25°C Free-Air Temperature unless otherwise noted.)

Rating	Symbol	MAD130	MAD1103	MAD1107 MAD1108	Unit
Peak Reverse Voltage(1)	V_{RM}	40	50	50	Vdc
Steady-State Reverse Voltage	V_R	25	25	40	Vdc
Peak Forward Current at (or below) 25°C Free-Air Temperature(1)	I_{FM}	500			mA
Continuous Forward Current at (or below) 25°C Free-Air Temperature(2)	I_F	400			mA
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature(3)	P_D	600			mW
Operating Free-Air Temperature Range	T_A	−65 to +125	−65 to +125	−55 to +150	°C
Storage Temperature Range	T_{stg}	−65 to +150	−65 to +150	−65 to +175	°C
Lead Temperature 1/16″ from Case for 10 Seconds		260			°C

NOTES:
1. These values apply for PW ≤ 100 μs, duty cycle ≤ 20%.
2. Derate linearity to +125°C temperature at rate of 3.2 mA/°C.
3. Derate linearity to +125°C temperature at rate of 6.0 mW/°C.

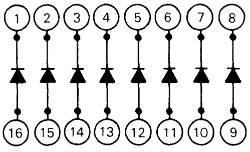
PACKAGE OPTIONS

	CERAMIC C Suffix		PLASTIC P Suffix		FLAT CERAMIC F Suffix			CERAMIC C Suffix		PLASTIC P Suffix		FLAT CERAMIC F Suffix	
Device	Pin Connection Ref. No.	Case	Pin Connection Ref. No.	Case	Pin Connection Ref. No.	Case	Device	Pin Connection Ref. No.	Case	Pin Connection Ref. No.	Case	Pin Connection Ref. No.	Case
MAD130 Dual 10-Diode Array	3	632-08	3	646-06	—	—	MAD1107 Dual 8-Diode Array	2	632-08	2	646-06	2	607-05
MAD1103 Dual 8-Diode Array	5	632-08	5	646-06	4	606-04	MAD1108 8-Diode Array	1	620-09	1	648-08	1	650-05

PIN CONNECTION DIAGRAMS

1

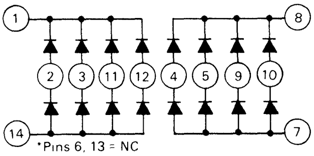
8-Diode Array
16-Pin Package



Case 620, Case 648, Case 650

2

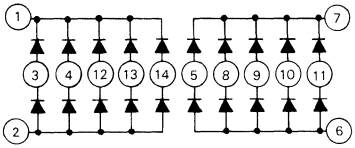
Dual 8-Diode Array
14-Pin Package



*Pins 6, 13 = NC
Case 607, Case 632, Case 646

3

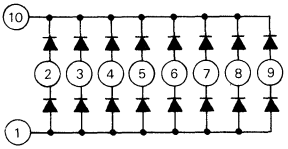
Dual 10-Diode Array
14-Pin Package



Case 632, Case 646

4

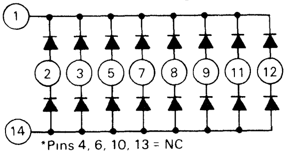
Dual 8-Diode Array
10-Pin Package



Case 606

5

Dual 8-Diode Array
14-Pin Package



*Pins 4, 6, 10, 13 = NC
Case 632, Case 646

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic		Symbol	Limit		Unit
			Min	Max	
Reverse Breakdown Voltage(1)		$V_{(BR)}$			
(I_R = 10 μA)	MAD130		40	—	Vdc
	MAD1103/1107/1108		50	—	
Static Reverse Current		I_R			μA
(V_R = 40 V)			— —	0.1	
Static Forward Voltage		V_F			Vdc
(I_F = 100 mA)			—	1.1	
(I_F = 500 mA)(2)			—	1.5	
Peak Forward Voltage(3) (I_F = 500 mA)		V_{FM}	—	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time, Figure 3 (I_F = 500 mA)	t_{fr}	20	ns
Reverse Recovery Time, Figure 2 (I_F = 200 mA, I_{RM} = 200 mA, R_L = 100 Ω, i_{rr} = 20 mA)	t_{rr}	8.0	ns

NOTES:

1. This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
2. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the pulse.
3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

FIGURE 1 — TYPICAL CHARACTERISTICS
STATIC FORWARD VOLTAGE

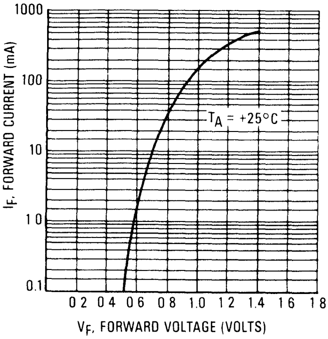


FIGURE 2 — FORWARD RECOVERY TIME AND PEAK FORWARD
VOLTAGE TEST CIRCUIT AND WAVEFORMS

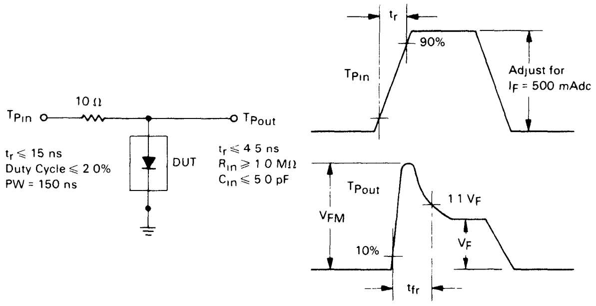
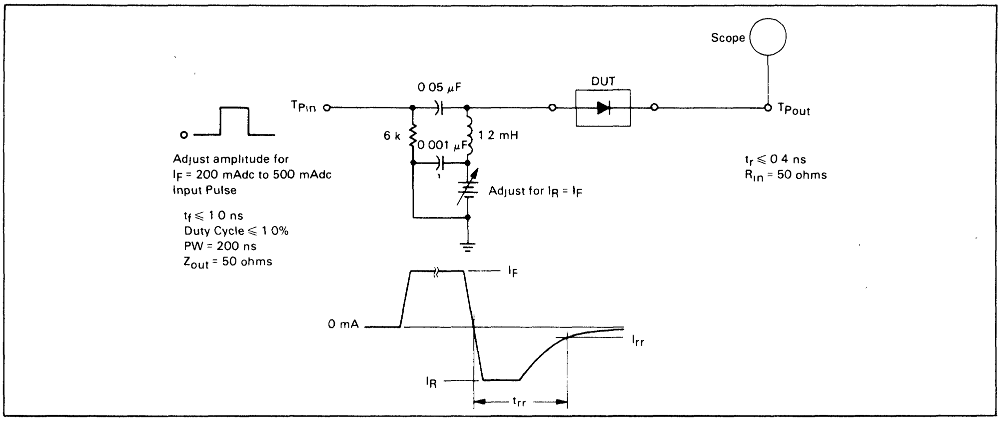
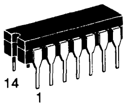


FIGURE 3 — REVERSE RECOVERY TIME TEST CIRCUIT AND WAVEFORMS

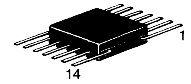


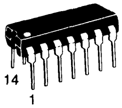
MAD1109



MAD1109C
CERAMIC
CASE 632-08
TO-116

MAD1109F
FLAT CERAMIC
CASE 607-05





MAD1109P
PLASTIC
CASE 646-06
TO-116

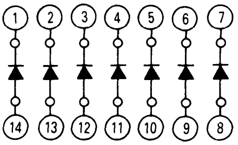
MONOLITHIC DIODE ARRAYS

MAXIMUM RATINGS (@ 25°C Free-Air Temperature unless otherwise noted.)

Rating	Symbol	Value			Unit
Peak Reverse Voltage(1)	V_{RM}	50			Vdc
Steady-State Reverse Voltage	V_R	40			Vdc
Peak Forward Current at (or below) 25°C Free-Air Temperature(1)	I_{FM}	500			mA
Continuous Forward Current at (or below) 25°C Free-Air Temperature(2)	I_F	400			mA
Continuous Power Dissipation at (or below) 25°C Free-Air Temperature(3)	P_D	600			mW
		MAD1109C	**MAD1109F**	**MAD1109P**	
Operating Free-Air Temperature Range	T_A	−65 to +175	−65 to +150	−55 to +125	°C
Storage Temperature Range	T_{stg}	−65 to +200	−65 to +175	−55 to +150	°C
Lead Temperature 1/16″ from Case for 10 Seconds		260			°C

NOTES:
1. These values apply for PW ≤ 100 μs, duty cycle ≤ 20%.
2. Derate linearity to +125°C temperature at rate of 3.2 mA/°C.
3. Derate linearity to +125°C temperature at rate of 6.0 mW/°C.

PIN CONNECTION DIAGRAM



ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Limit		Unit
		Min	Max	
Reverse Breakdown Voltage(4) (I_R = 10 μA)	$V_{(BR)}$	50	—	Vdc
Static Reverse Current (V_R = 40 V)	I_R	—	0.1	μA
Static Forward Voltage (I_F = 100 mA) (I_F = 500 mA)(5)	V_F	— —	1.1 1.5	Vdc
Peak Forward Voltage(6) (I_F = 500 mA)	V_{FM}	—	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time, Figure 3 (I_F = 500 mA)	t_{fr}	20	ns
Reverse Recovery Time, Figure 2 (I_F = 200 mA, I_{RM} = 200 mA, R_L = 100 Ω, i_{rr} = 20 mA)	t_{rr}	8.0	ns

NOTES:
4. This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
5. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the pulse.
6. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

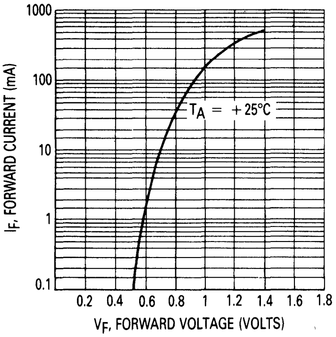


Figure 1. Typical Characteristics Static Forward Voltage

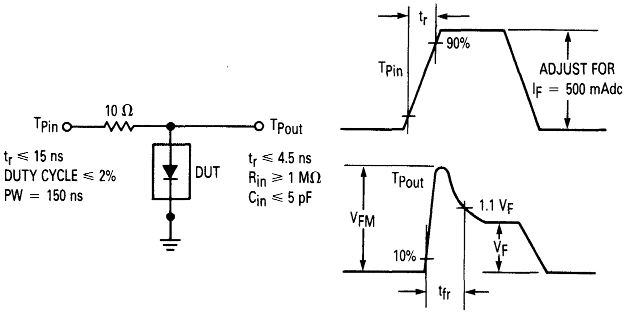


Figure 2. Forward Recovery Time and Peak Forward Voltage Test Circuit and Waveforms

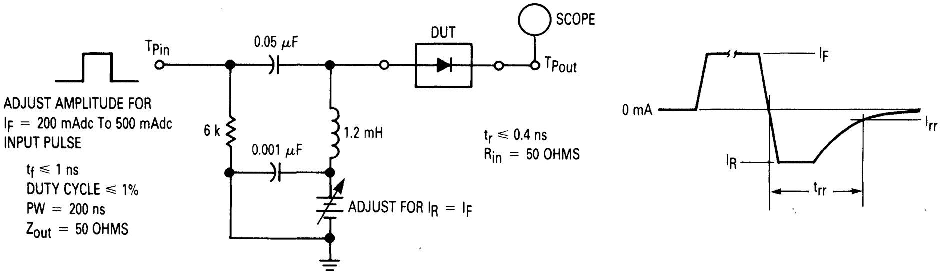
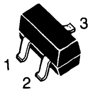
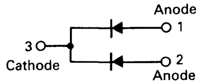


Figure 3. Reverse Recovery Time Test Circuit and Waveforms

MBAV70L

CASE 318-03, STYLE 9
SOT-23 (TO-236AB)





SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

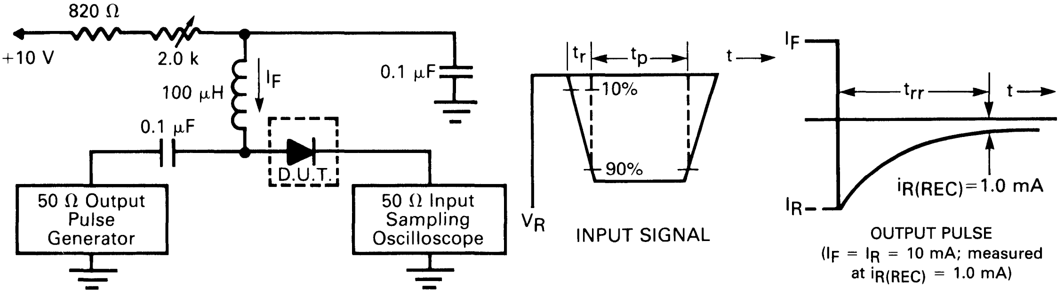
DEVICE MARKING

MBAV70L = A4X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	>70	—	Vdc
Reverse Voltage Leakage Current	I_R			μAdc
(V_R = 25 Vdc, T_J = 150°C)		—	60	
(V_R = 70 Vdc)		—	5.0	
(V_R = 70 Vdc, T_J = 150°C)		—	100	
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	1.5	pF
Forward Voltage	V_F			mVdc
(I_F = 1.0 mAdc)		—	715	
(I_F = 10 mAdc)		—	855	
(I_F = 50 mAdc)		—	1100	
(I_F = 100 mAdc)		—	1300	
Reverse Recovery Time (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	15	ns

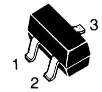
FIGURE 1 — Recovery Time Equivalent Test Circuit

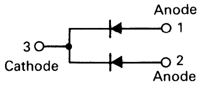


Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

MBAV74L

CASE 318-03, STYLE 9
SOT-23 (TO-236AB)





SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	50	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

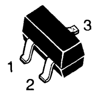
MBAV74L = JAX

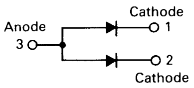
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 5.0 μAdc)	$V_{(BR)}$	50	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc, T_J = 125°C) (V_R = 50 Vdc)	I_R	 — —	 100 0.1	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.0	pF
Forward Voltage (I_F = 100 mAdc)	V_F	—	1.0	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc, measured at I_R = 1.0 mA, R_L = 100 Ω)	t_{rr}	—	15	ns

MBAW56L

CASE 318-03, STYLE 12
SOT-23 (TO-236AB)





DUAL SWITCHING DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	200	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

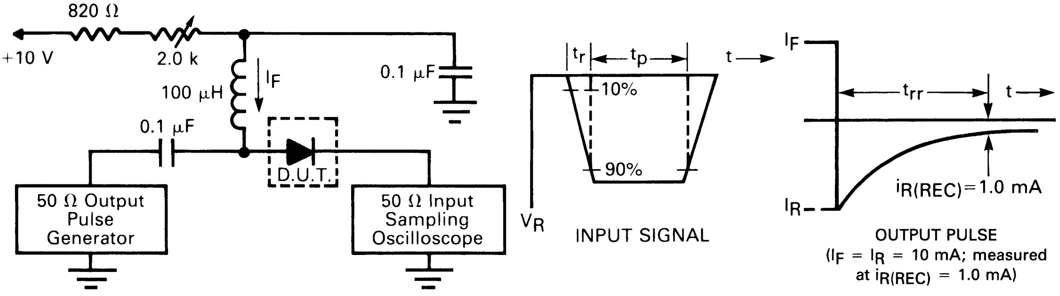
DEVICE MARKING

MBAW56L = A1X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current	I_R			μAdc
(V_R = 25 Vdc, T_J = 150°C)		—	30	
(V_R = 70 Vdc)		—	2.5	
(V_R = 70 Vdc, T_J = 150°C)		—	50	
Diode Capacitance (V_R = 0, f = 1.0 MHz)	C_D	—	2.5	pF
Forward Voltage	V_F			mVdc
(I_F = 1.0 mAdc)		—	715	
(I_F = 10 mAdc)		—	855	
(I_F = 50 mAdc)		—	1100	
(I_F = 100 mAdc)		—	1300	
Reverse Recovery Time (I_F = I_R = 10 mAdc, $I_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	15	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

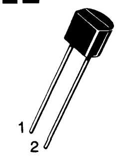
SILICON HOT-CARRIER DIODE (SCHOTTKY BARRIER DIODE)

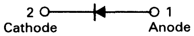
. . . designed primarily for UHF mixer applications but suitable also for use in detector and ultra-fast switching circuits. Supplied in an inexpensive plastic package for low-cost, high-volume consumer requirements. Also available in Surface Mount package.

- The Rugged Schottky Barrier Construction Provides Stable Characteristics by Eliminating the "Cat-Whisker" Contact
- Low Noise Figure — 6.0 dB Typ @ 1.0 GHz
- Very Low Capacitance — Less Than 1.0 pF @ Zero Volts
- High Forward Conductance — 0.5 Volts (Typ) @ I_F = 10 mA

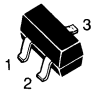
MBD101
MMBD101L

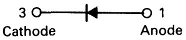
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





SILICON HOT-CARRIER UHF MIXER DIODES

MAXIMUM RATINGS

		MBD101	MMBD101,L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	4.0		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	200 2.0	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBD101L = 4M

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	4.0	5.0	—	Volts
Diode Capacitance (V_R = 0, f = 1.0 MHz, Note 1)	C_T	—	0.88	1.0	pF
Forward Voltage (1) (I_F = 10 mA)	V_F	—	0.5	0.6	Volts
Noise Figure (f = 1.0 GHz, Note 2)	NF	—	6.0	—	dB
Reverse Leakage (V_R = 3.0 V)	I_R	—	0.02	0.25	μA

TYPICAL CHARACTERISTICS

(T_A = 25°C unless noted)

FIGURE 1 — REVERSE LEAKAGE

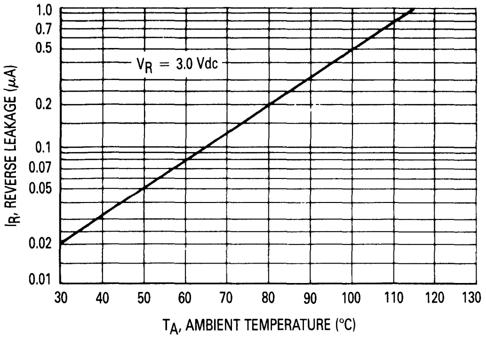


FIGURE 2 — FORWARD VOLTAGE

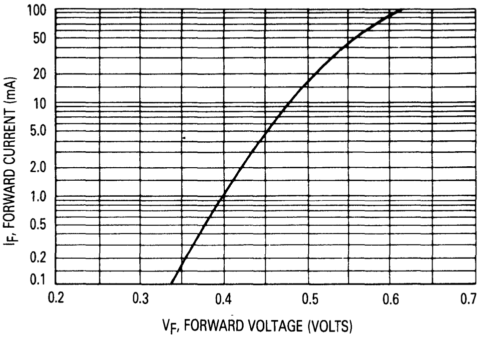


FIGURE 3 — CAPACITANCE

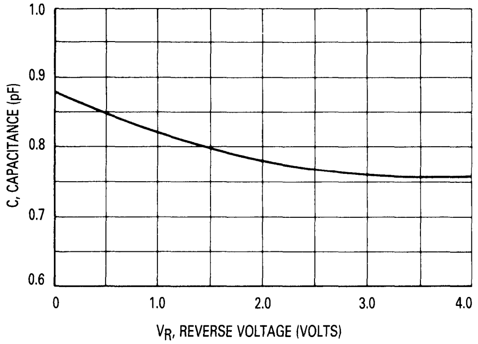


FIGURE 4 — NOISE FIGURE

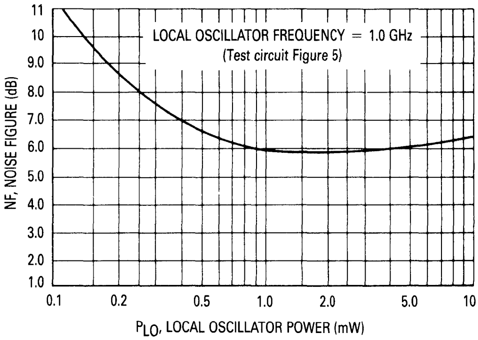
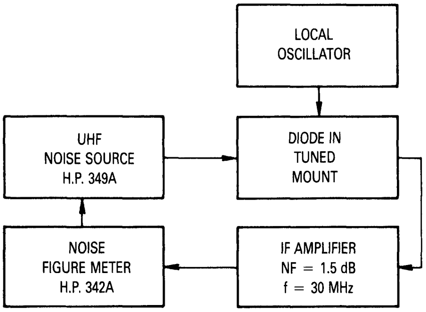


FIGURE 5 — NOISE FIGURE TEST CIRCUIT



NOTES ON TESTING AND SPECIFICATIONS

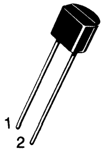
Note 1 — C_C and C_T are measured using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

Note 2 — Noise figure measured with diode under test in tuned diode mount using UHF noise source and local oscillator (LO) frequency of 1.0 GHz. The LO power is adjusted for 1.0 mW. IF amplifier NF = 1.5 dB, f = 30 MHz, see Figure 5.

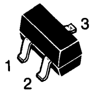
Note 3 — L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).

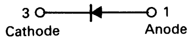
MBD201 MMBD201L
MBD301 MMBD301L

CASE 182-02, STYLE 1
(TO-226AC)



CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





20–30 VOLTS SILICON HOT-CARRIER DETECTOR AND SWITCHING DIODES

SILICON HOT-CARRIER DIODE
(SCHOTTKY BARRIER DIODE)

. . . designed primarily for high-efficiency UHF and VHF detector applications. Readily adaptable to many other fast switching RF and digital applications. Supplied in an inexpensive plastic package for low-cost, high-volume consumer and industrial/commercial requirements. Also available in Surface Mount package.

- The Schottky Barrier Construction Provides Ultra-Stable Characteristics By Eliminating the "Cat-Whisker" or "S-Bend" Contact
- Extremely Low Minority Carrier Lifetime — 15 ps (Typ)
- Very Low Capacitance — 1.5 pF (Max) @ V_R = 15 V
- Two Voltage Ranges — 20 V — MBD201, MMBD201
  — 30 V — MBD301, MMBD301
- Low Reverse Leakage — I_R = 10 nAdc (Typ) MBD201, MMBD201L
  = 13 nAdc (Typ) MBD301, MMBD301L

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD201 MBD301	MMBD201L MMBD301L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage MBD201 MBD301	V_R	20 30		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	T_J	−55 to +125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBR201L = 4S
MMBR301L = 4T

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	 MBD201, MMBD201L MBD301, MMBD301L	$V_{(BR)R}$	 20 30	 — —	 — —	Volts
Total Capacitance, Figure 1 (V_R = 15 Volts, f = 1.0 MHz)		C_T	—	0.9	1.5	pF
Minority Carrier Lifetime, Figure 2 (I_F = 5.0 mA, Krakauer Method)		τ	—	15	—	ps
Reverse Leakage, Figure 3 (V_R = 15 V) (V_R = 25 V)	 MBD201, MMBD201L MBD301, MMBD301L	I_R	 — —	 10 13	 200 200	nAdc
Forward Voltage, Figure 4 (I_F = 10 mAdc)		V_F	—	0.5	0.6	Vdc

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 — TOTAL CAPACITANCE

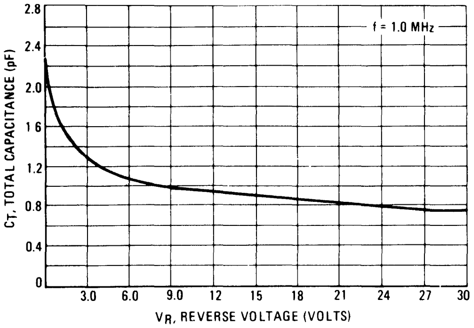


FIGURE 2 — MINORITY CARRIER LIFETIME

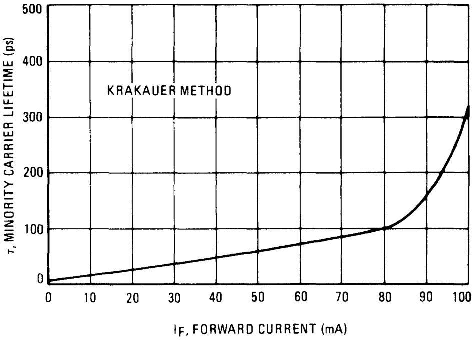


FIGURE 3 — REVERSE LEAKAGE

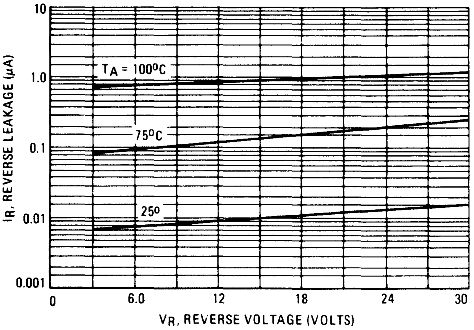
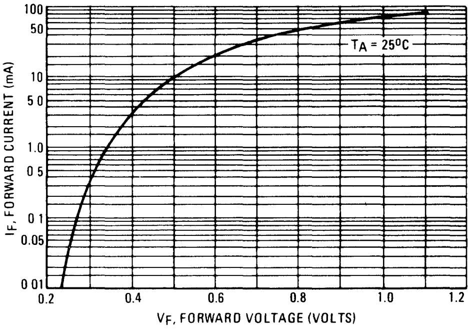
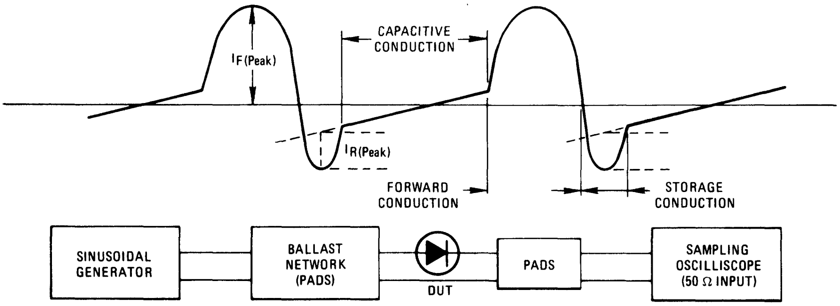


FIGURE 4 — FORWARD VOLTAGE



KRAKAUER METHOD OF MEASURING LIFETIME



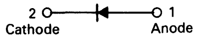
SILICON HOT-CARRIER DIODE (SCHOTTKY BARRIER DIODE)

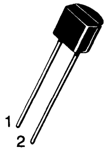
... designed primarily for high-efficiency UHF and VHF detector applications. Readily adaptable to many other fast switching RF and digital applications. Supplied in an inexpensive plastic package for low-cost, high-volume consumer and industrial/commercial requirements. Also available in Surface Mount package.

- The Schottky Barrier Construction Provides Ultra-Stable Characteristics by Eliminating the "Cat-Whisker" or "S-Bend" Contact
- Extremely Low Minority Carrier Lifetime — 15 ps (Typ)
- Very Low Capacitance — 1.0 pF @ V_R = 20 V
- High Reverse Voltage — to 70 Volts
- Low Reverse Leakage — 200 nA (Max)

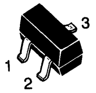
MBD501 MMBD501L
MBD701 MMBD701L

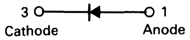
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





50–70 VOLTS
HIGH-VOLTAGE
SILICON HOT-CARRIER
DETECTOR AND SWITCHING
DIODES

MAXIMUM RATINGS (T_J = 125°C unless otherwise noted)

		MBD501 MBD701	MMBD501L MMBD701L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage MBD501 MBD701	V_R	50 70		Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	200 2.0	mW mW/°C
Operating Junction Temperature Range	T_J	−55 to +125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBD501L = 5F
MMBD701L = 5H

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	 MBD501, MMBD501L MBD701, MMBD701L	$V_{(BR)R}$	 50 70	 — —	 — —	Volts
Total Capacitance, Figure 1 (V_R = 20 Volts, f = 1.0 MHz)		C_T	—	0.5	1.0	pF
Minority Carrier Lifetime, Figure 2 (I_F = 5.0 mA, Krakauer Method)		τ	—	15	—	ps
Reverse Leakage, Figure 3 (V_R = 25 V) (V_R = 35 V)	 MBD501, MMBD501L MBD701, MMBD701L	I_R	 — —	 7.0 9.0	 200 200	nAdc
Forward Voltage, Figure 4 (I_F = 10 mAdc)		V_F	—	1.0	1.2	Vdc

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 — TOTAL CAPACITANCE

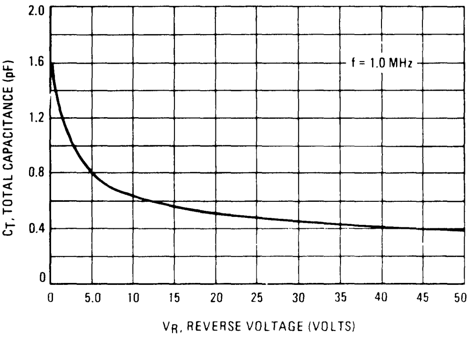


FIGURE 2 — MINORITY CARRIER LIFETIME

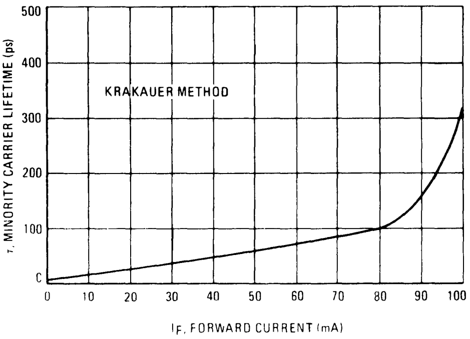


FIGURE 3 — REVERSE LEAKAGE

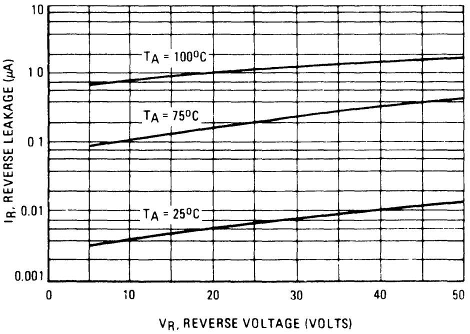
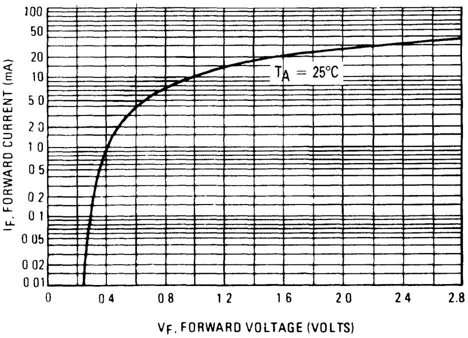
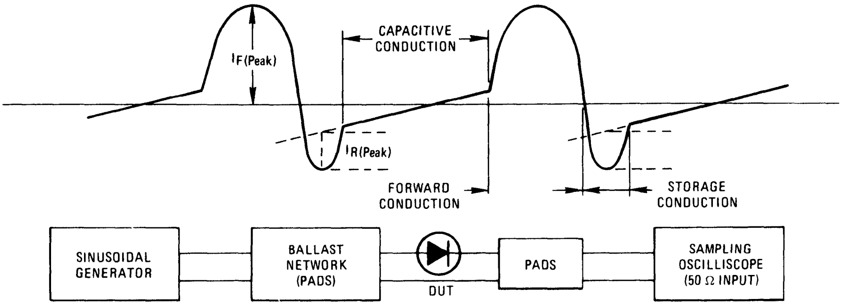


FIGURE 4 — FORWARD VOLTAGE

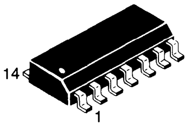


KRAKAUER METHOD OF MEASURING LIFETIME



MMAD130
MMAD1103
thru
MMAD1107
MMAD1109

CASE 751A-02
SO-14



MONOLITHIC
DIODE ARRAYS

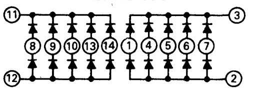
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V_{RM}	50	Vdc
Steady-State Reverse Voltage	V_R	40	Vdc
Peak Forward Current 25°C	I_{FM}	500	mA
Continuous Forward Current	I_F	400	mA
Power Dissipation Derating Factor	P_D	500 4.0	mW mW/°C
Operating Temperature	T_A	−65 to +125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

SO-14 Pin Diagram

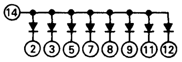
1.
Dual 10
Diode
Array

MMAD130



5.
8 Diode
Array
(Common
Anode)

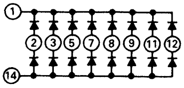
MMAD1106



NC Pin 1, 4, 6, 10, 13

2.
16
Diode
Array

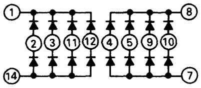
MMAD1103



NC Pin 4, 6, 10, 13

6.
Dual 8
Diode
Array

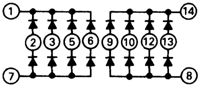
MMAD1107



NC Pin 6, 13

3.
Dual 8
Diode
Array

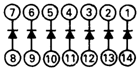
MMAD1104



NC Pin 4, 11

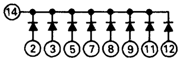
7.
7 Diode
Array
(Independant)

MMAD1109



4.
8 Diode
Array
(Common
Cathode)

MMAD1105



NC Pin 1, 4, 6, 10, 13

Device	Description	Diagram
MMAD130	Dual 10 Diode Array	1
MMAD1103	16 Diode Array	2
MMAD1104	Dual 8 Diode Array	3
MMAD1105	8 Diode Array Common Cathode	4
MMAD1106	8 Diode Array Common Anode	5
MMAD1107	Dual 8 Diode Array	6
MMAD1109	7 Diode Array	7

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Limit Min	Limit Max	Unit
Reverse Breakdown Voltage (1) (I_R = 10 μA)	$V_{(BR)}$	50	—	Vdc
Static Reverse Current (V_R = 40 V)	I_R	—	0.1	μA
Static Forward Voltage (I_F = 100 mA) (I_F = 500 mA) (2)	V_F	— —	1.1 1.5	Vdc
Peak Forward Voltage (3) (I_F = 500 mA)	V_{FM}	—	5.0	Vdc

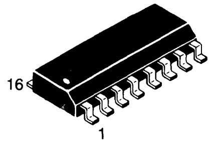
SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

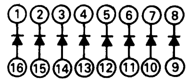
Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time (I_F = 500 mA)	t_{fr}	20	ns
Reverse Recovery Time (I_F = 200 mA, I_{RM} = 200 mA, R_L = 100 Ω, i_{rr} = 20 mA)	t_{rr}	8.0	ns

1. This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
2. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the pulse.
3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

MMAD1108

CASE 751B-03
SO-16





Pin Connections Diagram

MONOLITHIC DIODE ARRAY

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V_{RM}	50	Vdc
Steady-State Reverse Voltage	V_R	40	Vdc
Peak Forward Current 25°C	I_{FM}	500	mA
Continuous Forward Current	I_F	400	mA
Power Dissipation Derating Factor	P_D	500 4.0	mW mW/°C
Operating Temperature	T_A	−65 to +125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Limit		Unit
		Min	Max	
Reverse Breakdown Voltage (1) (I_R = 10 μA)	$V_{(BR)}$	50	—	Vdc
Static Reverse Current (V_R = 40 V)	I_R	—	0.1	μA
Static Forward Voltage (I_F = 100 mA) (I_F = 500 mA) (2)	V_F	 — —	 1.1 1.5	Vdc
Peak Forward Voltage (3) (I_F = 500 mA)	V_{FM}	—	5.0	Vdc

SWITCHING CHARACTERISTICS (@ 25°C Free-Air Temperature)

Characteristic	Symbol	Typical Value	Unit
Forward Recovery Time (I_F = 500 mA)	t_{fr}	20	ns
Reverse Recovery Time (I_F = 200 mA, I_{RM} = 200 mA, R_L = 100 Ω, i_{rr} = 20 mA)	t_{rr}	8.0	ns

1. This parameter must be measured using pulse techniques. PW = 100 μs, duty cycle ≤ 20%.
2. This parameter is measured using pulse techniques. PW = 300 μs, duty cycle ≤ 2.0%. Read time is 90 μs from the leading edge of the pulse.
3. The initial instantaneous value is measured using pulse techniques. PW = 150 ns, duty cycle ≤ 2.0%, pulse rise time ≤ 10 ns. The total capacitance shunting the diode is 19 pF maximum and the equipment bandwidth is 80 MHz.

MMBD101L For Specifications, See MBD101L

MMBD201L, MMBD301L For Specifications, See MBD201L

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Continuous Reverse Voltage	V_R	4.0	V_{CC}

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

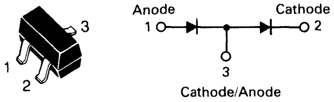
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

DEVICE MARKING

MMBD352L = 5G; MMBD353L = 4F

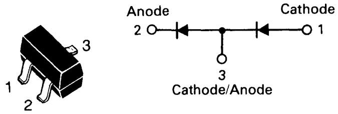
MMBD352L

CASE 318-03, STYLE 11
SOT-23 (TO-236AB)



MMBD353L

CASE 318-03, STYLE 19
SOT-23 (TO-236AB)



DUAL HOT CARRIER MIXER DIODES

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

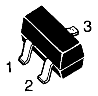
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Forward Voltage (I_F = 10 mA)	V_F	—	0.60	V
Reverse Voltage Leakage Current (V_R = 3.0 V) (V_R = 4.0 V)	I_R	 — —	 0.25 10	μA
Capacitance (V_R = 0 V, f = 1.0 MHz)	C	—	1.0	pF

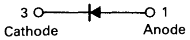
MMBD501L, MMBD701L

For Specifications,
See MBD501L Data.

MMBD914L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





HIGH-SPEED SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* $T_A = 25°C$ Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** $T_A = 25°C$ Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

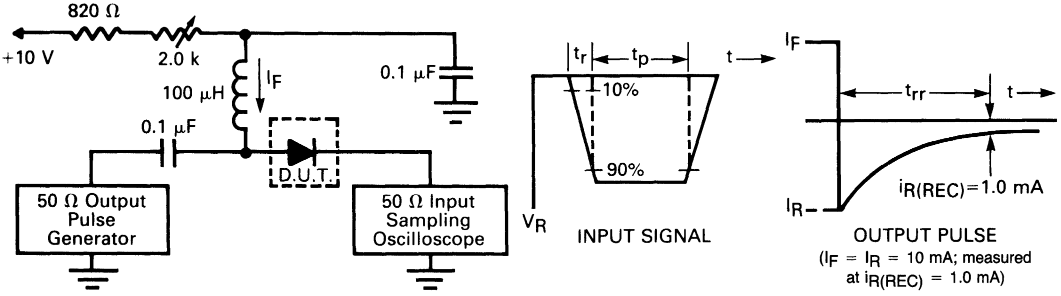
DEVICE MARKING

MMBD914XL = 5D

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_R = 100\ \mu Adc$)	$V_{(BR)}$	100	—	Vdc
Reverse Voltage Leakage Current ($V_R = 20$ Vdc) ($V_R = 75$ Vdc)	I_R	 — —	 25 5.0	 nAdc μAdc
Diode Capacitance ($V_R = 0$, f = 1.0 MHz)	C_T	—	4.0	pF
Forward Voltage ($I_F = 10$ mAdc)	V_F	—	1.0	Vdc
Reverse Recovery Time ($I_F = I_R = 10$ mAdc) (Figure 1)	t_{rr}	—	4.0	ns

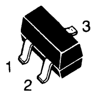
FIGURE 1 — Recovery Time Equivalent Test Circuit

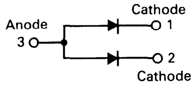


Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

MMBD2835XL
MMBD2836XL

CASE 318-03, STYLE 12
SOT-23 (TO-236AB)





DUAL SWITCHING DIODES

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Reverse Voltage	MMBD2836XL MMBD2835XL	V_R	75 35	Vdc
Forward Current		I_F	100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.

**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

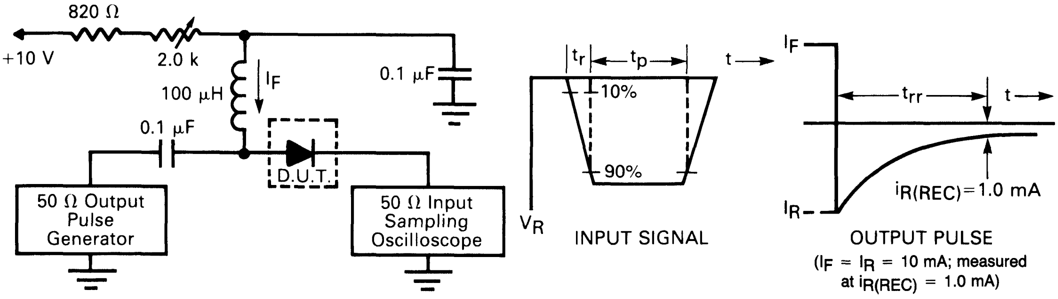
DEVICE MARKING

MMBD2835XL = A3X; MMBD2836XL = A2X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Reverse Breakdown Voltage (I_R = 100 μAdc)	 MMBD2835XL MMBD2836XL	$V_{(BR)}$	 35 75	 — —	Vdc
Reverse Voltage Leakage Current (V_R = 30 Vdc) (V_R = 50 Vdc)	 MMBD2835XL MMBD2836XL	I_R	 — —	 100 100	nAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)		C_T	—	4.0	pF
Forward Voltage (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 100 mAdc)		V_F	 — — —	 1.0 1.0 1.2	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)		t_{rr}	—	15	ns

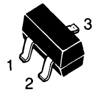
FIGURE 1 — Recovery Time Equivalent Test Circuit

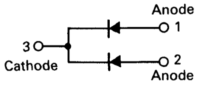


Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

MMBD2837XL
MMBD2838XL

CASE 318-03, STYLE 9
SOT-23 (TO-236AB)





DUAL SWITCHING DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Peak Reverse Voltage	V_{RM}	75	Vdc
D.C. Reverse Voltage MMBD2837XL MMBD2838XL	V_R	30 50	Vdc
Peak Forward Current	I_{FM}	450 300	mAdc
Average Rectified Current	I_O	150 100	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

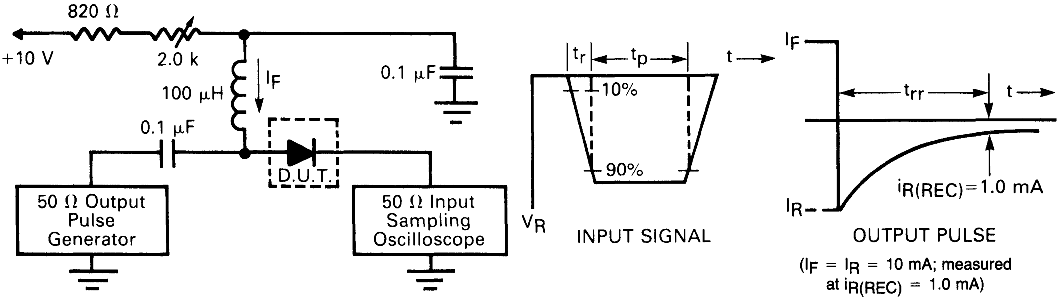
DEVICE MARKING

MMBD2837XL = A5X; MMBD2838XL = A6X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	 MMBD2837XL MMBD2838XL	$V_{(BR)}$	 35 75	 — —	Vdc
Reverse Voltage Leakage Current (V_R = 30 Vdc) (V_R = 50 Vdc)	 MMBD2837XL MMBD2838XL	I_R	 — —	 0.1 0.1	μAdc
Diode Capacitance (V_R = 0, f = 1.0 MHz)		C_T	—	4.0	pF
Forward Voltage (I_F = 10 mAdc) (I_F = 50 mAdc) (I_F = 100 mAdc)		V_F	 — — —	 1.0 1.0 1.2	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)		t_{rr}	—	15	ns

FIGURE 1 — Recovery Time Equivalent Test Circuit



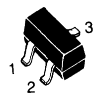
INPUT SIGNAL

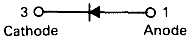
OUTPUT PULSE
(I_F = I_R = 10 mA; measured at $i_{R(REC)}$ = 1.0 mA)

Notes:
1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

MMBD6050L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





SWITCHING DIODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

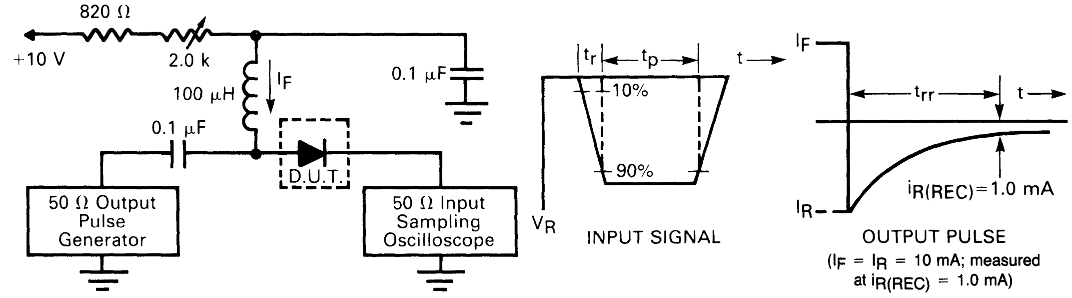
DEVICE MARKING

MMBD6050XL = 5A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc)	I_R	—	0.1	μAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 100 mAdc)	V_F	0.55 0.85	0.7 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	4.0	ns
Capacitance (V_R = 0)	C	—	2.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit



Notes: 1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. $t_p \gg t_{rr}$

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

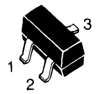
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

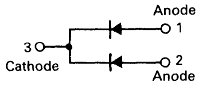
DEVICE MARKING

MMBD6100L = 5B

MMBD6100L

CASE 318-03, STYLE 9
SOT-23 (TO-236AB)



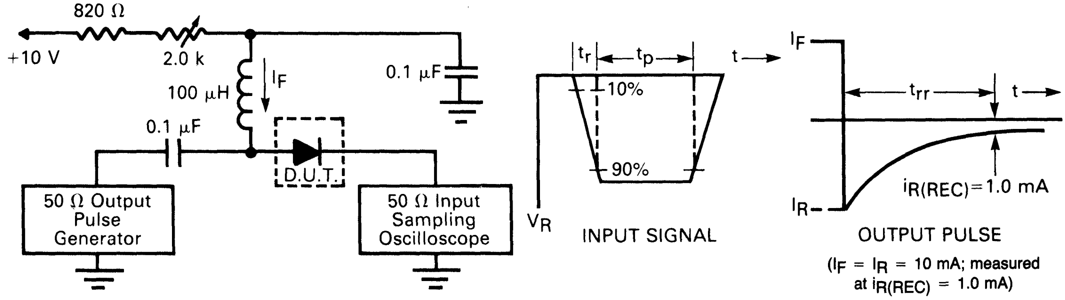


DUAL SWITCHING DIODES

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc)	I_R	—	0.1	μAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.85	 0.7 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc, $i_{R(REC)}$ = 1.0 mAdc) (Figure 1)	t_{rr}	—	15	ns
Capacitance (V_R = 0)	C	—	2.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit



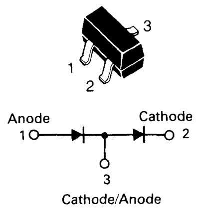
INPUT SIGNAL

OUTPUT PULSE
(I_F = I_R = 10 mA; measured at $i_{R(REC)}$ = 1.0 mA)

Notes:
1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

MMBD7000L

CASE 318-03, STYLE 11
SOT-23 (TO-236AB)



DUAL SWITCHING DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Forward Current	I_F	200	mAdc
Peak Forward Surge Current	$I_{FM(surge)}$	500	mAdc

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

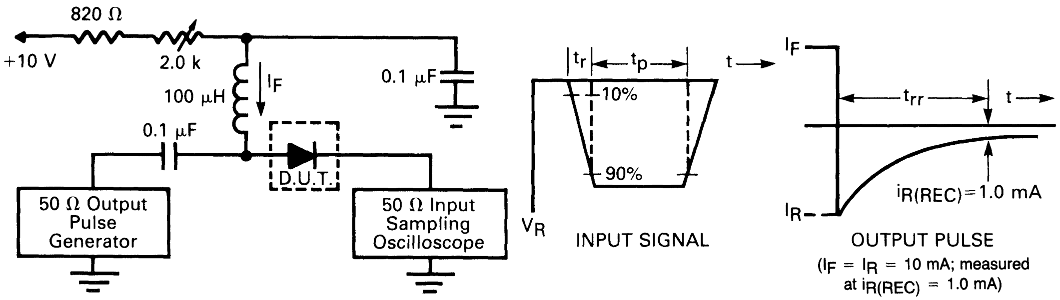
DEVICE MARKING

MMBD7000L = 5C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Reverse Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Voltage Leakage Current (V_R = 50 Vdc) (V_R = 100 Vdc) (V_R = 50 Vdc, 125°C)	 I_R I_{R2} I_{R3}	 — — —	 0.30 0.5 100	μAdc
Forward Voltage (I_F = 1.0 mAdc) (I_F = 10 mAdc) (I_F = 100 mAdc)	V_F	 0.55 0.67 0.75	 0.7 0.82 1.1	Vdc
Reverse Recovery Time (I_F = I_R = 10 mAdc) (Figure 1)	t_{rr}	—	4.0	ns
Capacitance (V_R = 0)	C	—	1.5	pF

FIGURE 1 — Recovery Time Equivalent Test Circuit



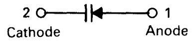
INPUT SIGNAL

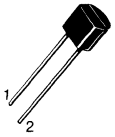
OUTPUT PULSE
(I_F = I_R = 10 mA; measured at $i_{R(REC)}$ = 1.0 mA)

Notes:
1. A 2.0 kΩ variable resistor adjusted for a Forward Current (I_F) of 10 mA.
2. Input pulse is adjusted so $I_{R(peak)}$ is equal to 10 mA.
3. t_p » t_{rr}

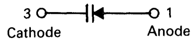
MMBV105GL
MV105G

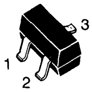
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





30 VOLTS
VOLTAGE VARIABLE
CAPACITANCE DIODES

SILICON EPICAP DIODES

. . . designed in the Surface Mount package for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- Controlled and Uniform Tuning Ratio

MAXIMUM RATINGS

Rating	Symbol	Value MV105G	Value MMBV105G,L	Unit
Reverse Voltage	V_R	30		Volts
Forward Current	I_F	200		mA
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	200 2.0	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBV105GL = 4E

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	Vdc
Reverse Voltage Leakage Current (VR = 28 V)	I_R	—	50	nAdc

Device Type	C_T V_R = 25 Vdc pF		Q f = 100 MHz V_R = 3.0 V	C_3/C_{25}	
	Min	Max	Typ	Min	Max
MMBV105G	1.8	2.8	150	4.0	6.0

FIGURE 1 — DIODE CAPACITANCE

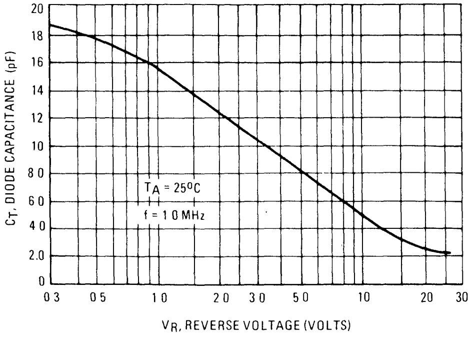


FIGURE 2 — FIGURE OF MERIT

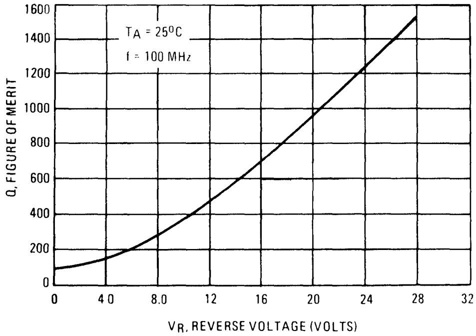
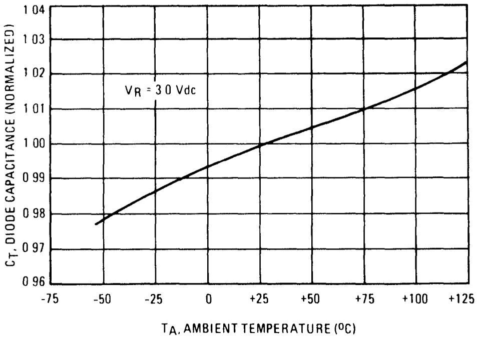


FIGURE 3 — DIODE CAPACITANCE



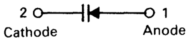
SILICON EPICAP DIODE

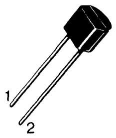
. . . designed for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio
- Available in Surface Mount Package

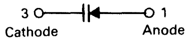
MMBV109L
MV209

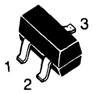
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





26–32 pF
VOLTAGE VARIABLE
CAPACITANCE DIODES

MAXIMUM RATINGS

		MV209	MMBV209,L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	30		Volts
Forward Current	I_F	200		mA
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	200 2.0	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBV109L = 4A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 3.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc f = 50 MHz (Note 1)	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz (Note 2)	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Max**
MMBV109L, MV209	26	29	32	200	5.0	6.5

FIGURE 1 — DIODE CAPACITANCE

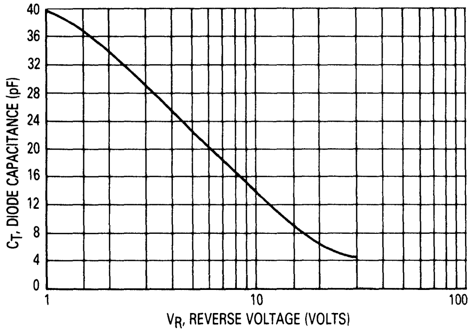


FIGURE 2 — FIGURE OF MERIT

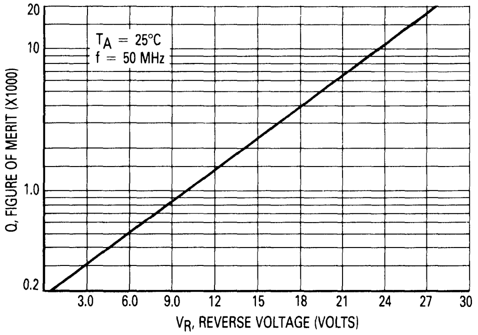


FIGURE 3 — LEAKAGE CURRENT

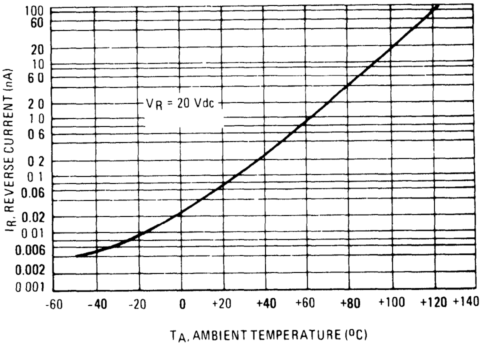
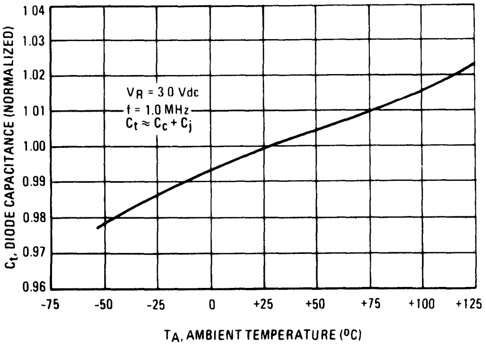


FIGURE 4 — DIODE CAPACITANCE



NOTES ON TESTING AND SPECIFICATIONS

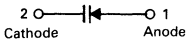
1. Q is calculated by taking the G and C readings of an admittance bridge, such as Boonton Electronics Model 33AS8, at the specified frequency and substituting in the following equation:

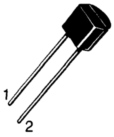
$$Q = \frac{2\pi fC}{G}$$

2. C_R is the ratio of C_t measured at 3.0 Vdc divided by C_t measured at 25 Vdc.

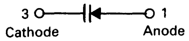
MMBV409L
MV409

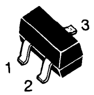
CASE 182-02, STYLE 1
TO-92 (TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





VOLTAGE VARIABLE CAPACITANCE DIODES

MAXIMUM RATINGS

Rating	Symbol	MV409 Value	MMBV409,L Value	Unit
Reverse Voltage	V_R	20		Volts
Forward Current	I_F	200		mA
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	225* 1.8	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

*FR5 Board 1.0 x 0.75 x 0.062 in.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic — All Types	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	20	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 15 Vdc)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 3 Vdc, f = 1 MHz)	TC_C	—	300	—	ppm/°C

	C_t, Diode Capacitance V_R = 3 Vdc, f = 1 MHz pF			Q, Figure of Merit V_R = 3 Vdc f = 50 MHz (Note 1)	C_R, Capacitance Ratio C_3/C_8 f = 1 MHz (Note 2)	
Device	**Min**	**Nom**	**Max**	**Min**	**Min**	**Max**
MMBV409L, MV409	26	29	32	200	1.5	1.9

NOTES ON TESTING AND SPECIFICATIONS

(1) Q is calculated by taking the G and C readings of an admittance bridge, such as Boonton Electronics Model 33AS8, at the specified frequency and substituting in the following equation:

$$Q = \frac{2\pi fC}{G}$$

(2) C_R is the ratio of C_t measured at 3 Vdc divided by C_t measured at 8 Vdc.

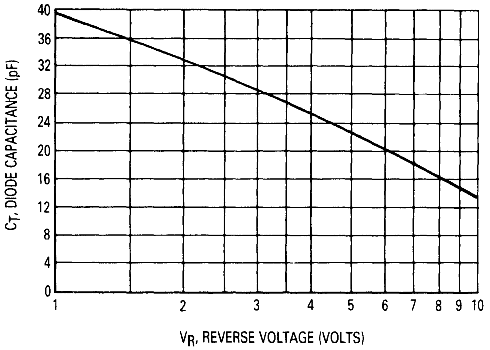


Figure 1. Diode Capacitance

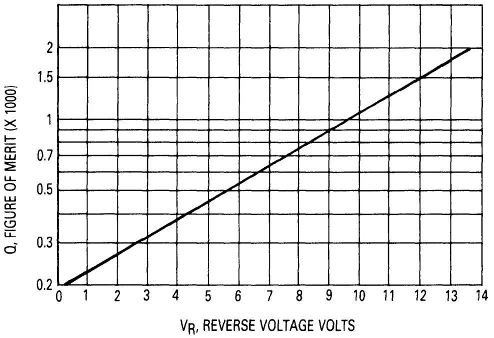


Figure 2. Figure of Merit

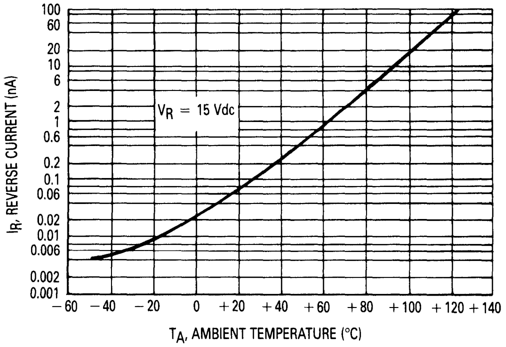


Figure 3. Leakage Current

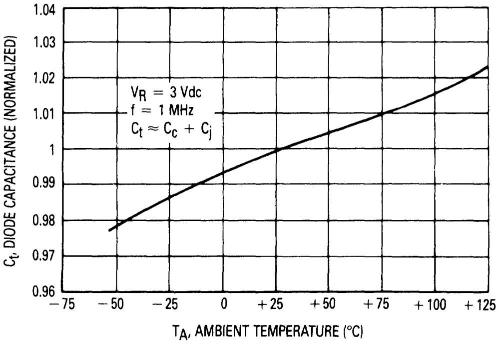


Figure 4. Diode Capacitance

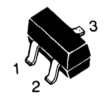
SILICON EPICAP DIODES

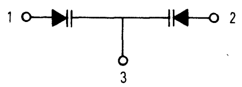
. . . designed for FM tuning, general frequency control and tuning, or any top-of-the-line application requiring back-to-back diode configuration for minimum signal distortion and detuning. This device is supplied in the SOT-23 plastic package for high volume, pick and place assembly requirements.

- High Figure of Merit — Q = 100 (Typ) @ V_R = 2.0 Vdc, f = 100 MHz
- Guaranteed Capacitance Range
- Dual Diodes — Save Space and Reduce Cost
- Surface Mount Package
- Available in 8 mm Tape and Reel
- Monolithic Chip Provides Improved Matching — Guaranteed ±1.0% (Max) Over Specified Tuning Range

MMBV432L

CASE 318-03, STYLE 9
SOT-23 (TO-236AB)





DUAL
VOLTAGE-VARIABLE
CAPACITANCE DIODES

MAXIMUM RATINGS (Each Diode)

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	14	Volts
Forward Current	I_F	200	mA
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−55 to +125	°C

DEVICE MARKING

MMBV432L = 4B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	14	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 9.0 Vdc)	I_R	—	—	100	nAdc
Diode Capacitance (V_R = 2.0 Vdc, f = 1.0 MHz)	C_T	43	—	48.1	pF
Capacitance Ratio C2/C8 (f = 1.0 MHz)	C_R	1.5	—	2.0	—
Figure of Merit* (V_R = 2.0 Vdc, f = 100 MHz)	Q	75	100	—	—

$$* Q = \frac{1}{2 \pi f C_T R_S}$$

TYPICAL CHARACTERISTICS (Each Diode)

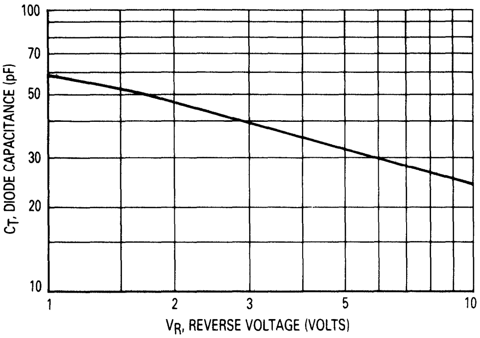


Figure 1. Diode Capacitance (Each Diode)

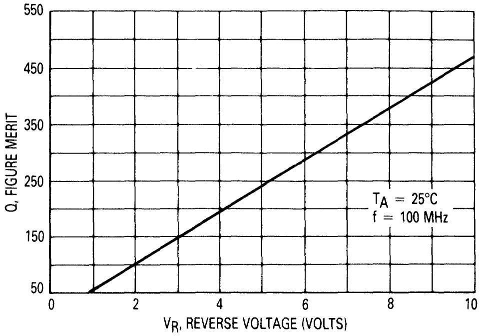


Figure 2. Figure of Merit versus Voltage

TYPICAL CHARACTERISTICS (Each Diode)

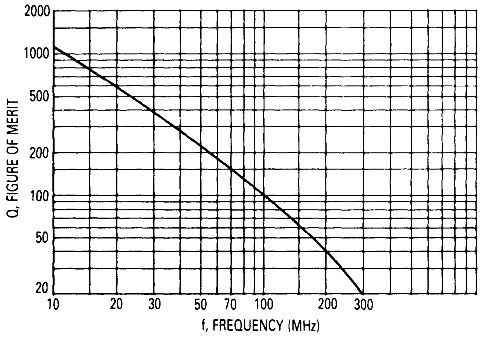


Figure 3. Figure of Merit versus Frequency

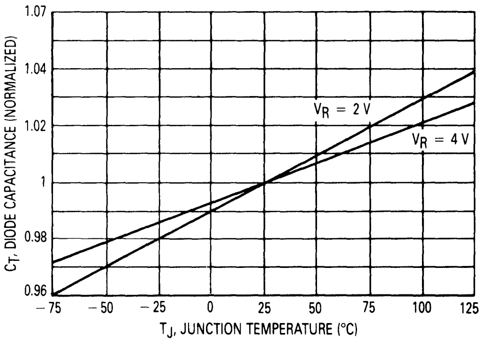


Figure 4. Diode Capacitance versus Temperature

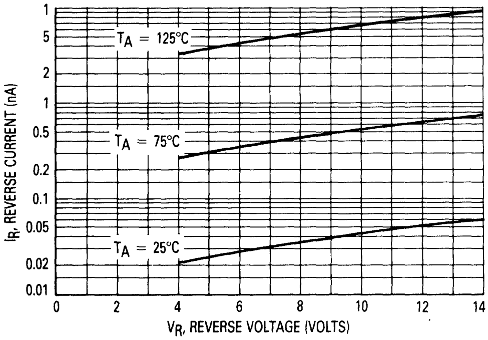


Figure 5. Reverse Current versus Reverse Voltage

SILICON EPICAP DIODES

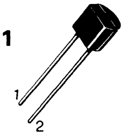
. . . designed in the popular PLASTIC PACKAGE for high volume requirements of FM Radio and TV tuning and AFC, general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

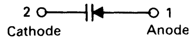
Also available in Surface Mount Package up to 33 pF.

- High Q with Guaranteed Minimum Values
- Controlled and Uniform Tuning Ratio
- Standard Capacitance Tolerance — 10%
- Complete Typical Design Curves

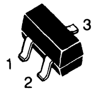
MMBV2101L thru MMBV2109L MV2101 thru MV2115

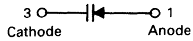
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





6.8–100 pF
30 VOLTS
VOLTAGE-VARIABLE
CAPACITANCE DIODES

MAXIMUM RATINGS

		MV2101 thru MV2115	MMBV2101L thru MMBV2109L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	30		Volts
Forward Current	I_F	200		mA
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	200 2.0	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBV2101L = 4G
MMBV2109L = 4J
MMBV2102L = 4Y
MMBV2103L = 4H
MMBV2104L = 4Z
MMBV2105L = 4U
MMBV2106L = 4V
MMBV2107L = 4W
MMBV2108L = 4X

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	280	—	ppm/°C

	C_T, Diode Capacitance V_R = 4.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 4.0 Vdc, f = 50 MHz	TR, Tuning Ratio C_2/C_{30} f = 1.0 MHz		
Device	**Min**	**Nom**	**Max**	**Typ**	**Min**	**Typ**	**Max**
MMBV2101L/MV2101	6.1	6.8	7.5	450	2.5	2.7	3.2
MMBV2102L/MV2102	7.4	8.2	9.0	450	2.5	2.8	3.2
MMBV2103L/MV2103	9.0	10	11	400	2.5	2.9	3.2
MMBV2104L/MV2104	10.8	12	13.2	400	2.5	2.9	3.2
MMBV2105L/MV2105	13.5	15	16.5	400	2.5	2.9	3.2
MMBV2106L/MV2106	16.2	18	19.8	350	2.5	2.9	3.2
MMBV2107L/MV2107	19.8	22	24.2	350	2.5	2.9	3.2
MMBV2108L/MV2108	24.3	27	29.7	300	2.5	3.0	3.2
MMBV2109L/MV2109	29.7	33	36.3	200	2.5	3.0	3.2
MV2110	35.1	39	42.9	150	2.5	3.0	3.2
MV2111	42.3	47	51.7	150	2.5	3.0	3.2
MV2112	50.4	56	61.6	150	2.6	3.0	3.3
MV2113	61.2	68	74.8	150	2.6	3.0	3.3
MV2114	73.8	82	90.2	100	2.6	3.0	3.3
MV2115	90	100	110	100	2.6	3.0	3.3

PARAMETER TEST METHODS

1. **C_T, DIODE CAPACITANCE**
   ($C_T = C_C + C_J$), C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).

2. **TR, TUNING RATIO**
   TR is the ratio of C_T measured at 2.0 Vdc divided by C_T measured at 30 Vdc.

3. **Q, FIGURE OF MERIT**
   Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equations:

$$Q = \frac{2\pi fC}{G}$$

   (Boonton Electronics Model 33AS8). Use Lead Length ≈ 1/16″.

4. **TC_C, DIODE CAPACITANCE TEMPERATURE COEFFICIENT**
   TC_C is guaranteed by comparing C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = -65°C$ with C_T at $V_R = 4.0$ Vdc, f = 1.0 MHz, $T_A = +85°C$ in the following equation which defines TC_C:

$$TC_C = \frac{C_T(+85°C) - C_T(-65°C)}{85 + 65} \cdot \frac{10^6}{C_R(25°C)}$$

   Accuracy limited by measurement of C_T to ± 0.1 pF.

TYPICAL DEVICE PERFORMANCE

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE

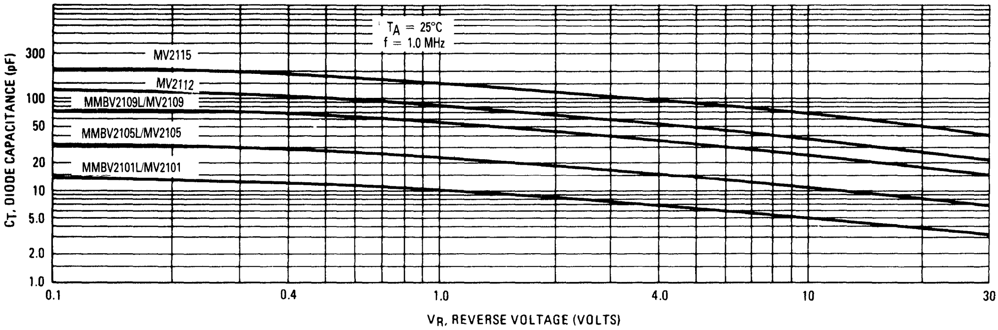


FIGURE 2 — NORMALIZED DIODE CAPACITANCE versus JUNCTION TEMPERATURE

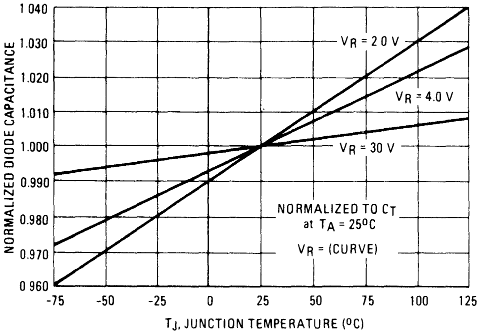


FIGURE 3 — REVERSE CURRENT versus REVERSE BIAS VOLTAGE

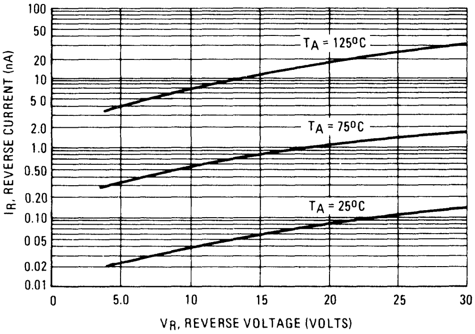


FIGURE 4 — FIGURE OF MERIT versus REVERSE VOLTAGE

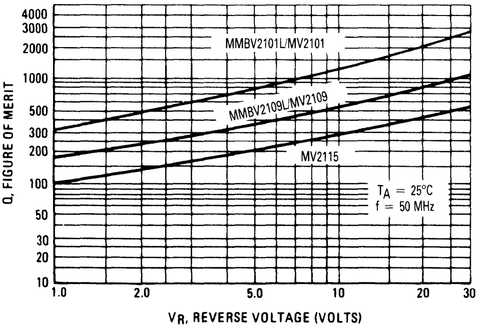
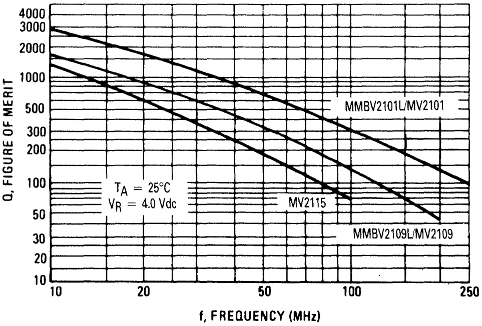


FIGURE 5 — FIGURE OF MERIT versus FREQUENCY



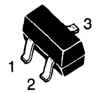
SILICON EPICAP DIODES

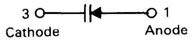
. . . designed in the Surface Mount package for general frequency control and tuning applications; providing solid-state reliability in replacement of mechanical tuning methods.

- High Q with Guaranteed Minimum Values at VHF Frequencies
- Controlled and Uniform Tuning Ratio

MMBV3102L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





22 pF (Nominal)
30 VOLTS
VOLTAGE VARIABLE
CAPACITANCE DIODES

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	30	Vdc
Forward Current	I_F	200	mAdc
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 2.0	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

DEVICE MARKING

MMBV3102L = 4C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	30	—	—	Vdc
Reverse Voltage Leakage Current (V_R = 25 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	300	—	ppm/°C

	C_T, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF			Q, Figure of Merit V_R = 3.0 Vdc, f = 50 MHz	C_R, Capacitance Ratio C_3/C_{25} f = 1.0 MHz	
Device	Min	Nom	Max	Min	Min	Typ
MV3102L	20	22	25	200	4.5	4.8

FIGURE 1 — DIODE CAPACITANCE

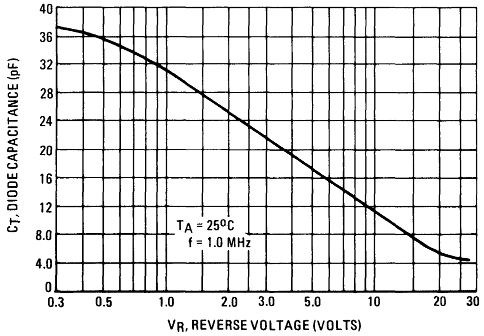


FIGURE 2 — FIGURE OF MERIT

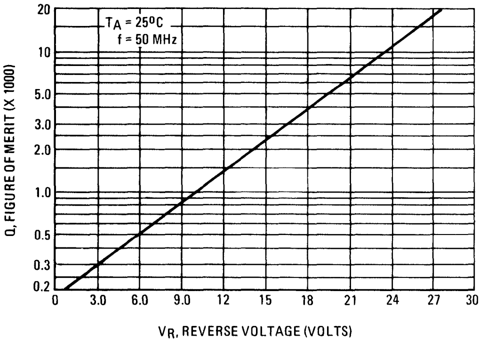


FIGURE 3 — LEAKAGE CURRENT

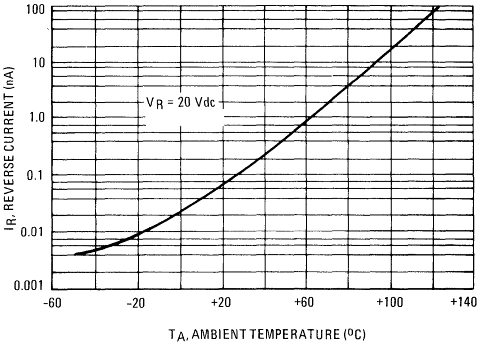
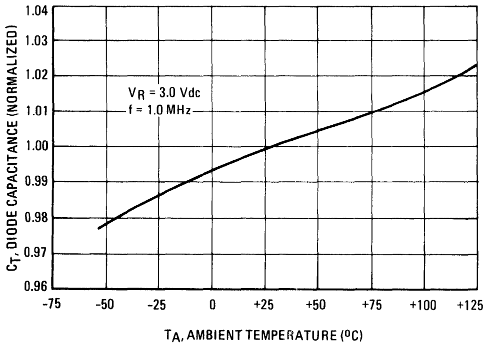


FIGURE 4 — DIODE CAPACITANCE



NOTES ON TESTING AND SPECIFICATIONS

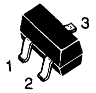
1. L_S is measured on a package having a short instead of a die, using an impedance bridge (Boonton Radio Model 250A RX Meter).
2. C_C is measured on a package without a die, using a capacitance bridge (Boonton Electronics Model 75A or equivalent).
3. Q is calculated by taking the G and C readings of an admittance bridge, such as Boonton Electronics Model 33AS8, at the specified frequency and substituting in the following equation:

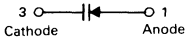
$$Q = \frac{2\pi fC}{G}$$

4. C_R is the ratio of C_T measured at 3.0 Vdc divided by C_T measured at 25 Vdc.

MMBV3401L

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





SILICON PIN SWITCHING DIODE

SILICON PIN DIODE

. . . designed primarily for VHF band switching applications but also suitable for use in general-purpose switching and attenuator circuits. Supplied in a Surface Mount package.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Capacitance — 0.7 pF Typ at $V_R = 20$ V
- Very Low Series Resistance at 100 MHz — 0.34 Ohms (Typ) @ $I_F = 10$ mAdc

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Vdc
Forward Power Dissipation @ $T_A = 25°C$ Derate above 25°C	P_F	200 2.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

DEVICE MARKING

MMBV3401L = 4D

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage ($I_R = 10\ \mu A$)	$V_{(BR)R}$	35	—	—	Volts
Diode Capacitance ($V_R = 20$ V)	C_T	—	—	1.0	pF
Series Resistance (Figure 5) ($I_F = 10$ mA) f = 100 MHz	R_S	—	—	0.7	Ohms
Reverse Leakage Current ($V_R = 25$ V)	I_R	—	—	0.1	μA

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 – SERIES RESISTANCE

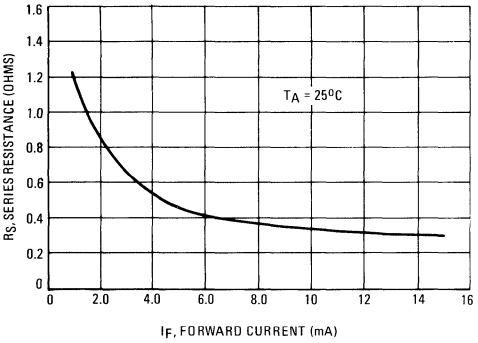


FIGURE 2 – FORWARD VOLTAGE

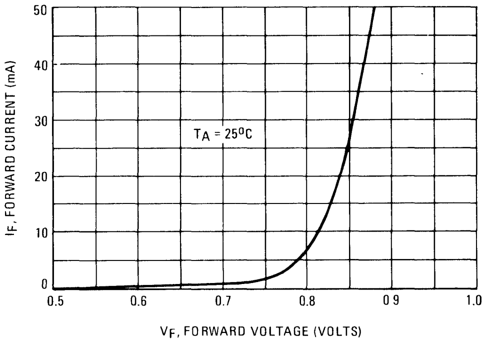


FIGURE 3 — DIODE CAPACITANCE

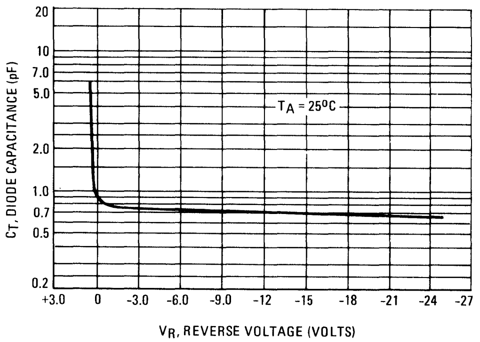


FIGURE 4 — LEAKAGE CURRENT

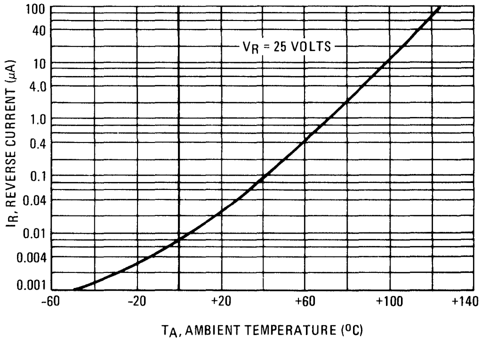
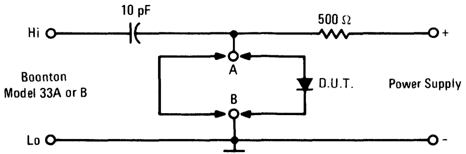


FIGURE 5 — FORWARD SERIES RESISTANCE TEST METHOD



For test fixture, leads should be as short as possible.

All measurements @ 100 MHz

To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

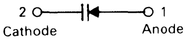
1. The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.
2. Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
3. Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
4. Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
5. Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈ 130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (R_S) can now be calculated from:

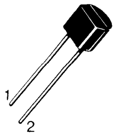
$$R_S = \frac{2.533\,G}{C^2}$$

Where:
G — in micromhos,
C — in pF,
R_S — in ohms

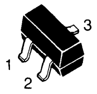
MMBV3700L
MPN3700

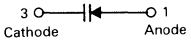
CASE 182-02, STYLE 1
(TO-226AC)





CASE 318-03, STYLE 8
SOT-23 (TO-236AB)





SILICON PIN
SWITCHING DIODES

HIGH VOLTAGE SILICON PIN DIODE

. . . designed primarily for VHF band switching applications but also suitable for use in general-purpose switching and attenuator circuits. Supplied in a cost effective plastic package for economical, high-volume consumer and industrial requirements.

- Long Reverse Recovery Time
  t_{rr} = 300 ns (Typ)
- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz —
  R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Reverse Breakdown Voltage = 200 V (Min)

MAXIMUM RATINGS

		MPN3700	MMBV3700,L	
Rating	**Symbol**	**Value**		**Unit**
Reverse Voltage	V_R	200		Volts
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	280 2.8	200 2.0	mW mW/°C
Junction Temperature	T_J	+125		°C
Storage Temperature Range	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBV3700L = 4R

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	200	—	—	Volts
Diode Capacitance (V_R = 20 Vdc, f = 1.0 MHz)	C_T	—	—	1.0	pF
Series Resistance (Figure 5) (I_F = 10 mA)	R_S	—	0.7	1.0	Ohms
Reverse Leakage Current (V_R = 150 Vdc)	I_R	—	—	0.1	μA
Reverse Recovery Time (I_F = I_R = 10 mA)	t_{rr}	—	300	—	ns

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 — SERIES RESISTANCE

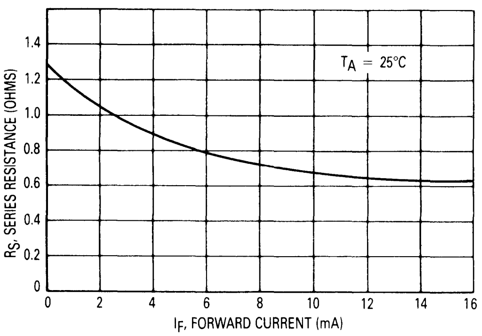


FIGURE 2 — FORWARD VOLTAGE

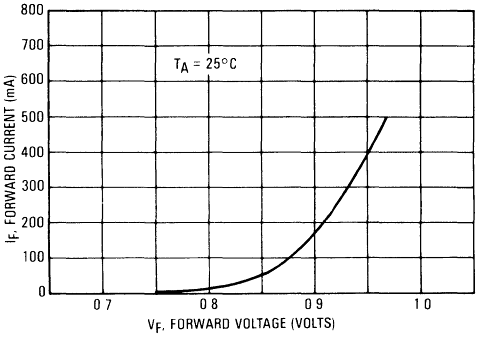


FIGURE 3 — DIODE CAPACITANCE

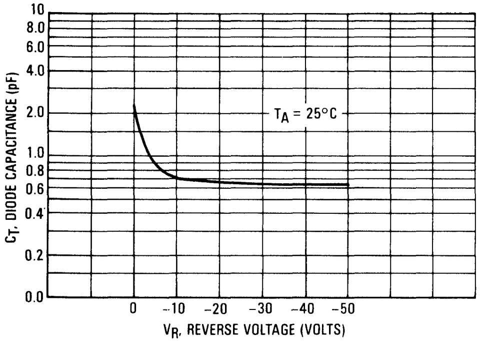


FIGURE 4 — LEAKAGE CURRENT

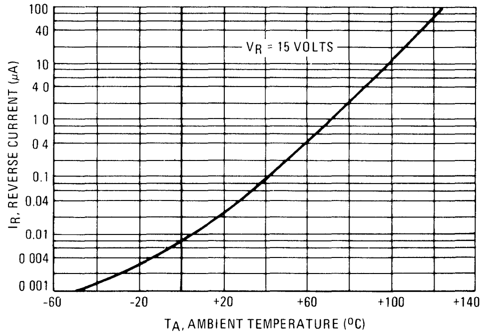
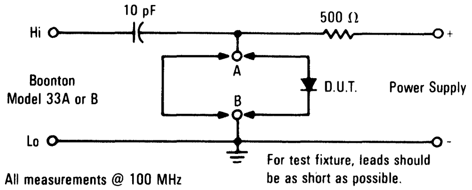


FIGURE 5 — FORWARD SERIES RESISTANCE TEST METHOD



To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

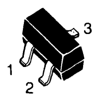
1. The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.
2. Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
3. Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
4. Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
5. Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (R_S) can now be calculated from:

$$R_S = \frac{2.533\,G}{C^2}$$

Where:
G — in micromhos,
C — in pF,
R_S — in ohms

MMBZ5226BL
thru
MMBZ5257BL

CASE 318-03, STYLE 8
SOT-23 (TO-236AB)



ZENER DIODES

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation FR-5 Board,* T_A = 25°C Derate above 25°C	P_D	225 1.8	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	556	°C/W
Total Device Dissipation Alumina Substrate,** T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W
Junction and Storage Temperature	T_J, T_{stg}	−55 to +150	°C

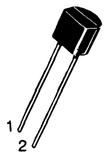
*FR-5 = 1.0 x 0.75 x 0.062 in.
**Alumina = 0.4 x 0.3 x 0.024 in. 99.5% alumina.

Pinout: 1-Anode, 2-NC, 3-Cathode (V_F = 0.9 V Max @ I_F = 10 mA for all types.)

Device	Marking	Test Current I_{ZT} mA	Zener Voltage V_Z (±5%) Nominal	Z_{ZK} I_Z = 0.25 mA Ω Max	Z_{ZT} I_Z = I_{ZT} @ 10% Mod Ω Max	Max I_R µA	@ V_R V
MMBZ5226BL	8A	20	3.3	1600	28	25	1.0
MMBZ5227BL	8B	20	3.6	1700	24	15	1.0
MMBZ5228BL	8C	20	3.9	1900	23	10	1.0
MMBZ5229BL	8D	20	4.3	2000	22	5.0	1.0
MMBZ5230BL	8E	20	4.7	1900	19	5.0	2.0
MMBZ5231BL	8F	20	5.1	1600	17	5.0	2.0
MMBZ5232BL	8G	20	5.6	1600	11	5.0	3.0
MMBZ5233BL	8H	20	6.0	1600	7.0	5.0	3.5
MMBZ5234BL	8J	20	6.2	1000	7.0	5.0	4.0
MMBZ5235BL	8K	20	6.8	750	5.0	3.0	5.0
MMBZ5236BL	8L	20	7.5	500	6.0	3.0	6.0
MMBZ5237BL	8M	20	8.2	500	8.0	3.0	6.5
MMBZ5238BL	8N	20	8.7	600	8.0	3.0	6.5
MMBZ5239BL	8P	20	9.1	600	10	3.0	7.0
MMBZ5240BL	8Q	20	10	600	17	3.0	8.0
MMBZ5241BL	8R	20	11	600	22	2.0	8.4
MMBZ5242BL	8S	20	12	600	30	1.0	9.1
MMBZ5243BL	8T	9.5	13	600	13	0.5	9.9
MMBZ5244BL	8U	9.0	14	600	15	0.1	10
MMBZ5245BL	8V	8.5	15	600	16	0.1	11
MMBZ5246BL	8W	7.8	16	600	17	0.1	12
MMBZ5247BL	8X	7.4	17	600	19	0.1	13
MMBZ5248BL	8Y	7.0	18	600	21	0.1	14
MMBZ5249BL	8Z	6.6	19	600	23	0.1	14
MMBZ5250BL	81A	6.2	20	600	25	0.1	15
MMBZ5251BL	81B	5.6	22	600	29	0.1	17
MMBZ5252BL	81C	5.2	24	600	33	0.1	18
MMBZ5253BL	81D	5.0	25	600	35	0.1	19
MMBZ5254BL	81E	4.6	27	600	41	0.1	21
MMBZ5255BL	81F	4.5	28	600	44	0.1	21
MMBZ5256BL	81G	4.2	30	600	49	0.1	23
MMBZ5257BL	81H	3.8	33	700	58	0.1	25

MPN3404

CASE 182-02, STYLE 1
(TO-226AC)



SILICON PIN SWITCHING DIODE

SILICON PIN DIODE

. . . designed primarily for VHF band switching applications but also suitable for use in general-purpose switching and attenuator circuits. Supplied in a cost effective TO-92 type plastic package for economical, high-volume consumer and industrial requirements.

- Rugged PIN Structure Coupled with Wirebond Construction for Optimum Reliability
- Low Series Resistance @ 100 MHz —
  R_S = 0.7 Ohms (Typ) @ I_F = 10 mAdc
- Sturdy TO-92 Style Package for Handling Ease

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	20	Volts
Forward Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	400 4.0	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μA)	$V_{(BR)R}$	20	—	—	Volts
Diode Capacitance (V_R = 15 Vdc, f = 1.0 MHz)	C_T	—	1.3	2.0	pF
Series Resistance (Figure 5) (I_F = 10 mA)	R_S	—	0.7	0.85	Ohms
Reverse Leakage Current (V_R = 15 Vdc)	I_R	—	—	0.1	μA

TYPICAL ELECTRICAL CHARACTERISTICS

FIGURE 1 – SERIES RESISTANCE

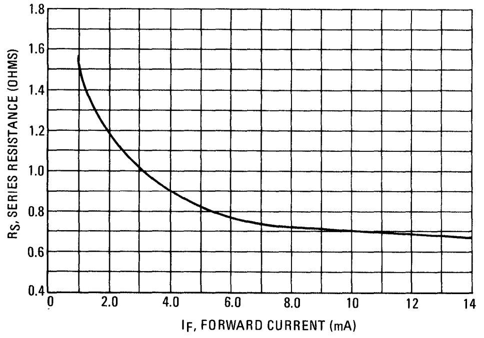


FIGURE 2 – FORWARD VOLTAGE

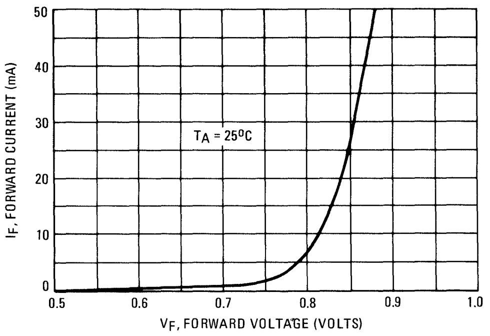


FIGURE 3 — DIODE CAPACITANCE

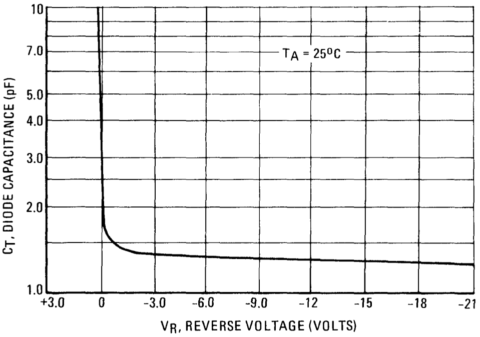


FIGURE 4 — LEAKAGE CURRENT

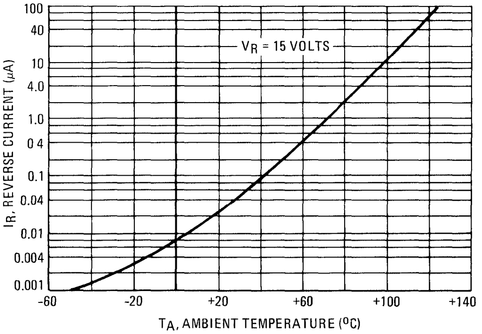
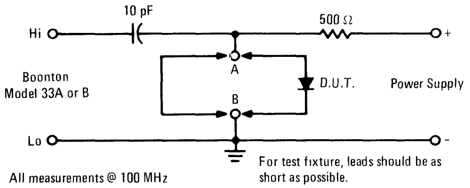


FIGURE 5 — FORWARD SERIES RESISTANCE TEST METHOD



For test fixture, leads should be as short as possible.

All measurements @ 100 MHz

To measure series resistance, a 10 pF capacitor is used to reduce the forward capacitance of the circuit and to prevent shorting of the external power supply through the bridge. The small signal from the bridge is prevented from shorting through the power supply by the 500-ohm resistor. The resistance of the 10 pF capacitor can be considered negligible for this measurement.

1. The RF Admittance Bridge (Boonton 33A or B) must be initially balanced, with the test circuit connected to the bridge test terminals. The conductance scale will be set at zero and the capacitance scale will be set at 120 pF, as required when using the 100 MHz test coil.
2. Use a short length of wire to short the test circuit from point "A" to "B". Then connect the power supply providing 10 mA of bias current to the test circuit.
3. Adjust the capacitance scale arm of the bridge and the "G" zero control for a minimum null on the "null meter". The null occurs at approximately 130 pF.
4. Replace the wire short with the device to be tested. Bias the device to a forward conductance state of 10 mA.
5. Obtain a minimum null on the "null meter", with the capacitance and conductance scale adjustment arms.
6. Read conductance (G) direct from the scale. Now read the capacitance value from the scale (≈ 130 pF) and subtract 120 pF which yields capacitance (C). The forward resistance (R_S) can now be calculated from:

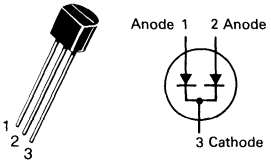
$$R_S = \frac{2.533\,G}{C^2}$$

Where:
G — in micromhos,
C — in pF,
R_S - in ohms

MPN3700 For Specifications, See MMBV3700

MSD6100X

CASE 29-04, STYLE 3
TO-92 (TO-226AA)



DUAL SWITCHING DIODES COMMON CATHODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	100	Vdc
Recurrent Peak Forward Current	I_F	200	mA
Peak Forward Surge Current (Pulse Width = 10 μsec)	$I_{FM(surge)}$	500	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D(1)	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}(1)	−55 to +135	°C

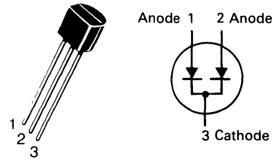
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	100	—	Vdc
Reverse Current	I_R			μAdc
(V_R = 100 Vdc)		—	5.0	
(V_R = 50 Vdc)		—	0.1	
(V_R = 50 Vdc, T_A = 125°C)		—	20	
Forward Voltage	V_F			Vdc
(I_F = 1.0 mAdc)		0.55	0.7	
(I_F = 10 mAdc)		0.67	0.82	
(I_F = 100 mAdc)		0.75	1.1	
Capacitance (V_R = 0)	C	—	1.5	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, i_{rr} = 1.0 mAdc)	t_{rr}	—	15	ns

(1) Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 25°C — 8.0 mW/°C, T_J = −65 to +150°C, θ_{JC} = 125°C/W.

MSD6102

CASE 29-04, STYLE 3
TO-92 (TO-226AA)



DUAL DIODES COMMON CATHODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Recurrent Peak Forward Current	I_F	200	mA
Peak Forward Surge Current (Pulse Width = 10 μs)	$I_{FM(surge)}$	500	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D(1)	625 5.0	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}(1)	−55 to +135	°C

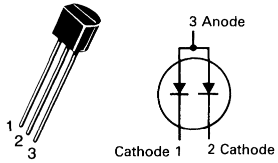
(1) Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 25°C — 8.0 mW/°C, T_J = −65 to +150°C, θ_{JC} = 125°C/W.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	Vdc
Reverse Current (V_R = 50 Vdc)	I_R	—	0.1	μAdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	1.0	Vdc
Capacitance (V_R = 0)	C	—	3.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, i_{rr} = 1.0 mAdc)	t_{rr}	—	100	ns

MSD6150

CASE 29-04, STYLE 4
TO-92 (TO-226AA)



DUAL DIODES COMMON ANODE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Reverse Voltage	V_R	70	Vdc
Peak Forward Recurrent Current	I_F	200	mA
Peak Forward Surge Current (Pulse Width = 10 μs)	$I_{FM(surge)}$	500	mA
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D(1)	625 5.0	mW mW°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}(1)	−55 to +135	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
Breakdown Voltage ($I_{(BR)}$ = 100 μAdc)	$V_{(BR)}$	70	—	—	Vdc
Reverse Current (V_R = 50 Vdc)	I_R	—	—	0.1	μAdc
Forward Voltage (I_F = 10 mAdc)	V_F	—	0.80	1.0	Vdc
Capacitance (V_R = 0)	C	—	5.0	8.0	pF
Reverse Recovery Time (I_F = I_R = 10 mAdc, V_R = 5.0 Vdc, i_{rr} = 1.0 mAdc)	t_{rr}	—	—	100	ns

(1) Continuous package improvements have enhanced these guaranteed Maximum Ratings as follows: P_D = 1.0 W @ T_C = 25°C, Derate above 8.0 mW/°C, P_D = 10 W @ T_C = 25°C, Derate above 80 mW/°C, T_J, T_{stg} = −55 to +150°, θ_{JC} = 12.5°C/W, θ_{JA} = 125°C.

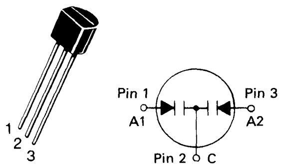
SILICON EPICAP DIODES

. . . designed for FM tuning, general frequency control and tuning, or any top-of-the-line application requiring back-to-back diode configurations for minimum signal distortion and detuning. This device is supplied in the popular TO-92 plastic package for high volume, economical requirements of consumer and industrial applications.

- High Figure of Merit —
  Q = 140 (Typ) @ V_R = 3.0 Vdc, f = 100 MHz
- Guaranteed Capacitance Range
  37–42 pF @ V_R = 3.0 Vdc (MV104)
- Dual Diodes — Save Space and Reduce Cost
- TO-92 Package for Easy Handling and Mounting
- Monolithic Chip Provides Near Perfect Matching — Guaranteed ±1% (Max) Over Specified Tuning Range

MV104

CASE 29-04, STYLE 15
(TO-226AA)



DUAL
VOLTAGE-VARIABLE
CAPACITANCE DIODES

MAXIMUM RATINGS (Each Device)

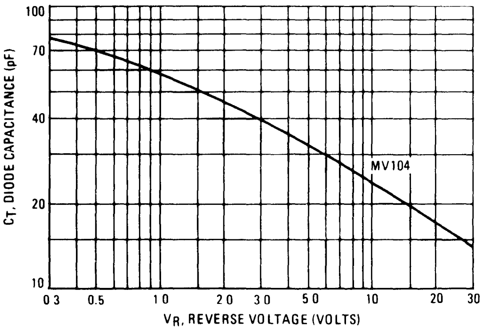
Rating	Symbol	Value	Unit
Reverse Voltage	V_R	32	Volts
Forward Current	I_F	200	mA
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_F	280 2.8	mW mW/°C
Junction Temperature	T_J	+125	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	32	—	—	Vdc
Reverse Voltage Leakage Current T_A = 25°C (V_R = 30 Vdc) T_A = 60°C	I_R	— —	— —	50 500	nAdc
Diode Capacitance Temperature Coefficient (V_R = 4.0 Vdc, f = 1.0 MHz)	TC_C	—	280	400	ppm/°C

	C_T, Diode Capacitance V_R = 3.0 Vdc, f = 1.0 MHz pF		***Q, Figure of Merit V_R = 3.0 Vdc f = 100 MHz**		**C_R, Capacitance Ratio C_3/C_{30} f = 1.0 MHz**	
Device	**Min**	**Max**	**Min**	**Typ**	**Min**	**Max**
MV104	37	42	100	140	2.5	2.8

FIGURE 1 — DIODE CAPACITANCE (Each Device)



TYPICAL CHARACTERISTICS (Each Device)

FIGURE 2 – FIGURE OF MERIT versus VOLTAGE

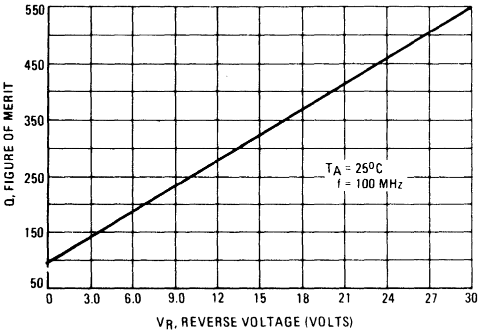


FIGURE 3 – FIGURE OF MERIT versus FREQUENCY

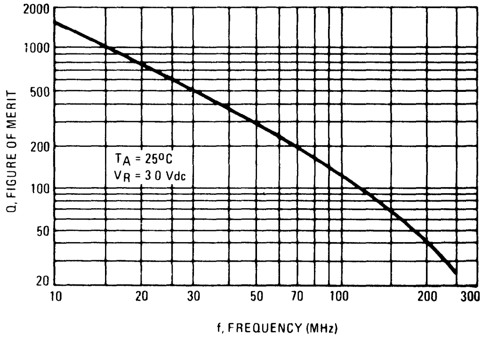


FIGURE 4 – DIODE CAPACITANCE versus TEMPERATURE

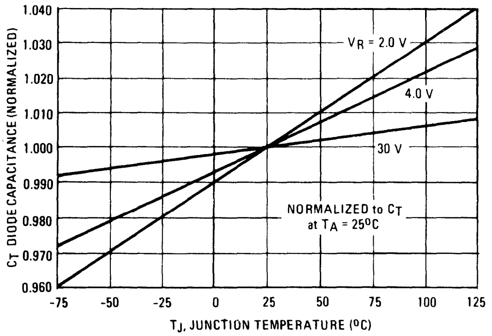
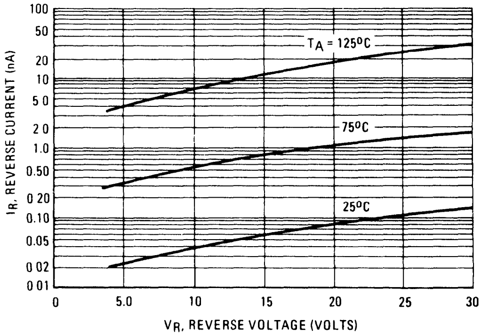


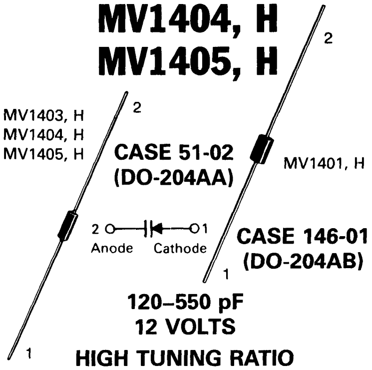
FIGURE 5 – REVERSE CURRENT versus REVERSE VOLTAGE



MV105G For Specifications, See MMBV109L

MV409 For Specifications, See MMBV409L

MV1401, H
MV1403, H
MV1404, H
MV1405, H



120–550 pF
12 VOLTS

HIGH TUNING RATIO VOLTAGE-VARIABLE CAPACITANCE DIODES

SILICON HYPER-ABRUPT TUNING DIODES

. . . designed with high capacitance and a capacitance change of greater than TEN TIMES for a bias change from 2.0 to 10 volts. Provides tuning over broad frequency ranges; tunes AM radio broadcast band, general AFC and tuning applications in lower RF frequencies.

- High Capacitance: 120–550 pF
- Large Capacitance Change with Small Bias Change
- Guaranteed High Q
- Available in Standard Axial Glass Packages
- H Suffix Devices with 100% Screening

MAXIMUM RATINGS

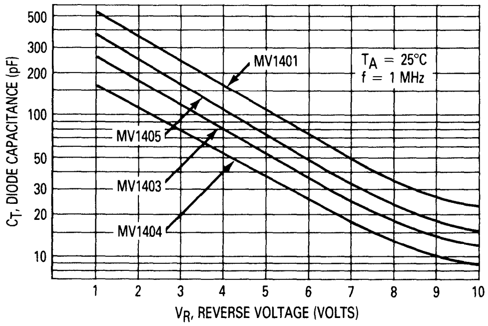
Rating	Symbol	Value	Unit
Reverse Voltage	V_R	12	Volts
Forward Current	I_F	250	mA
Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.67	mW mW/°C
Junction Temperature	T_J	+175	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Reverse Breakdown Voltage (I_R = 10 μAdc)	$V_{(BR)R}$	12	—	—	Vdc
Leakage Current at Reverse Voltage (V_R = 10 Vdc, T_A = 25°C)	I_R	—	—	0.1	μAdc
Series Inductance (f = 250 MHz, Lead Length ≈ 1/16″)	L_S	—	5.0	—	nH
Case Capacitance (f = 1.0 MHz, Lead Length ≈ 1/16″)	C_C	—	0.25	—	pF

	C_T, Diode Capacitance						Q, Figure of Merit	TR, Tuning Ratio	
	V_R = 1.0 Vdc, f = 1.0 MHz pF			V_R = 2.0 Vdc, f = 1.0 MHz pF			V_R = 2.0 Vdc, f = 1.0 MHz	C_1/C_{10} f = 1.0 MHz	C_2/C_{10} f = 1.0 MHz
Device	Min	Nom	Max	Min	Nom	Max	Min	Min	Min
MV1401, H	468	550	633	—	—	—	200	14	—
MV1403, H	—	—	—	140	175	210	200	—	10
MV1404, H	—	—	—	96	120	144	200	—	10
MV1405, H	—	—	—	200	250	300	200	—	10

FIGURE 1 — DIODE CAPACITANCE versus REVERSE VOLTAGE



100% SCREENING FOR HIGH RELIABILITY

MV1401H, MV1403H, MV1404H, MV1405H are screened with the following tests:

Internal Visual Inspection
per 12M53957B (MIL-STD-750 METHOD 2073 PARAGRAPH 3.3 AND METHOD 2074 PARAGRAPH 3.1.3)

High Temperature Storage
$T_A = 200°C$, $t \geqslant 48$ hours

Thermal Shock (Temperature Cycling)
MIL-STD-202, Method 107, Condition C except 10 cycles continuously performed
t(extremes) = 15 minutes

Constant Acceleration
MIL-STD-750, Method 2006
20,000 G's (Y1 axis only)

Hermetic Seal
MIL-STD-750, Method 1071
Fine Leak - Condition G
Gross Leak - Condition D, Step 1

Electrical Test
I_R and C_T

High Temperature Reverse Bias
$T_A = 120°C \pm 5°C$, $t \geqslant 96$ hours
$V_R = 80\%$ of $V_{(BR)R}$ MIN
Lower temperature till $T_A = 30 \pm 5°C$.
Maintain this temperature prior to removal of Reverse Bias Voltage. Perform Electrical Test within 24 hours following bias removal.

Electrical Test
I_R and C_T

PARAMETER TEST METHODS

1. **L_S, SERIES INDUCTANCE**
   L_S is measured on a shorted package at 250 MHz using an impedance bridge (Boonton Radio Model 250A RX Meter).
2. **C_C, CASE CAPACITANCE**
   C_C is measured on an open package at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).
3. **C_T, DIODE CAPACITANCE**
   ($C_T = C_C + C_J$) C_T is measured at 1.0 MHz using a capacitance bridge (Boonton Electronics Model 75A or equivalent).
4. **TR, TUNING RATIO**
   TR is the ratio of C_T measured at 2.0 Vdc (1.0 Vdc for MV1401) divided by C_T measured at 10 Vdc.
5. **Q, FIGURE OF MERIT**
   Q is calculated by taking the G and C readings of an admittance bridge at the specified frequency and substituting in the following equation:

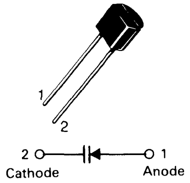
$$Q = \frac{2\pi fC}{G}$$

(Boonton Electronics Model 33AS8). Use Lead Length ≈ 1/16″.

MV2101 thru MV2115 For Specifications, See MMBV2101L

MVAM108
MVAM109
MVAM115
MVAM125

CASE 182-02, STYLE 1
(TO-226AC)



TUNING DIODES
WITH VERY HIGH
CAPACITANCE RATIO

SILICON TUNING DIODES

. . . designed for electronic tuning of AM receivers and high capacitance, high tuning ratio applications.

- High Capacitance Ratio — C_R = 15 (Min), MVAM108, 115, 125
- Guaranteed Diode Capacitance — C_t = 440 pF (Min) — 560 pF (Max) @ V_R = 1.0 VDc, f = 1.0 MHz, MVAM108, MVAM115, MVAM125
- Guaranteed Figure of Merit — Q = 150 (Min) @ V_R = 1.0 Vdc, f = 1.0 MHz

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Reverse Voltage	MVAM108	V_R	12	Volts
	MVAM109		15	
	MVAM115		18	
	MVAM125		28	
Forward Current		I_F	50	mA
Power Dissipation @ T_A = 25°C		P_D	280	mW
Derate above 25°C			2.8	mW/°C
Operating and Storage Junction Temperature Range		T_J, T_{stg}	−55 to +125	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted, Each Device)

Characteristic		Symbol	Min	Typ	Max	Unit
Breakdown Voltage		$V_{(BR)R}$				Vdc
(I_R = 10 μAdc)	MVAM108		12	—	—	
	MVAM109		15	—	—	
	MVAM115		18	—	—	
	MVAM125		28	—	—	
Reverse Current		I_R				nAdc
(V_R = 8.0 V)	MVAM108		—	—	100	
(V_R = 9.0 V)	MVAM109		—	—	100	
(V_R = 15 V)	MVAM115		—	—	100	
(V_R = 25 V)	MVAM125		—	—	100	
Diode Capacitance Temperatujre Coefficient (1) (V_R = 1.0 Vdc, f = 1.0 MHz, T_A = −40°C to +85°C)		TC_C	—	435	—	ppm/°C
Case Capacitance (f = 1.0 MHz, Lead Length 1/16″)		C_C	—	0.18	—	pF
Diode Capacitance (2)		C_t				pF
(V_R = 1.0 Vdc, f = 1.0 MHz)	MVAM108, 115, 125		440	500	560	
	MVAM109		400	460	520	
Figure of Merit (f = 1.0 MHz, Lead Length 1/16″, V_R = 1.0 Vdc)		Q	150	—	—	—
Capacitance Ratio						—
(f = 1.0 MHz)	MVAM108	C1/C8	15	—	—	
	MVAM109	C1/C9	12	—	—	
	MVAM115	C1/C15	15	—	—	
	MVAM125	C1/C25	15	—	—	

NOTES:

1. The effect of increasing temperature 1.0°C, at any operating point, is equivalent to lowering the effective tuning voltage 1.25 mV. The percent change of capacitance per °C is nearly constant from −40°C to +100°C.
2. Upon request, diodes are available in matched sets. All diodes in a set can be matched for capacitance to 3% or 2.0 pF (whichever is greater) at all points along the specified tuning range.

FIGURE 1 — TYPICAL AM RADIO APPLICATION

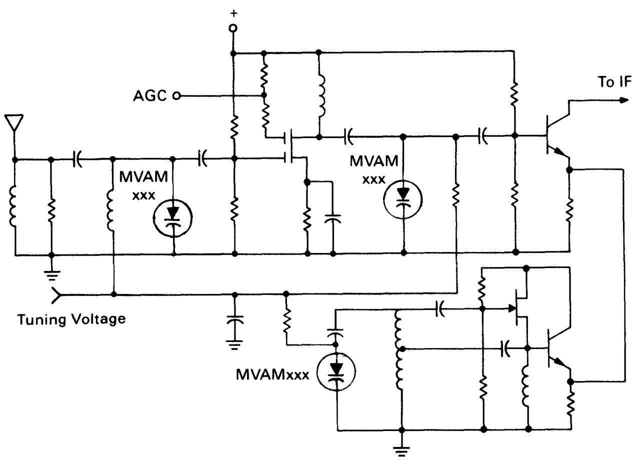


FIGURE 2 – CAPACITANCE versus REVERSE VOLTAGE

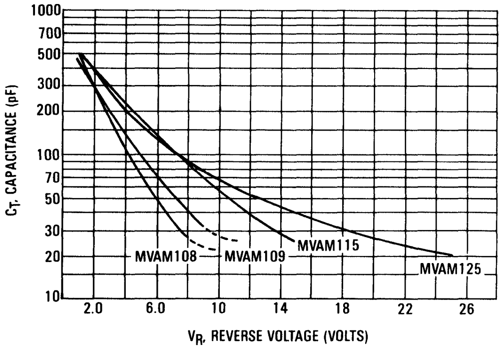
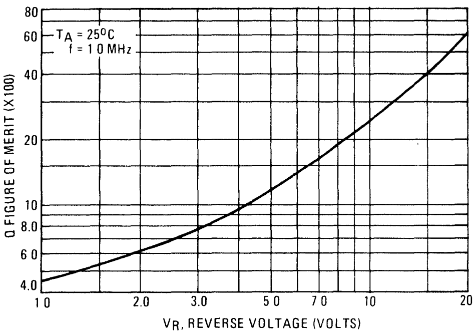
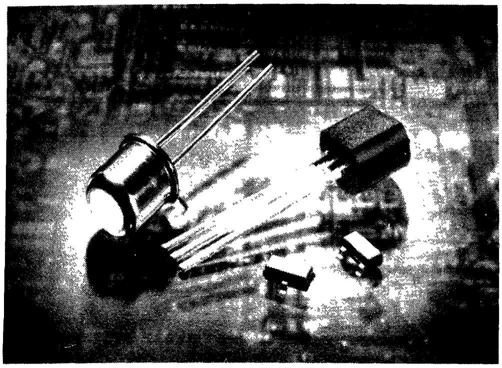


FIGURE 3 – FIGURE OF MERIT





Tape and Reel Specifications

6

Embossed Tape and Reel

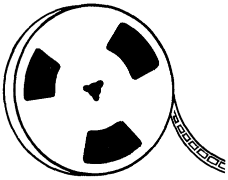
Embossed Tape and Reel is used to facilitate automatic pick and place equipment feed requirements. The tape is used as the shipping container for various products and requires a minimum of handling. The antistatic/conductive tape provides a secure cavity for the product when sealed with the "peel-back" cover tape.

- Two Reel Sizes Available (7″ and 13″)
- Used For Automatic Pick and Place Feed Systems
- Minimizes Product Handling
- EIA 481
- MLL-34, SOT-23, SOT-143 in 8 mm Tape
- MLL-41, SO-8, SOT-89, SOT-223 in 12 mm Tape
- DPAK, SO-14, SO-16 in 16 mm Tape

Ordering Information

Use the standard device title and add the required suffix as listed in the option table below. Note that the individual reels have a finite number of devices depending on the type of product contained in the tape. Also note the minimum lot size is one full reel for each line item, and orders are required to be in increments of the single reel quantity. Minimum order $200.00/line-line.

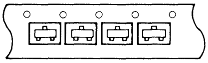
Tape and Reel Data for Discrete Surface Mount Devices



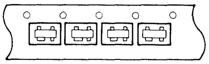
PACKAGES

MLL-34 SO-8
MLL-41 SO-14
SOT-23 SO-16
SOT-143 DPAK

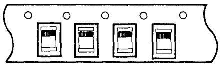
SOT-23
8 mm



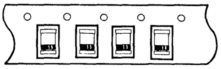
SOT-143
8 mm



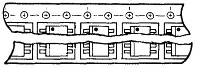
MLL-34
8 mm



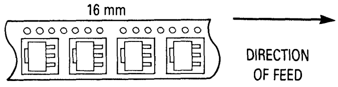
MLL-41
12 mm



SO-8, 14, 16
12, 16 mm



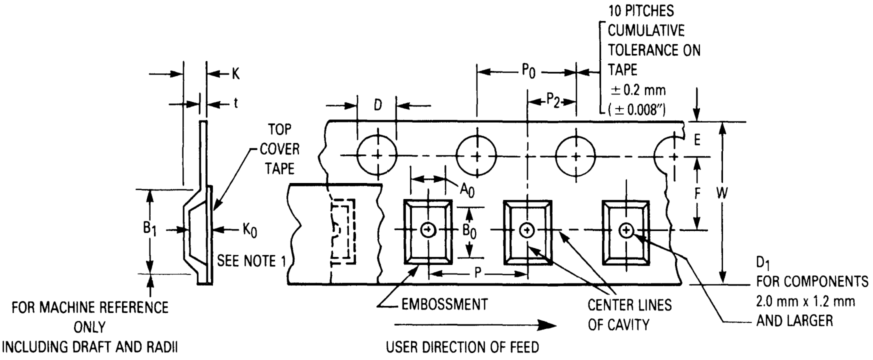
DPAK
16 mm

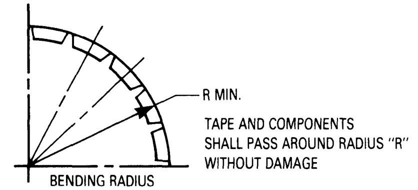


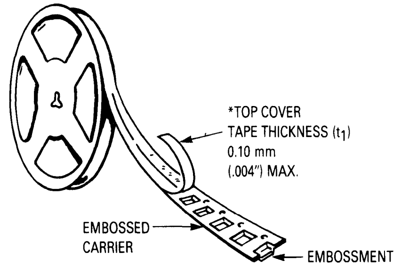
Package	Tape Width (mm)	Device per Reel	Reel Size (inch)	Tape & Reel Lot Size (Min)	Device Suffix
SOT-23	8 8	3,000 10,000	7 13	3,000 10,000	T1 T3
SOT-143	8 8	3,000 10,000	7 13	3,000 10,000	T1 T3
MLL-34	8 8	2,000 5,000	7 13	2,000 5,000	T1 T3
MLL-41	12 12	1,000 5,000	7 13	1,000 5,000	T1 T3
SO-8	12 12	500 2,500	7 13	500 2,500	R1 R2
SOT-89	12	1K 4K	7 13	1K 4K	T1 T3
SOT-223	12	1K 4K	7 13	1K 4K	— —
SO-14	16 16	500 2,500	7 13	500 2,500	R1 R2
SO-16	16 16	500 2,500	7 13	500 2,500	R1 R2
DPAK	16	1,800	13	1,800	RL

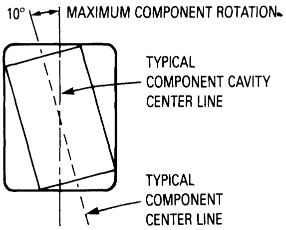
TAPE AND REEL DATA FOR DISCRETE SMD

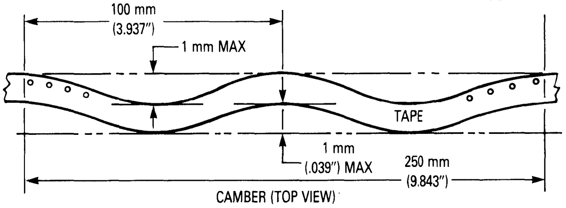
CARRIER TAPE SPECIFICATIONS











CAMBER (TOP VIEW)

ALLOWABLE CAMBER TO BE 1 mm/100 mm NONACCUMULATIVE OVER 250 mm

DIMENSIONS

Tape Size	B_1 Max	D	D_1	E	F	K	P	P_0	P_2	R Min	T Max	W
8 mm	4.2 mm (.165")	1.5 + 0.1 mm − 0.0 (.059 + .004" − 0.0)	1.0 ± 0.1 mm Min (.039")	1.75 ± 0.1 mm (.069 ± .004")	3.5 ± 0.05 mm (.138 ± .002")	2.4 mm Max (.094")	4.0 ± 0.1 mm (.157 ± .004")	4.0 ± 0.1 mm (.157 ± .004")	2.0 ± 0.1 mm (.079 ± .002")	25 mm (.98")	0.400 mm (.016")	8.0 ± .30 mm (.315 ± .012")
12 mm	8.2 mm (.323")		1.5 mm Min (.060")		5.0 ± 0.05 mm (217 ± .002")	4.5 mm Max (.177")	4.0 ± 0.1 mm (.157 ± .004") 8.0 ± .01 mm (.315 ± .004")			25 mm (1.18")		12 ± .30 mm (.470 ± .012")
16 mm	12.1 mm (.476")				7.5 ± 0.10 mm (.295 ± .004")	6.5 mm (.256")	4.0 ± 0.1 mm (.157 ± .004") 8.0 ± .01 mm (.315 ± .004") 12.0 ± .004 mm (.472 ± .004")		2.0 ± .010 mm (.079 ± .004")	40 mm (1.575")		16 ± .30 mm (.630 ± .012")

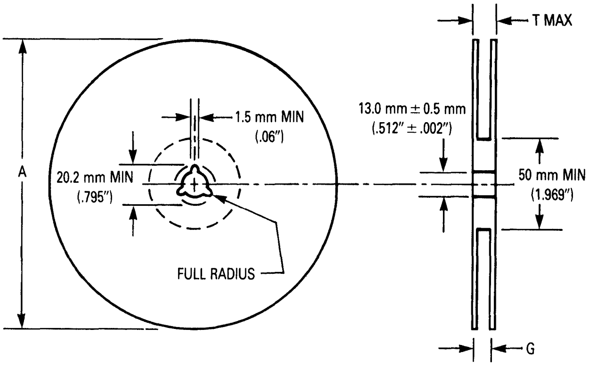
Metric Dimensions Govern — English are in parentheses for reference only.

NOTE 1: A_0, B_0, and K_0 are determined by component size. The clearance between the components and the cavity must be within .05 min. to .50 max., the component cannot rotate more than 10° within the determined cavity.

TAPE AND REEL DATA FOR DISCRETE SMD

REEL DIMENSIONS

Metric Dimensions Govern — English are in Parentheses for Reference only.



Size	A Max	G	T Max
8 mm	330 mm (12.992")	8.4 mm + 1.5 mm, −0.0 (.33" + .059", −0.00)	14.4 mm (.56")
12 mm	330 mm (12.992")	12.4 mm + 2.0 mm, −0.0 (.49" + .079", −0.00)	18.4 mm (.72")
16 mm	360 mm (14.173")	16.4 mm + 2.0 mm, −0.00 (.646" + .078", −0.00)	22.4 mm (.882")

TO-92 EIA Radial Tape Reel or Ammo Pack

Radial tape reel and ammo pack of the reliable TO-92 package are the best methods of capturing devices for automatic insertion in printed circuit boards. These methods of taping are compatible with various equipment for active and passive component insertion.

- Available on 360 mm Reels
- Available in Ammo Pack (Fan Fold Box)
- Accommodates Various Inserters
- Allows Flexible Circuit Board Layout
- 2.5 mm Pin Spacing For Soldering
- Conforms to EIA ACP Standard 1375 (RS-468)

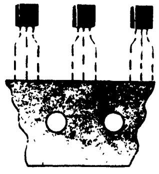
Ordering Notes:

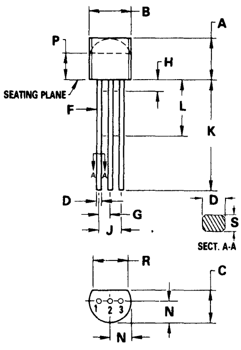
When ordering radial tape on reel or in ammo pack, specify the style per Figures 3 thru 8. Add the suffix "RLR" and "Style" to the device title, i.e. MPS3904RLRA. This will be a standard MPS3904 radial taped and supplied on a reel per Figure 3.

Reel Information — Minimum order quantity 1 Reel/$200LL.
Order in increments of 2000.

Ammo Pack Information — Minimum order quantity 1 Box/$200LL.
Order in increments of 2000.

TO-92 EIA RADIAL TAPE REEL OR AMMO PACK





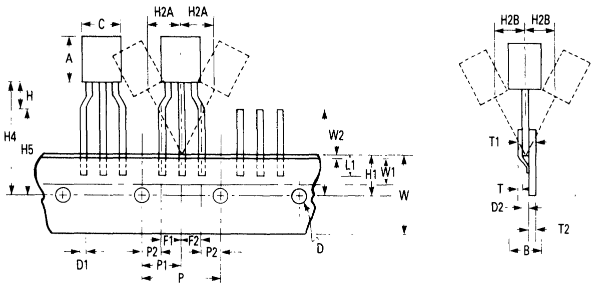
NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED.
2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12 70mm (0.5") FROM SEATING PLANE.
3. CONTROLLING DIM: INCH.

CASE 29-04
TO-226AC
(TO-92)

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0 41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

TO-92 EIA RADIAL TAPE REEL OR AMMO PACK

Figure 1. Device Positioning on Tape



Symbol	Item	Specification			
		Inches		Millimeter	
		Min	Max	Min	Max
A	Component Body Height	0.170	0.210	4.32	5.33
B	Component Body Width	0.125	0.165	3.18	4.19
C	Component Body Length along Tape	0.1748	0.2052	4.44	5.21
D	Tape Feedhole Diameter	0.145	0.1693	3.7	4.3
D1	Component Lead Width Dimension	0.016	0.022	0.41	0.56
D2	Component Lead Thickness Dimension	0.015	0.020	0.38	0.51
F1, F2	Component Lead Pitch	0.0945	0.110	2.4	2.8
H	Bottom of Component to Seating Plane	0	0.0985	0	2.5
H1	Feedhole Location	0.3346	0.3741	8.5	9.5
H2A	Deflection Left or Right	0	0.039	0	1
H2B	Deflection Front or Rear	0	0.051	0	1.3
H3	Feedhole to Overall Component Height	0	1.2600	0	32
H4	Feedhole to Bottom of Component	0.7086	0.768	18	19.5
H5	Feedhole to Seating Plane	0.610	0.649	15.5	16.5
L	Defective Unit Clipped Dimension	0.3346	0.433	8.5	11
L1	Lead Wire Enclosure	0.09842	—	2.5	—
P	Feedhole Pitch	0.4921	0.5079	12.5	12.9
P1	Feedhole Center to Center Lead	0.2342	0.2658	5.95	6.75
P2	First Lead Spacing Dimension	0.1397	0.1556	3.55	3.95
T	Adhesive Tape Thickness	0.06	0.08	0.15	0.20
T1	Overall Taped Package Thickness	—	0.0567	—	1.44
T2	Carrier Strip Thickness	0.014	0.027	0.35	0.65
W	Carrier Strip Width	0.6889	0.07481	17.5	19
W1	Adhesive Tape Width	0.2165	0.2841	5.5	6.3
W2	Adhesive Tape Position	—	0.01968	—	0.5

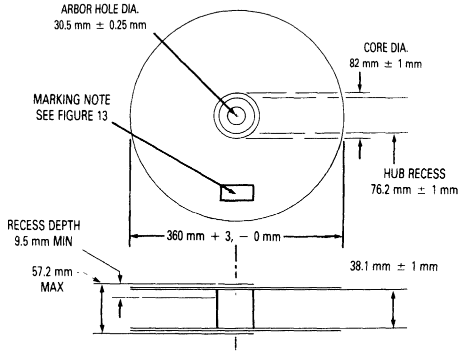
NOTES:

1. Maximum alignment deviation between leads not to be greater than 0.2 mm.
2. Defective components shall be clipped from the carrier tape such that the remaining protrusion (L) does not exceed a maximum of 11 mm.
3. Component lead to tape adhesion must meet the pull test requirements established in Figures 10, 11 and 12.
4. Maximum non-cumulative variation between tape feed holes shall not exceed 1 mm in 20 pitches.
5. Holddown tape not to extend beyond the edge(s) of carrier tape and there shall be no exposure of adhesive.
6. No more than 3 consecutive missing components is permitted.
7. A tape trailer, having at least three feed holes is required after the last component.
8. Splices shall not interfere with the sprocket feed holes.

TO-92 EIA RADIAL TAPE REEL OR AMMO PACK

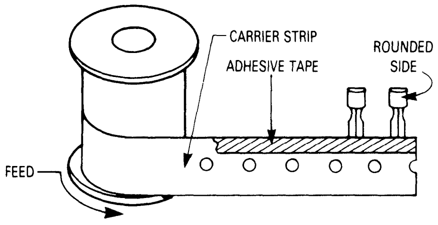
REEL STYLES

Figure 2. Reel Specifications



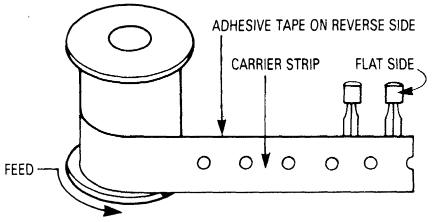
Material used must not cause deterioration of components or degrade lead solderability.

Figure 3. Style A



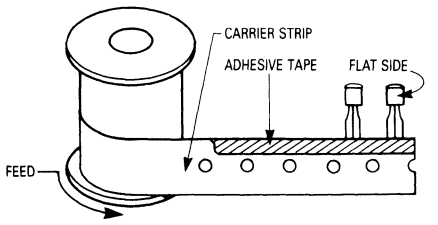
Rounded size of transistor and adhesive tape visible.

Figure 4. Style B



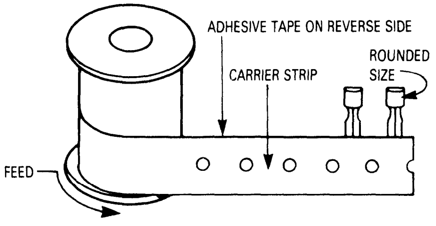
Flat side of transistor and carrier strip visible (adhesive tape on reverse side).

Figure 5. Style E



Flat side of transistor and adhesive tape visible.

Figure 6. Style F

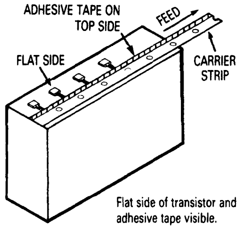


Rounded side of transistor and carrier strip visible (adhesive tape on reverse side).

TO-92 EIA RADIAL TAPE REEL OR AMMO PACK

AMMO PACK STYLES

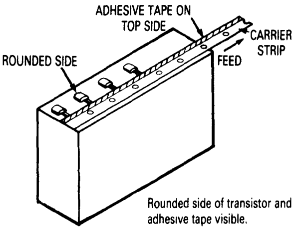
Figure 7. Style M



Flat side of transistor and adhesive tape visible.

Style M ammo pack is equivalent to Styles E and F of reel pack dependent on feed orientation from box.

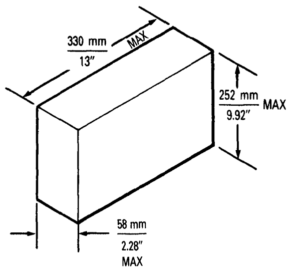
Figure 8. Style P



Rounded side of transistor and adhesive tape visible.

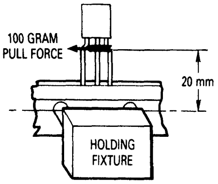
Style P ammo pack is equivalent to Styles A and B of reel pack dependent on feed orientation from box.

Figure 9. Ammo Pack Dimensions



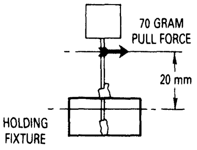
ADHESION PULL TESTS

Figure 10. Test #1



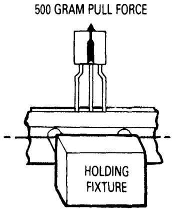
The component shall not pull free with a 300 gram load applied to the leads for 3 ± 1 second.

Figure 11. Test #2



The component shall not pull free with a 70 gram load applied to the leads for 3 ± 1 second.

Figure 12. Test #3

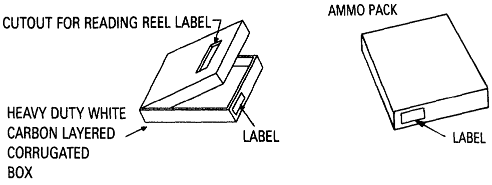


There shall be no deviation in the leads and no component leads shall be pulled free of the tape with a 500 gram load applied to the component body for 3 ± 1 second.

Figure 13. Marking for Reel/Ammo Pack

DEVICE : REV : QTY:
CUST P / N : REV :
QA LOT # : D/C :
CONTROL # : SOURCE :
O.A. # : REV :

Figure 14. TO-92 Tape and Reel Shipping Container



TO-92 Tape Reel Pro Electron

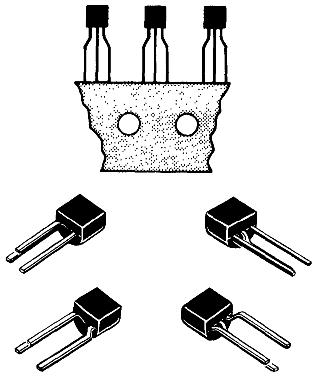
Radial tape reel and ammo pack of the reliable TO-92 package are the best methods of capturing devices for automatic insertion in printed circuit boards. These methods of taping are compatible with various equipment for active and passive component insertion.

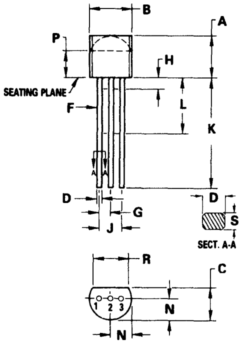
- Available on 365 mm Reels
- Available in Ammo Pack (Fan Fold Box)
- Accommodates Various Inserters
- Allows Flexible Circuit Board Layout
- 2.5 mm Pin Spacing for Soldering
- Conforms to EIA ACP Standard 1375 (RS-468)*

*EIA ACP reel diameter 360 mm. Motorola is 365 mm.

When ordering radial type ON REEL specify the style per Figure 4. Add the suffix to the device title, i.e. BC237ARL1. This will be a standard BC237A radial taped and supplied on a reel per RL1 option.

TO-92
Tape Reel
and
Lead Forming





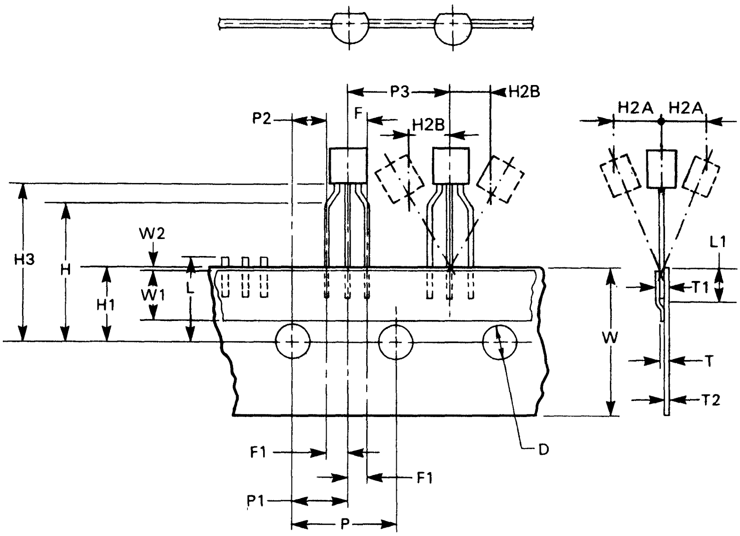
NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED
2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE. LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12.70mm (0.5") FROM SEATING PLANE.
3. CONTROLLING DIM: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

CASE 29-04
TO-226AC
(TO-92)

TO-92 TAPE REEL AND LEAD FORMING (PRO ELECTRON)

Figure 1. Taping Procedure



Symbol	Item	Specification Min mm	Specification Max mm	Remarks
D	Tape Feed Hole Diameter	3.7	4.3	
F	Overall Component Lead Pitch	4.8	5.8	
F1	Component Lead Pitch	2.4	2.9	
H	Height of Seating Plane	15.5	16.5	Note 2
H1	Feed Hole Location	8.5	9.75	Notes 9 & 10
H2A, B	Deflection Front or Rear, Left or Right	0	1.0	Note 1
H3	Feed Hole to Bottom of Component	18	19	
L	Lead Length After Component Removal	0	11	Notes 3 & 8
L1	Lead Wire Enclosure	2.5	—	Note 4
P	Feed Hole Pitch	12.4	13	Note 5
P1	Feed Hole — Component Centre Distance	5.95	6.75	
P2	Feed Hole — First Lead Distance	3.02	4.35	
P3	Component Centre Pitch	11.7	13.7	
T	Total Tape Thickness	0.5	0.9	
T1	Overall Taped Package Thickness	—	1.44	Note 6
T2	Carrier Tape Thickness	0.38	0.68	Note 6
W	Overall Tape Width	17.5	19	Note 7
W1	Holddown Tape Width	5.7	6.3	Note 7
W2	Holddown Tape Position	0	0.5	Note 7

Notes:

1. Maximum alignment deviation between leads not to be greater than 0.2 mm.
2. As illustrated, the clearance to the lead standoff form shall be defined to the point of radius for the standoff form.
3. Defective components shall be clipped from the carrier tape such that the remaining protrusion (L) does not exceed a maximum of 11 mm.
4. Component lead to tape adhesion must meet the pull test requirements established in Figures 4, 5 and 6.
5. Maximum non-cumulative variation between tape and feed holes shall not exceed 1.0 mm in 20 pitches.
6. Overall taped package thickness, including component leads and tape splices shall not exceed 1.44 mm.
7. Holddown tape not to extend beyond the edge(s) of carrier tape and there shall be no exposure of adhesive.
8. No more than 3 consecutive missing components is permitted.
9. A tape trailer having at least three feed holes is required after the last component.
10. Splices shall not interfere with the sprocket feed holes.

Figure 2. REEL Pack Dimensions

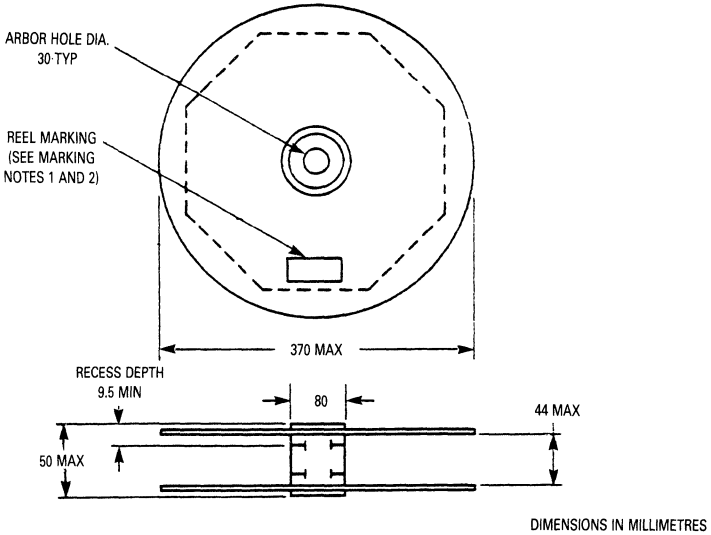
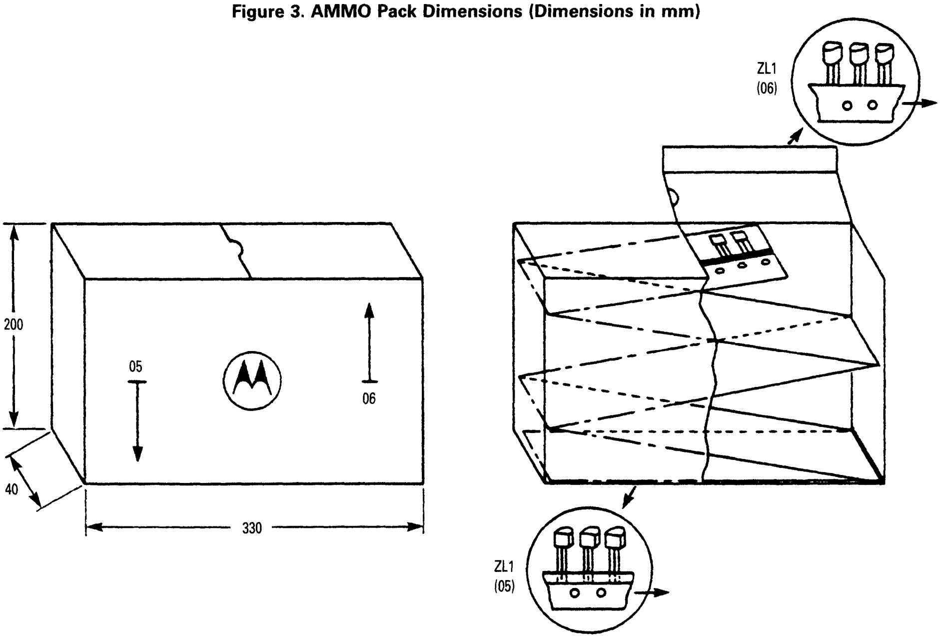


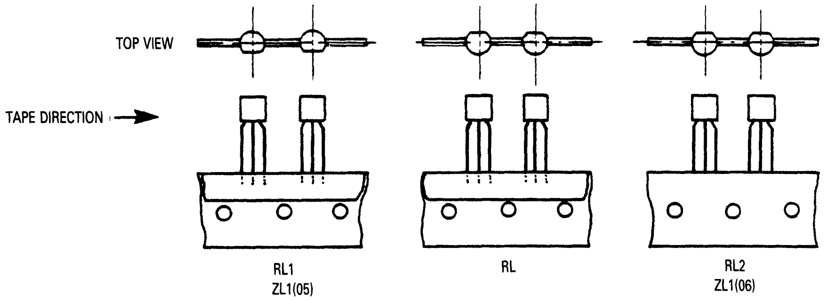
Figure 3. AMMO Pack Dimensions (Dimensions in mm)



TO-92 TAPE REEL AND LEAD FORMING (PRO ELECTRON)

Figure 4. Ordering Notes

1. Each package (AMMO and REEL) contains two thousand pieces: **orders have to be a multiple of 2000.**
2. How to choose a style of Reel Winding?
   - — Determine the pinout of the device (Style Number — see Product Data Sheet)
   - — Determine with the customer which lead he wishes to see first when pulling the tape.
   - — Match both Style Number and First Lead information to find compatible options (see table in Figure 4).



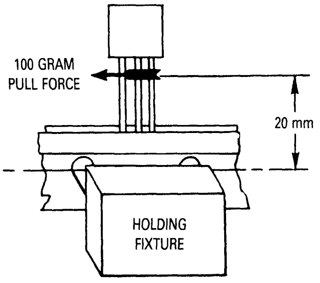
Style	Pinning Bottom View 1 2 3			First Lead Seen				
				REEL Tape Option			AMMO Pack Option	
				RL1	RL	RL2	ZL1(05)*	ZL1(06)*
	Transistors							
	1	2	3					
1	E	B	C	Collector	Emitter	Emitter	Collector	Emitter
17	C	B	E	Emitter	Collector	Collector	Emitter	Collector
2	B	E	C	Collector	Base	Base	Collector	Base
14	E	C	B	Base	Emitter	Emitter	Base	Emitter
21	C	E	B	Base	Collector	Collector	Base	Collector
	FETs							
	1	2	3					
23	G	S	D	Drain	Gate	Gate	Drain	Gate
5	D	S	G	Gate	Drain	Drain	Gate	Drain
22	S	G	D	Drain	Source	Source	Drain	Source
30	D	G	S	Source	Drain	Drain	Source	Drain

Example:
BC237B with Emitter first lead from tape . . . (see Data Sheet for style)
Style 17 gives RL1 option for Tape on REEL or AMMO Pack accessed from side 05.

*ZL2 is the same as ZL1 except the unit at the fold is missing and each row is 24 units.

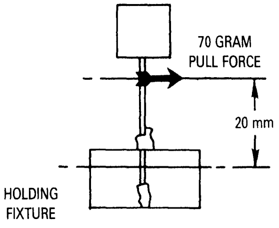
TO-92 TAPE REEL AND LEAD FORMING (PRO ELECTRON)

Figure 5. Adhesion Pull Test



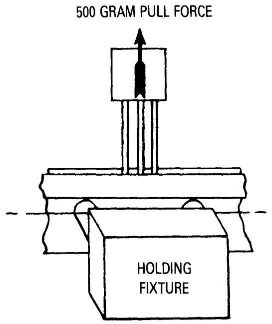
The component shall not pull free with a 300 gram load applied to the leads for 3 ± 1 second.

Figure 6. Adhesion Pull Test No. 2



The component shall not pull free with a 70 gram load applied to the leads for 3 ± 1 second.

Figure 7. Adhesion Pull Test No. 3



There shall be no deviation in the leads and no component leads shall be pulled free of the tape with a 500 gram load applied to the component body for 3 ± 1 second.

Marking Notes:

1. Minimum container and reel marking shall consist of the following items:
   - a. Motorola
   - b. Customer Purchase Order Number
   - c. Quantity
   - d. Date of Reeling
   - e. Motorola Part Number
2. Where applicable, the following items will be included:
   - a. Customer Part Number
   - b. Device Date Code

TO-92 LEAD FORMING

Figure 8. Ordering Notes

How to choose Lead Form option:

1. Determine option either TO-18 or TO-5, see Dimensional Drawings
   *Identify measurement between centres of the two outside leads:
   i.e. 2.5 mm for TO-18
   5.0 mm for TO-5
2. Determine the pinout of the device (Style Number — see Product Data Sheet)
3. Identify Drawing corresponding to Style Number (see Figures 8a and 8b).

Example:
BC237B configured TO-18. . . .
See Data Sheet for Style Number
Style 17 . . . Drawing indicates Dimensions, and that position of Centre Lead is towards the round side of the product (towards the back)
Order type: **BC237B18**

Other Examples:

P2N2222-18	P2N2222A18
2N5551-5	BC488A18
BC337-25-5	BC547C5

Note: For reverse configurations, please consult the factory.

TO-92 Lead Forming

Lead configurations conform to TO-18 or TO-5 pin circles.

Ordering Notes:
When ordering Lead Formed TO-92, verify the style per Figures 1a and 1b.

Figure 1a. TO-18 Styles and Dimensions

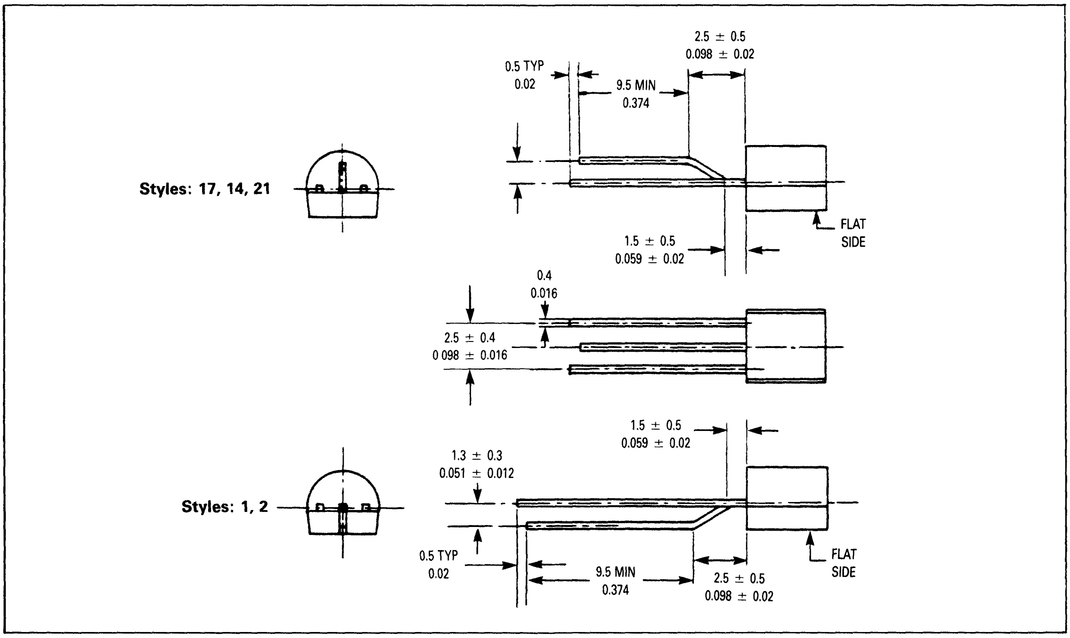
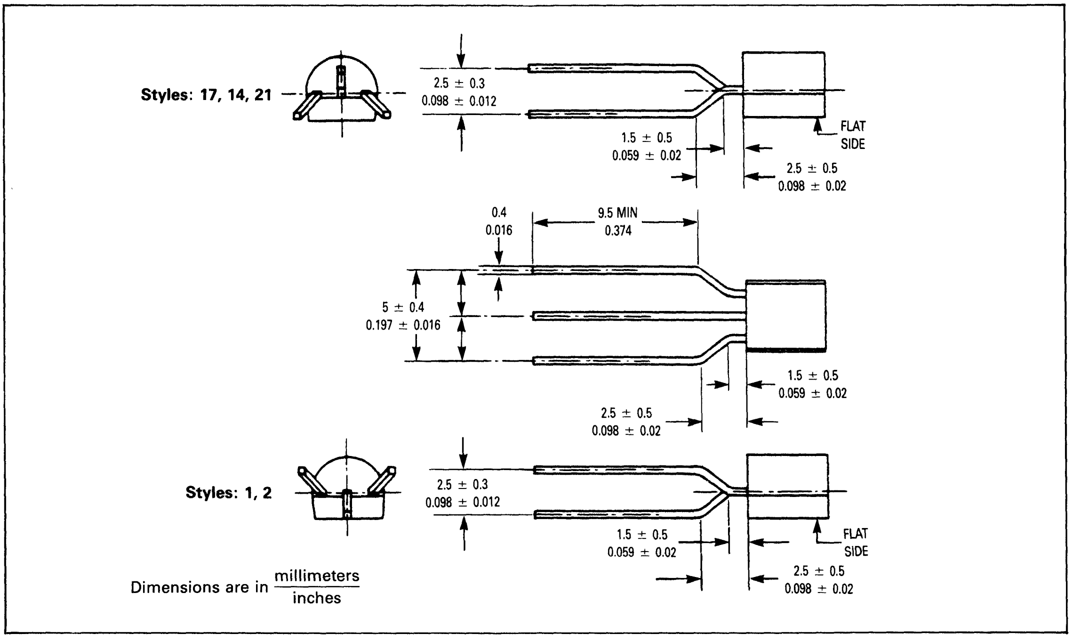
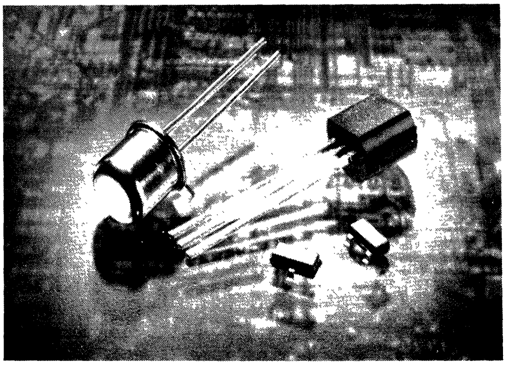


Figure 1b. TO-5 Styles and Dimensions





The following pages contain information on the various packages referenced on the individual data sheets. Information includes: a picture of the package, dimensions in both millimeters and inches, the various pinout configurations (styles), a cross reference for case numbers, old JEDEC "TO" numbers, and the new JEDEC "TO" designation.

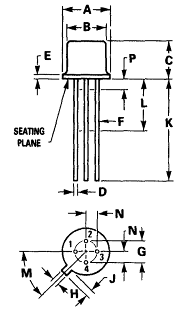
Additionally, abstracts of available application notes are provided. Please contact your local sales representative for those desired.

Package Outline Dimensions and Application Literature

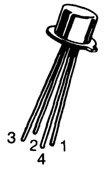
Package Outline Dimensions

Dimensions are in inches unless otherwise noted.

CASE 20-03 TO-72 (TO-206AF) METAL



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

All JEDEC dimensions and notes apply.

CASE 20 STYLES

STYLE 1:
PIN 1. SOURCE
2. DRAIN
3. GATE
4 CASE LEAD

STYLE 2:
PIN 1. SOURCE
2. GATE
3. DRAIN
4. SUBSTRATE AND CASE LEAD

STYLE 3:
PIN 1. DRAIN
2. SOURCE
3. GATE
4. CASE LEAD

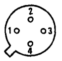
STYLE 4:
PIN 1. SOURCE
2. GATE
3. DRAIN
4. GATE 2 — SUBSTRATE AND CASE

STYLE 5:
PIN 1. SOURCE
2. GATE 1
3. DRAIN
4. CASE

STYLE 6:
PIN 1. DRAIN
2. SOURCE AND SUBSTRATE
3. GATE
4. SOURCE AND SUBSTRATE

STYLE 7:
PIN 1. DRAIN
2. SOURCE
3. GATE
4. CASE AND SUBSTRATE

STYLE 8:
PIN 1. EMITTER 2
2. BASE 1
3. COLLECTOR
4. EMITTER 1 BASE 2

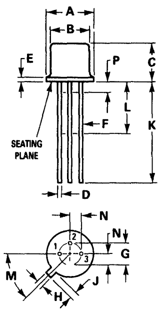


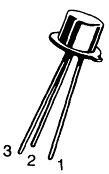
STYLE 9:
PIN 1. DRAIN
2. GATE 2
3. GATE 1
4. SOURCE, SUBSTRATE AND CASE

STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

STYLE 11:
PIN 1. EMITTER
2. CATHODE
3. COLLECTOR
4. ANODE

CASE 22-03 TO-18 (TO-206AA) METAL





DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.406	0.533	0.016	0.021
E	—	0.762	—	0.030
F	0.406	0.483	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0 050 BSC	
P	—	1.27	—	0.050

All JEDEC notes and dimensions apply.

CASE 22 STYLES

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 2:
PIN 1. SOURCE, SUBSTRATE AND CASE
2. GATE
3. DRAIN

STYLE 3:
PIN 1. SOURCE
2. DRAIN
3 GATE

STYLE 4.
PIN 1. SOURCE
2. DRAIN
3. GATE AND CASE

STYLE 5:
PIN 1. EMITTER
2. BASE 1
3. BASE 2

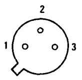
STYLE 6:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 7:
PIN 1. ANODE
2. BASE
3. CATHODE

STYLE 8:
PIN 1. GATE
2. ANODE 1
3 ANODE 2

STYLE 9:
PIN 1. ANODE 2
2. ANODE 1
3. GATE (CONNECTED TO CASE)

STYLE 10:
PIN 1. BASE
2. EMITTER
3. BASE

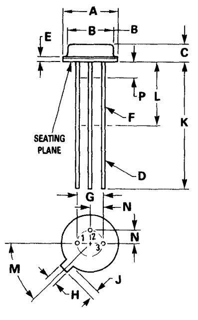


STYLE 11:
PIN 1. DRAIN
2 GATE
3 SOURCE, SUBSTRATE

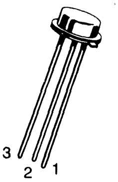
STYLE 12:
PIN 1. SOURCE
2. GATE
3. DRAIN (CASE)

STYLE 13:
PIN 1. ANODE
2. GATE
3. CATHODE

CASE 26-03 TO-46 (TO-206AB) METAL



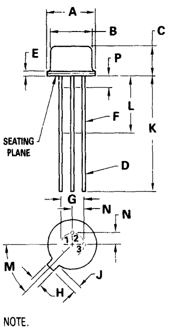
STYLE 1.
PIN 1. EMITTER
2. BASE
3. COLLECTOR



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

All JEDEC dimensions and notes apply.

CASE 27-02 TO-52 (TO-206AC) METAL



NOTE.
1 ALL RULES & NOTES ASSOCIATED WITH TO-52 OUTLINE SHALL APPLY.

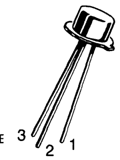
STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 2:
PIN 1 DRAIN
2. SOURCE
3. GATE & CASE

STYLE 3:
PIN 1. EMITTER
2. BASE
3. BASE 2

STYLE 4:
PIN 1. SOURCE
2. DRAIN
3. GATE & CASE

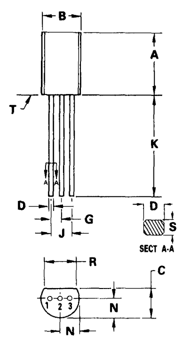
STYLE 5.
PIN 1. SOURCE
2. GATE
3. DRAIN & CASE



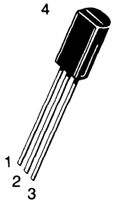
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	2.92	3.81	0.115	0.150
D	—	0.533	—	0.021
E	—	0.762	—	0 030
F	0.406	0.483	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0 028	0.048
K	12 70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

PACKAGE OUTLINE DIMENSIONS (continued)

CASE 29-03 TO-92 (TO-226AE) PLASTIC

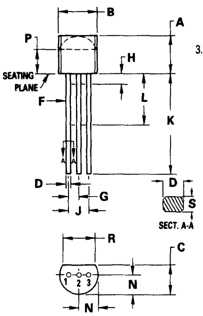


NOTES:
1. DIMENSIONS -A- AND -B- ARE DATUMS.
2. -T- IS SEATING PLANE.
3. POSITIONAL TOLERANCE FOR LEADS:
   | ⌖ | ϕ 0.10 (0.004) Ⓜ | T | A Ⓜ | B Ⓜ |
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
5. CONTROLLING DIM: INCH.

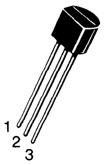


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.37	7.87	0.290	0.310
B	4.44	5.21	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.46	0.61	0.018	0.024
G	1.27 BSC		0.050 BSC	
J	2.54 BSC		0.100 BSC	
K	12.70	—	0.500	—
N	2.03	2.92	0.080	0.115
R	3.43	—	0.135	—
S	0.46	0.61	0.018	0.024

CASE 29-04 TO-92 (TO-226AA) PLASTIC



NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED.
2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE. LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12.70mm (0.5") FROM SEATING PLANE.
3. CONTROLLING DIM· INCH.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

CASE 29 STYLES

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 2:
PIN 1. BASE
2. EMMITTER
3. COLLECTOR

STYLE 3:
PIN 1. ANODE
2. ANODE
3. CATHODE

STYLE 4:
PIN 1. CATHODE
2. CATHODE
3. ANODE

STYLE 5:
PIN 1. DRAIN
2. SOURCE
3. GATE

STYLE 6:
PIN 1. GATE
2. SOURCE & SUBSTRATE
3. DRAIN

STYLE 7:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 8:
PIN 1. DRAIN
2. GATE
3. SOURCE & SUBSTRATE

STYLE 9:
PIN 1. BASE 1
2. EMITTER
3. BASE 2

STYLE 10:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 11:
PIN 1. ANODE
2. CATHODE & ANODE
3. CATHODE

STYLE 12:
PIN 1. MAIN TER 1
2. GATE
3. MAIN TER 2

STYLE 13:
PIN 1. ANODE 1
2. GATE
3. CATHODE 2

STYLE 14:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 15:
PIN 1. ANODE 1
2. CATHODE
3. ANODE 2

STYLE 16:
PIN 1. ANODE
2. GATE
3. CATHODE

STYLE 17·
PIN 1. COLLECTOR
2. BASE
3. EMITTER

STYLE 18:
PIN 1. ANODE
2. CATHODE
3. NOT CONN

STYLE 19:
PIN 1. GATE
2. ANODE
3. CATHODE

STYLE 20:
PIN 1. NOT CONN
2. CATHODE
3. ANODE

STYLE 21:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

STYLE 22:
PIN 1. SOURCE
2. GATE
3. DRAIN

STYLE 23:
PIN 1. GATE
2. SOURCE
3. DRAIN

STYLE 24·
PIN 1. EMITTER
2. COLLECTOR/ ANODE
3. CATHODE

STYLE 25:
PIN 1. MT 1
2. GATE
3. MT 2

STYLE 26:
PIN 1 V_{CC}
2. GROUND
3. OUTPUT

STYLE 27:
PIN 1. MT
2. SUBSTRATE
3. MT

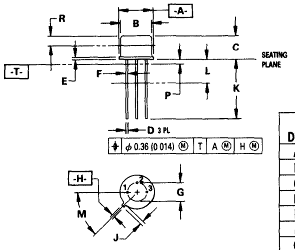
STYLE 28:
PIN 1. CATHODE
2. ANODE
3. GATE

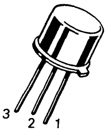
STYLE 29:
PIN 1. NOT CONN
2. ANODE
3. CATHODE

STYLE 30:
PIN 1. DRAIN
2. GATE
3. SOURCE

STYLE 31:
PIN 1. GATE
2. DRAIN
3. SOURCE

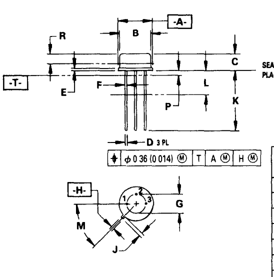
CASE 79-04 TO-39 (TO-205AD) METAL

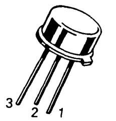




DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

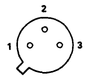
CASE 79-05 TO-39 (TO-205AF) METAL





DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79 STYLES



NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION: INCH.
3 DIMENSION J MEASURED FROM DIMENSION A MAXIMUM
4 DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM

STYLE 1
PIN 1 EMITTER
2 BASE
3 COLLECTOR

STYLE 2
PIN 1 DRAIN
2. SOURCE
3 GATE

STYLE 3.
PIN 1 CATHODE
2 GATE
3 ANODE

STYLE 4
PIN 1 MAIN TERM 1
2 GATE
3 MAIN TERM 2

STYLE 5
PIN 1 COLLECTOR
2 BASE
3 EMITTER

STYLE 6.
PIN 1 SOURCE
2 GATE
3 DRAIN
(CASE)

STYLE 7
PIN 1 DRAIN
2 GATE
3. SOURCE

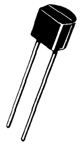
STYLE 8
PIN 1 ANODE
2 ANODE
3 CATHODE

STYLE 9
PIN 1 SOURCE
2 DRAIN
3 GATE

STYLE 10
PIN 1 COLLECTOR
2 EMITTER
3 BASE

PACKAGE OUTLINE DIMENSIONS (continued)

CASE 182-02 TO-92 (TO-226AC) PLASTIC

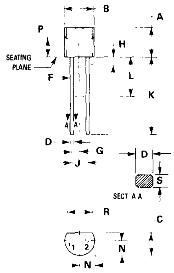


NOTES
1 CONTOUR OF PACKAGE BEYOND ZONE P IS UNCONTROLLED
2 DIMENSION F APPLIES BETWEEN H AND L DIMENSION D AND S APPLIES BETWEEN L AND 12 70mm (0 5") FROM SEATING PLANE LEAD DIMENSION IS UNCONTROLLED IN H AND BEYOND 12 70mm (0 5") FROM SEATING PLANE

STYLE 1
PIN 1 ANODE
2 CATHODE

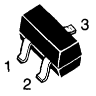
STYLE 2
PIN 1 CATHODE
2 ANODE

STYLE 3
PIN 1 MAIN TERMINAL 1
2 MAIN TERMINAL 2

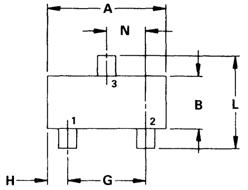


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.21	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.56	0.016	0.022
F	0.407	0.482	0.016	0.019
G	1.27 BSC		0.050 BSC	
H	—	1.27	—	0.050
J	2.54 BSC		0.100 BSC	
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.03	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.36	0.41	0.014	0.016

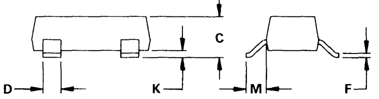
CASE 318-03 TO-236AB (SOT-23) PLASTIC



NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION. INCH.



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.80	3.04	0.1102	0.1197
B	1.20	1.40	0.0472	0.0551
C	0.89	1.11	0.0350	0.0440
D	0.37	0.50	0.0150	0.0200
F	0.085	0.130	0.0034	0.0051
G	1.78	2.04	0.0701	0.0807
H	0.45	0.60	0.0177	0.0236
K	0.013	0.100	0.0005	0.0040
L	2.10	2.50	0.0830	0 0984
M	0.45	0.60	0.0180	0.0236
N	0.89	1.02	0.0350	0.0401



CASE 318 STYLES

STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

STYLE 7:
PIN 1. EMITTER
2. BASE
3 COLLECTOR

STYLE 8.
PIN 1. ANODE
2. NO CONNECTION
3. CATHODE

STYLE 9:
PIN 1 ANODE
2. ANODE
3. CATHODE

STYLE 10.
PIN 1 DRAIN
2. SOURCE
3. GATE

STYLE 11:
PIN 1. ANODE
2. CATHODE
3. CATHODE-ANODE

STYLE 12:
PIN 1. CATHODE
2. CATHODE
3. ANODE

STYLE 13:
PIN 1. SOURCE
2. DRAIN
3. GATE

STYLE 14:
PIN 1. CATHODE
2. GATE
3. ANODE

STYLE 15:
PIN 1. GATE
2. CATHODE
3. ANODE

STYLE 16.
PIN 1. ANODE
2. CATHODE
3. CATHODE

STYLE 17:
PIN 1. NO CONNECTION
2. ANODE
3. CATHODE

STYLE 18:
PIN 1. NO CONNECTION
2. CATHODE
3. ANODE

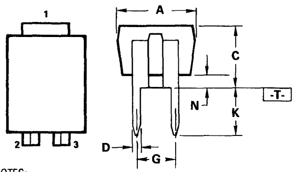
STYLE 19:
PIN 1. CATHODE
2. ANODE
3. CATHODE — ANODE

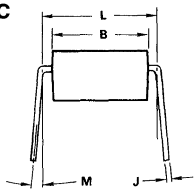
STYLE 20:
PIN 1 CATHODE
2. ANODE
3. GATE

STYLE 21:
PIN 1. GATE
2. SOURCE
3. DRAIN

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

CASE 370-01 (FET DIP) PLASTIC





NOTES:
1. SURFACE "T" IS BOTH A DATUM AND SEATING PLANE.
2. POSITIONAL TOLERANCE FOR LEADS; D DIM 4 PL

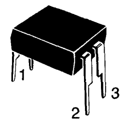
⌖ | 0.27 (.010) Ⓜ | -T- | A Ⓜ

LEADS; J DIM 4 PL

⌖ | 0.27 (0.010) Ⓜ | -T- | B Ⓜ

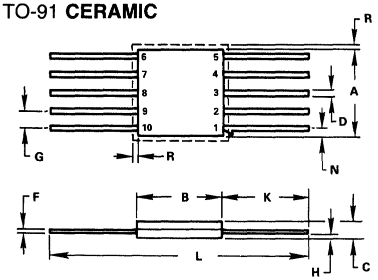
3. DIMENSIONING AND TOLERANCING PER Y14.5M, 1982.
4. CONTROLLING DIMENSION: INCH
5. DIMENSION "J" PRIOR TO SOLDER DIP PLATING

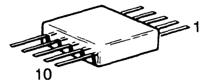
STYLE 1:
PIN 1. DRAIN
2. GATE
3. SOURCE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.70	5.02	0.185	0.198
B	6.10	7.11	0.240	0.280
C	4.06	5.08	0.160	0.200
D	0.38	0.63	0.015	0.025
G	2.54 BSC		0.100 BSC	
J	0.30	0.43	0.012	0.017
K	2.79	3.81	0.110	0.150
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.77	0.020	0.070

CASE 606-04 TO-91 CERAMIC

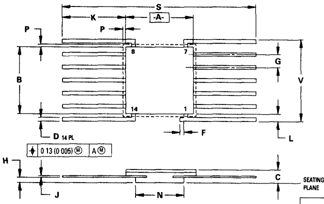




NOTE:
1. ALL RULES & NOTES ASSOCIATED WITH TO-91 OUTLINE SHALL APPLY.
2. LEADS WITHIN 0.25 mm (0.010) TOTAL OF TRUE POSITION AT MAXIMUM MATERIAL CONDITION (AT BODY)

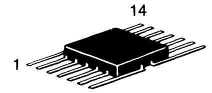
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.10	7.36	0.240	0.290
B	6.10	6.60	0.240	0.260
C	0.762	1.77	0.030	0.070
D	0.254	0.482	0.010	0.019
F	0.077	0.152	0.003	0.006
G	1.15	1.39	0.045	0.055
H	0.127	0.889	0.005	0.035
K	1.78	—	0.070	—
R	—	0.381	—	0.015

CASE 607-04 CERAMIC



STYLE 1.
PIN 1 COLLECTOR
2 BASE
3 EMITTER
4 NOT CONNECTED
5. EMITTER
6. BASE
7 COLLECTOR
8 COLLECTOR
9 BASE
10 EMITTER
11. NOT CONNECTED
12 EMITTER
13. BASE
14 COLLECTOR

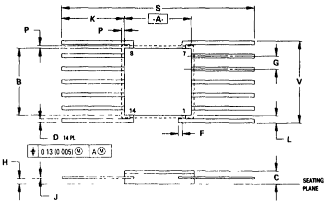
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION· INCH
3. DIMENSIONS P DETERMINE ZONE WITHIN WHICH ALL BODY AND LEAD IRREGULARITIES LIE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.10	6.98	0.240	0.275
B	6 10	6.98	0.240	0 275
C	0.77	1.77	0.030	0.070
D	0.26	0.48	0.010	0.019
F	—	0.38	—	0.015
G	1 27 BSC		0.050 BSC	
H	0 13	0.88	0.005	0.035
J	0 08	0 015	0.003	0 006
K	6 35	—	0.250	—
L	0.26	—	0.010	—
N	4.45	4.95	0.175	0.195
P	—	0 38	—	0 015
S	18.80	—	0 740	—
V	7.62	8 38	0 300	0.330

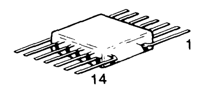
PACKAGE OUTLINE DIMENSIONS (continued)

CASE 607-05 CERAMIC



STYLE 1
PIN 1 COLLECTOR
2 BASE
3. EMITTER
4 NOT CONNECTED
5 EMITTER
6 BASE
7 COLLECTOR
8 COLLECTOR
9 BASE
10 EMITTER
11 NOT CONNECTED
12 EMITTER
13 BASE
14 COLLECTOR

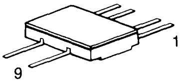
NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION· INCH
3. DIMENSIONS P DETERMINE ZONE WITHIN WHICH ALL BODY AND LEAD IRREGULARITIES LIE

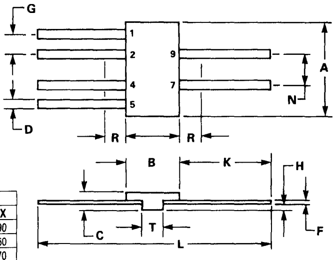


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6 10	6.60	0.240	0.260
B	6.10	6 60	0 240	0.260
C	0 77	1 77	0 030	0.070
D	0.33	0.48	0.013	0 019
F	—	0.38	—	0.015
G	1 27 BSC		0 050 BSC	
H	0 30	0 88	0.012	0.035
J	0.08	0.15	0 003	0.006
K	6.35	9.39	0.250	0 370
L	0.26	—	0.010	—
P	—	0.38	—	0.015
S	18.80	—	0.740	—
V	7.62	8.38	0.300	0.330

CASE 610A-04 CERAMIC

STYLE 1:
PIN 1. BASE
2. EMITTER
4. EMITTER
5. BASE
7. COLLECTOR
9. COLLECTOR

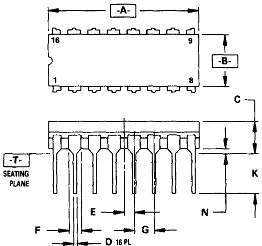


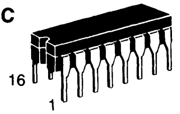


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.10	7.37	0.240	0.290
B	2.92	4.06	0.115	0.160
C	0.76	2.03	0.030	0.070
D	0.36	0.48	0.014	0.019
F	0.08	0.15	0.003	0.006
G	1.27 BSC		0.050 BSC	
H	0.13	0.89	0.005	0.035
K	3.81	—	0.150	—
L	10.54	—	0.415	—
N	2.54 BSC		0.100 BSC	
R	—	1.27	—	0.050
T	1 65	2 03	0.065	0.080

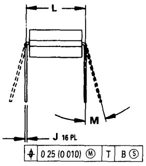
NOTES:
1. DIM "D," "G" & "N" TO BE MEASURED IN ZONE "R."
2. LEADS WITHIN 0.13 mm (0.005) TOTAL OF TRUE POSITION WITHIN "R" AT MAXIMUM MATERIAL CONDITION.

CASE 620-09 (16-PIN DIP) CERAMIC





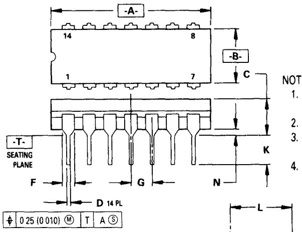
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION: INCH.
3 DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIM F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY

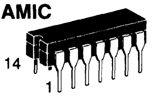


STYLE 1:
PIN 1. CATHODE 9. ANODE
2. CATHODE 10. ANODE
3. CATHODE 11. ANODE
4. CATHODE 12. ANODE
5. CATHODE 13. ANODE
6. CATHODE 14. ANODE
7. CATHODE 15. ANODE
8. CATHODE 16. ANODE

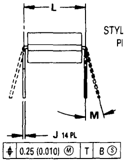
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.55	0.750	0.770
B	6.10	7.36	0.240	0.290
C	—	4.19	—	0.165
D	0.39	0.53	0.015	0.021
E	1.27 BSC		0.050 BSC	
F	1.40	1 77	0.055	0.070
G	2.54 BSC		0.100 BSC	
J	0.23	0.27	0.009	0.011
K	—	5.08	—	0.200
L	7 62 BSC		0 300 BSC	
M	0°	15°	0°	15°
N	0.39	0.88	0.015	0.035

CASE 632-08 MO-001AA (TO-116) CERAMIC





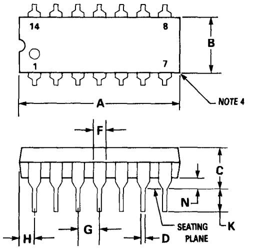
NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIM F MAY NARROW TO 0 76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.

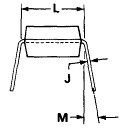


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.94	0.750	0.785
B	6.23	7.11	0.245	0.280
C	3.94	5.08	0.155	0.200
D	0.39	0.50	0.015	0.020
F	1.40	1.65	0.055	0.065
G	2.54 BSC		0.100 BSC	
J	0.21	0.38	0.008	0.015
K	3.18	4.31	0.125	0.170
L	7 62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.01	0.020	0.040

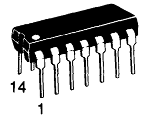
STYLE 1		STYLE 4	
PIN 1	COLLECTOR	PIN 1	DRAIN
2	BASE	2	SOURCE
3	EMITTER	3	GATE
4	NO CONNECTION	4	NO CONNECTION
5	EMITTER	5	GATE
6.	BASE	6	SOURCE
7	COLLECTOR	7	DRAIN
8	COLLECTOR	8.	DRAIN
9	BASE	9.	SOURCE
10	EMITTER	10	GATE
11.	NO CONNECTION	11	NO CONNECTION
12.	EMITTER	12	GATE
13	BASE	13	SOURCE
14	COLLECTOR	14	DRAIN

CASE 646-06 (14-PIN DIP) PLASTIC





STYLE 1:		STYLE 5.	
PIN	1. COLLECTOR	PIN	1. GATE
	2. BASE		2. DRAIN
	3. EMITTER		3 SOURCE
	4. NO CONNECTION		4. NO CONNECTION
	5. EMITTER		5 SOURCE
	6. BASE		6. DRAIN
	7. COLLECTÓR		7 GATE
	8 COLLECTOR		8. GATE
	9. BASE		9. DRAIN
	10. EMITTER		10. SOURCE
	11. NO CONNECTION		11. NO CONNECTION
	12 EMITTER		12. SOURCE
	13. BASE		13. DRAIN
	14. COLLECTOR		14. GATE

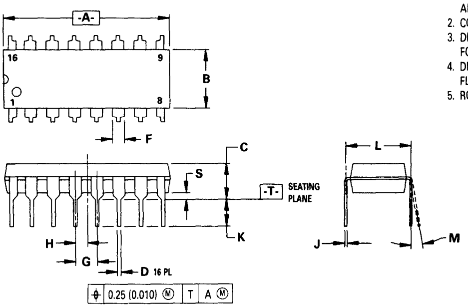


NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

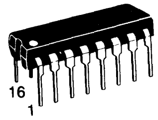
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.16	19.56	0.715	0.770
B	6.10	6.60	0.240	0.260
C	3.69	4.69	0.145	0.185
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.32	2.41	0.052	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.39	1.01	0.015	0.039

PACKAGE OUTLINE DIMENSIONS (continued)

CASE 648-08 (16-PIN DIP) PLASTIC



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

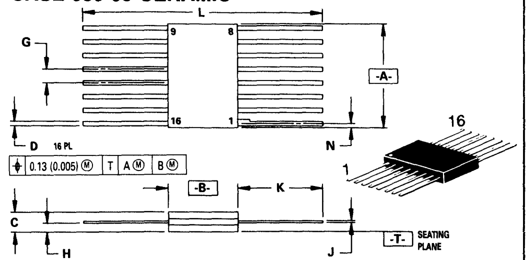


STYLE 1:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. CATHODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE
15. ANODE
16. ANODE

STYLE 2.
PIN 1. COMMON DRAIN
2. COMMON DRAIN
3. COMMON DRAIN
4. COMMON DRAIN
5. COMMON DRAIN
6. COMMON DRAIN
7. COMMON DRAIN
8. COMMON DRAIN
9. GATE
10. SOURCE
11. GATE
12. SOURCE
13. GATE
14. SOURCE
15. GATE
16. SOURCE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.80	19.55	0.740	0.770
B	6.35	6.85	0.250	0.270
C	3.69	4.44	0.145	0.175
D	0.39	0.53	0.015	0.021
F	1.02	1.77	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.27 BSC		0.050 BSC	
J	0.21	0.38	0.008	0.015
K	2.80	3.30	0.110	0.130
L	7.50	7.74	0.295	0.305
M	0°	10°	0°	10°
S	0.51	1.01	0.020	0.040

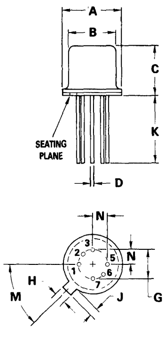
CASE 650-05 CERAMIC

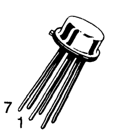


NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION "A" AND "B" ALLOW FOR LID MISALIGNMENT, AND GLASS MINISCUS.
4. DIMENSION "H" SHALL BE MEASURED AT THE POINT OF EXIT OF THE LEAD FROM THE BODY.
5. LEAD NUMBER 1 IDENTIFIED BY TAB ON LEAD OR DOT ON COVER.
6 DIMENSION "J" INCLUDES SOLDER LEAD FINISH.
7. LEAD NUMBERS SHOWN FOR REFERENCE ONLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.90	0.370	0.390
B	6.23	6.60	0.245	0.260
C	1.53	2.15	0.060	0.085
D	0.36	0.48	0.014	0.019
G	1.27 BSC		0.050 BSC	
H	0.64	1.01	0.025	0.040
J	0.11	0.17	0.004	0.007
K	6.35	9.39	0.250	0.370
L	18.93	—	0.745	—
N	—	0.50	—	0.020

CASE 654-07 METAL



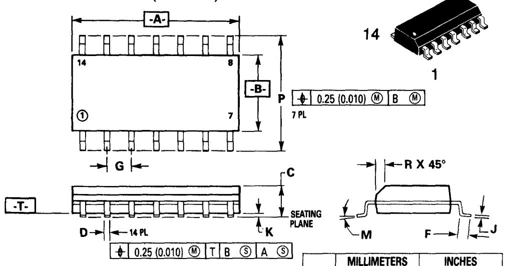


STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. OMITTED
5. EMITTER
6. BASE
7. COLLECTOR
8. OMITTED

STYLE 5:
SIDE 1 (NPN)
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. OMITTED
SIDE 2 (PNP)
5. EMITTER
6. BASE
7. COLLECTOR
8. OMITTED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.40	0.335	0.370
B	7.75	8.51	0.305	0.335
C	3.81	4.70	0.150	0.185
D	0.41	0.53	0.016	0.021
G	5.08 BSC		0.200 BSC	
H	0.71	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	—	0.500	—
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	

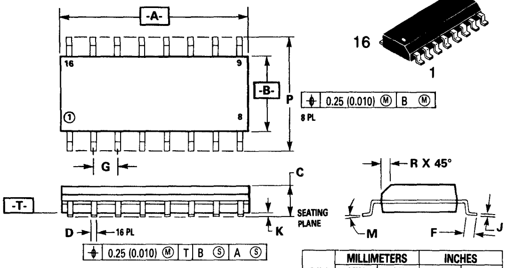
CASE 751A-02 (SO-14) PLASTIC



NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIMENSION: MILLIMETER.
4. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

CASE 751B-03 (SO-16) PLASTIC



NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIMENSION: MILLIMETER.
4 DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

Application Note Abstracts

(Application Notes are available upon request.)

AN-211A Field-Effect Transistors in Theory and Practice

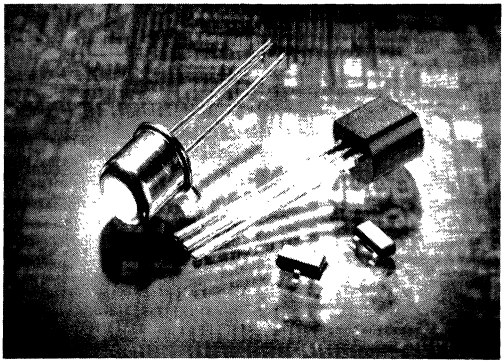
The basic theory, construction, and application information for field-effect transistors (junction and MOS types) are given. Also included are some typical test circuits for checking FET parameters.

AN-270 Nanosecond Pulse Handling Techniques in IC Interconnections

The rapid advancement in the field of high speed digital integrated circuits has brought into focus many problem areas in the methods of pulse measurement techniques and new concepts dealing with these problems. This paper is intended to discuss the more common, yet perhaps not well

AN-421 Semiconductor Noise Figure Considerations

A summary of many of the important noise figure considerations related with the design of low noise amplifiers is presented. The basic fundamentals involving noise, noise figure, and noise figure-frequency characteristics are then discussed with the emphasis on characteristics common to all semiconductors. A brief introduction is made to various methods of data sheet presentation of noise figure and a summary is given for the various methods of measurement. A discussion of low noise circuit design, utilizing many of the previously discussed considerations, is included.



Discrete products are available from Motorola in three quality levels: Industrial/Commercial grade, Military grade, and Customer Specials.

This Reliability and Quality Assurance section contains information on final test and quality assurance processing. Included is a listing of Q.A. tests and the applicable MIL-STD methods relating to the above-noted quality levels.

High reliability (JAN, JANTX, JANTXV, and JANS) processing of transistors is outlined by using a processing and quality control flow chart.

A glossary of Reliability and Quality terms is also included.

Reliability and Quality Assurance

Reliability and Quality Assurance

Quality Levels

Most small-signal discrete products are available from Motorola in three quality levels:

1. INDUSTRIAL/COMMERCIAL GRADE — Identified by a part number prefix such as 2N, MM or MPS and tested to a published Motorola, JEDEC or Proelectron specification.
2. MILITARY GRADE — Identified by a 2N part number prefix, a JAN, JTX, JTXV or JANS suffix, and manufactured and tested per MIL-S-19500.
    - JAN — Controlled lot with sample environmental and life testing
    - JTX — Same as JAN plus 100% processing
    - JTXV — Same as JTX plus 100% internal visual inspection
    - JANS — Same as JTXV plus wafer lot acceptance and additional 100% processing requirements.
3. CUSTOMER SPECIAL — Screening, testing and marking as determined by the customer to meet his particular requirements. This may range from a custom-marked industrial/commercial grade product to a hi-rel product which is subjected to a series of stringent inspections and tests to meet aerospace or special military requirements.

Final Test Processing

Device lots are subjected to 100% processing in Final Test. This processing may be as simple as electrical testing to data sheet specifications or as complex as a series of mechanical, environmental and burn-in screening tests preceded and followed by electrical readouts. All lots, whether industrial/commercial, military or hi-rel, are subjected to a minimum eight-hour storage bake at 150°C or 200°C.

Quality Assurance Processing

All products are transferred to QA where they are subjected to Group A electrical testing, usually to the same specifications used by Final Test. In the past, QA has primarily performed sample testing; but now, at Motorola, most small-signal metal can transistors are 100% electrical tested by QA, and when this expansion program is completed, all small-signal transistors will be subjected to 100% QA electrical testing. Military and hi-rel lots may undergo additional 100% screening in QA. Using the popular 2N2222A family as an example, Table 1 compares the varying degrees of preconditioning and screening that are done on the 2N2222A, 2N2222AJAN, 2N2222AJTX, 2N2222AJTXV and 2N2222AJANS transistors. QA randomly selects test samples for Group A, B and C testing as defined in MIL-S-19500. The individual tests are defined in MIL-STD-750. Tables 2 and 3 list the Group B and C test requirements for the 2N2222A military family.

TABLE 1 — 100% PRECONDITIONING AND SCREENING (Example of 2N2222A Family)

Test	MIL-STD-750 Method	Condition	2N2222A 2N2222AJAN	2N2222AJTX 2N2222AJTXV	2N2222AJANS
1. Electrical tests	—	go – no go	100%	100%	100%
2. High temperature storage	1032	200°C, 24 hours	—	100%	100%
3. Thermal shock	1051	C, 20 cycles	—	100%	100%
4. Constant acceleration	2006	20,000 G, Y1	—	100%	100%
5. Particle impact noise	2052	B	—	—	100%
6. Hermetic seal					
fine leak	1071	G or H	—	100%	100%
gross leak	1071	A, C, E or F	—	100%	100%
7. Electrical tests	—	read & record	—	—	100%
8. H.T. reverse bias	1039	150°C, 48 hours	—	100%	100%
9. Electrical tests	—	read & record*	—	100%	100%
10. Full-power burn-in	1039	25°C, 168 hours	—	100%	—
11. Full-power burn-in	1039	25°C, 240 hours	—	—	100%
12. Electrical tests	—	read & record*	—	100%	100%
13. Hermetic seal					
fine leak	1071	G or H	—	100%	100%
gross leak	1071	A, C, E or F	—	100%	100%
14. X-ray	2076	—	—	—	100%
15. External visual	2071	—	—	—	100%

*Bin & cell may be used for JTX and JTXV product

TABLE 2 — GROUP B TESTS (Example of 2N2222AJAN/JTX/JTXV/JANS)

Inspection or Test	MIL-STD-750 Method	Condition	LTPD (Accept No.) and Military Classification
SUBGROUP LTPD			10 (0)
Physical dimensions	2066	—	JANS
SUBGROUP LTPD			15 (1)
Solderability	2026	—	ALL
Solvent resistance	1022	—	ALL
SUBGROUP LTPD			10 (1)
Thermal shock	1051	C1, 25 cycles	JAN, JTX, JTXV
Thermal shock	1051	C3, 100 cycles	JANS
Hermetic seal			
fine leak	1071	G or H	ALL
gross leak	1071	A, C, E or F	ALL
Decap internal visual	2075	—	JANS
Bond strength	2037	A	JANS
Die shear	2017	—	JANS
SUBGROUP LTPD			5 (2)
Operating life	1027	25°C, 340 hours	JAN, JTX, JTXV
SUBGROUP LTPD			20 (0)
Decap internal visual	2075	—	JAN, JTX, JTXV
Bond strength	2037	A	JAN, JTX, JTXV
SUBGROUP LTPD			10 (2)
Intermittent operating life	1037	25°C, 2000 cycles	JANS
SUBGROUP LTPD			10 (2)
Accelerated operating life	1027	125°C, 96 hours	JANS
SUBGROUP LTPD			7 (2)
High-temperature storage life	1032	200°C, 340 hours	JAN, JTX, JTXV

TABLE 3 — GROUP C TESTS (Example of 2N2222AJAN/JTX/JTXV/JANS)

Inspection or Test	MIL-STD-750 Method	Condition	LTPD (Accept No.) and Military Classification
SUBGROUP LTPD			15 (1)
Physical dimensions	2066	—	ALL
SUBGROUP LTPD			10 (1)
Thermal shock	1056	A	ALL
Terminal strength	2036	E	ALL
Hermetic seal			
fine leak	1071	G or H	ALL
gross leak	1071	A, C, E or F	ALL
Moisture resistance	1021	Omit initial precond.	ALL
External visual	2071	—	ALL
SUBGROUP LTPD			10 (1)
Shock	2016	1500G	ALL
Variable-frequency vibration	2056	100–2000 Hz	ALL
Constant acceleration	2006	20,000 G	ALL
SUBGROUP LTPD			15 (1)
Salt atmosphere	1041	—	ALL
SUBGROUP LTPD			10 (1)
Operating life	1026	25°C, 1000 hours	ALL

High Reliability Processing of Transistors

I WAFER PROCESSING

After wafers are processed, they are subjected to Motorola visual inspection requirements and overlay geometry wafers are subjected to a sample SEM inspection to assure good step coverage. The wafers are then probed to electrical requirements and the rejects are inked. Finally, they are sawn and separated to form the individual dice.

II ASSEMBLY

The die are attached to headers and then wire bonded. The following mechanical tests are performed by Quality Control inspectors on a sample basis to ensure assembly process controls.

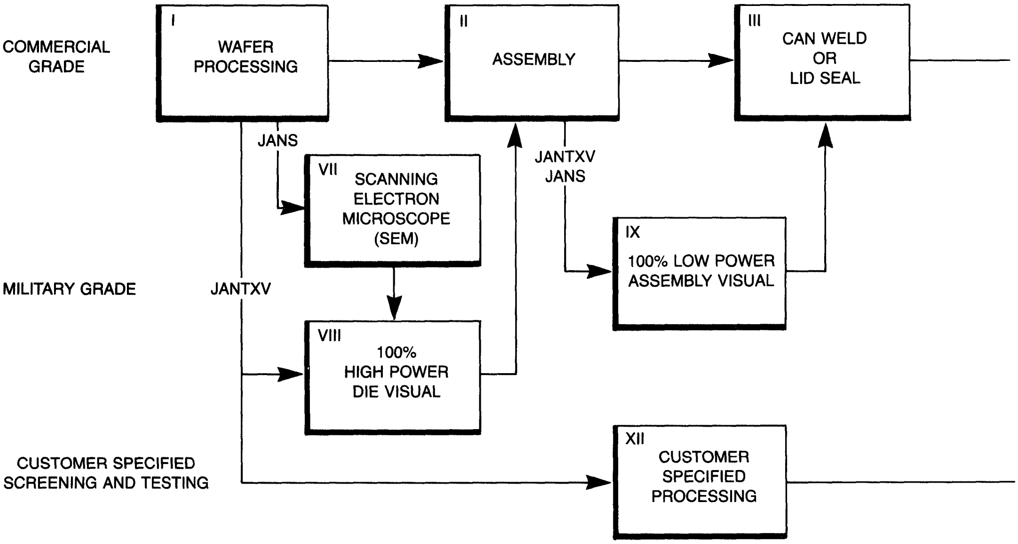
(1) Wire pull tests
(2) Die push off tests

Units are stored in dry air until ready for capping.

III CAN WELD OR LID SEAL

Completed headers are loaded into a vacuum chamber for can weld or processed thru a furnace for top attachments on ceramic packages. All devices are subjected to a high temperature storage (stabilization bake) prior to final electrical test.

PROCESSING AND QUALITY CONTROL FLOW CHART



VII SCANNING ELECTRON MICROSCOPE

All JANS product with overlay geometry requires a SEM inspection per MIL-STD-750, method 2077. To assure good metallization step coverage, Motorola monitors all overlay geometry transistor wafer lines whether or not it is required.

XII CUSTOMER SPECIFIED PROCESSING

Screening, testing and marking as determined by the customer to meet his particular requirements, which may range from a custom-marked standard product to a hi-rel product that is subjected to the most stringent tests for aerospace or military applications.

VIII 100% HIGH POWER DIE VISUAL

The high power portion of the inspection is performed to assure good die construction and front metal conditions. Individual reject criteria includes the following: Metallization defects such as scratches, voids, corrosion, adherence, bridging and alignment. Poor die construction conditions such as oxide and faults are also rejected.

IX 100% LOW POWER ASSEMBLY VISUAL

The low power visual inspection controls workmanship, i.e., die attachment, internal lead-wire attachment, and package defects. Die attachment inspection includes assuring good watting, die placement and proper orientation. Internal lead wires must have proper arc and all attachment bonds must be properly placed and in good condition. Package defect inspection includes checking for foreign material, improper construction and cracked feedthroughs.

IV 100% FINAL ELECTRICAL TEST

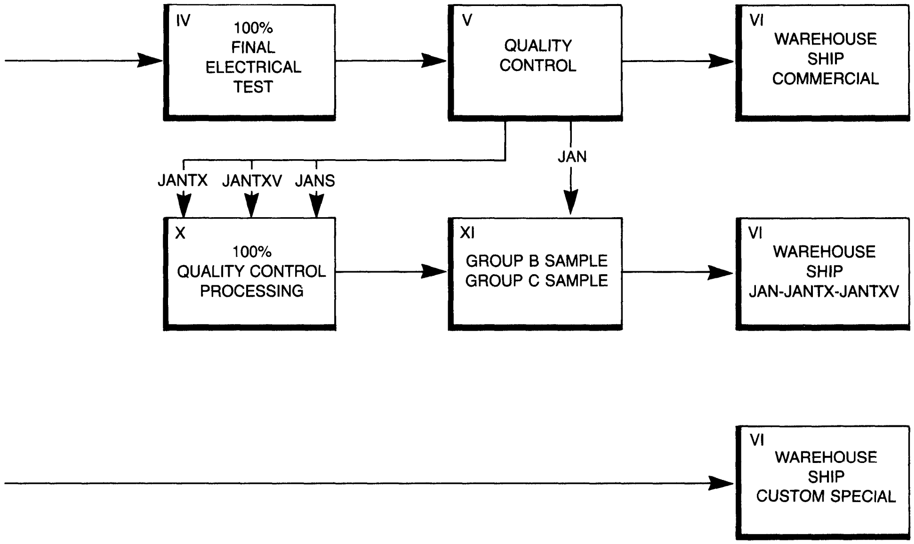
Completed devices are subjected to 100% testing to electrical requirements. When different devices are sourced from a single product line, they are sorted for voltage and gain.

V QUALITY CONTROL

Although it has been traditional for QA to perform sample testing, today most small-signal metal can transistors are 100% electrical tested by QA. Soon, all transistors will be 100% tested by QA. Group A and B tests are performed on JAN devices. Group A and B tests and 100% processing are performed on JANTX, JANTXV and JANS devices. Group C testing is required on a periodic basis.

VI WAREHOUSE

Upon completion, the finished product is ready for shipping. Purchase order requirements are carefully checked again prior to shipping. Warranty tests (Group A) are performed every 24 months on military devices.



X 100% QUALITY CONTROL PROCESSING

a. High-temperature storage
b. Thermal shock
c. Constant acceleration
d. Particle impact noise (JANS)
e. Hermetic seal
f. High-temperature reverse bias
g. Full-power burn-in
h. X-ray (JANS)
i External visual (JANS)
j. Read and record parameters

XI GROUP B AND GROUP C INSPECTION

Typical Group B Processing	Typical Group C Processing
a. Physical dimensions	a. Physical dimensions
b. Solderability	b. Thermal shock
c. Solvent resistance	c. Terminal strength
d. Thermal shock	d. Hermetic seal
e. Hermetic seal	e. Moisture resistance
f. Decap internal visual	f. External visual
g. Bond strength	g. Shock
h. Die shear	h. Variable-frequency vibration
i. 340 hr. operating life	i. Constant acceleration
j. Intermittent operating life (JANS)	j. Salt atmosphere
k. Accelerated operating life (JANS)	k. 1000 hr. operating life
l. 340 hr. storage life	

Test Descriptions

The following tests are frequently used for screening, acceptance and evaluation of semiconductor devices.

A. Steady State Operating Life (SSOL)

The purpose of this test is to evaluate the bulk stability of the die and to generate defects resulting from manufacturing aberrations that are manifested as time and stress-dependent failures.

Conditions: T_A = 25°C, PD = max rated power

B. Intermittent Operating Life (IOL)

The purpose of this test is the same as Operating Life in addition to checking the integrity of both the wire and die bonds by means of thermal stressing.

Conditions: T_A = 25°C, PD = max rated power. $T_{(on)}$ = $T_{(off)}$ = 1 min.

C. High Temperature Storage Life

The purpose of this test is to generate time/temperature failure mechanisms and to evaluate long-term storage stability.

Conditions: T_A = 150°C no bias applied

D. High Temperature Reverse Bias (HTRB)

The purpose of this test is to align mobile ions by means of temperature and voltage stresses to form a high-current leakage path between two or more terminals.

Conditions: T_A = 150°C, V_{CB} = 80% max rated V_{CB},

E. High Temperature High Humidity Reverse Bias (H^3TRB)

The purpose of this test is to evaluate the moisture resistance of non-hermetic components. The addition of voltage bias accelerates the corrosive effect after moisture penetration has taken place. With time, this is a catastrophically destructive test.

Conditions: T_A = 85°C, RH = 85%, V_{CB} = 80% max rated V_{CB},

F. Moisture Resistance

The purpose of this test is to evaluate the moisture resistance of components under temperature/humidity conditions typical of tropical environments.

Conditions: Mil-Std-750, Method 1021.

G. Pressure Cooker

The purpose of this test is to evaluate the moisture resistance of non-hermetic components under pressure/temperature conditions.

Conditions: T = 121°C, P = 1 atmosphere (15 psig)

H. Temperature Cycle (Air to Air)

The purpose of this test is to evaluate the ability of the device to withstand both exposure to extreme temperatures and the transition between temperature extremes, and to expose excessive thermal mismatch between materials.

Conditions: Mil-Std-750, Method 1051, −55°C to 150°C, 15 minutes dwell time at each temperature

I. Thermal Shock (Liquid to Liquid)

This test is an accelerated version of temperature cycle.

Conditions: Mil-Std-750, Method 1056, 0°C to 100°C, 15 seconds dwell time at each temperature

J. Terminal Strength

The purpose of this test is to evaluate the ability of the device terminals to withstand the lead forming and tension associated with component installation into a circuit.

Conditions: Mil-Std-750, Method 2036, Condition E.

K. Solderability

The purpose of this test is to determine the solderability of the device terminals.

Conditions: Mil-Std-750, Method 2026.

L. Salt Atmosphere (Corrosion)

The purpose of this test is to accelerate the corrosion effects of an environment in which salt (NaC1) is present.

Conditions: Mil-Std-750, Method 1041

M. Mechanical Stress Tests

Vibration, shock and constant acceleration tests are infrequently used since they rarely generate failures in small-signal transistors. However, they are still specified for acceptance of military product.

Glossary of Reliability and Quality Terms

Acceptable Quality Level (AQL) — A measure of quality for which a given lot will be accepted most of the time. This is usually established at a probability of acceptance equal to 95%. It is referred to as the producer's risk because the probability of rejecting a good lot is 5%.

Acceptance Number (Ac) — The largest number of defectives in an inspection sample under consideration that will permit acceptance of the lot.

Acceptance Tests — Tests to determine conformance to specification requirements as a basis for lot acceptance.

Average Outgoing Quality (AOQ) — The average quality of outgoing product after 100% screening of rejected lots. This is usually measured in parts per million (PPM).

Average Outgoing Quality Limit (AOQL) — The maximum average outgoing quality that is possible for a given sampling plan.

Defect — Any deviation of a device that does not conform to specified requirements. One device may contain more than one defect.

Defective — A device which contains one or more defects.

Double Sampling — Sampling inspection in which the inspection of the first sample leads to a decision to accept, to reject, or to take a second sample. The inspection of a second sample, when required, always leads to a decision to accept or to reject.

Failure — The inability of a device to perform a specified function within previously-established limits.

Failure Rate — The statistical probability of a failure occurring within a stated period of time. For electronic components it is usually assumed that failures follow an exponential distribution, in which case the failure rate over any stated period of time is constant. The failure rate of semiconductor devices is generally given in percent per thousand hours.

Infant Mortality — Premature failures occurring at a failure rate substantially greater than that observed during subsequent life prior to wear-out.

Lot — A group of devices from which samples are drawn and inspected to determine compliance with acceptance criteria (inspection lot).

Lot Tolerance Percent Defective (LTPD) — A measure of quality for which a given lot will be rejected most of the time. This is usually established at a probability of acceptance equal to 10%. It is referred to as the consumer's risk because the probability of accepting a bad lot is 10%.

Mean Time Between Failures (MTBF) — The total measured operating time of a group of equipments divided by the total number of failures of a repairable equipment. In the case of an exponential failure distribution, this ratio is the reciprocal of failure rate.

Operating Characteristic Curve (OC curve) — A graph of the probability of acceptance as a function of the lot quality or process average quality, whichever is applicable.

Percent Defective — The number of defective devices in a lot divided by the total number of devices in that lot, multiplied by 100.

Probability of Acceptance (Pa) — The fractional probability that a lot will be accepted, usually expressed as a decimal.

Process Average Quality — The expected quality of product from a given process, usually estimated from first sample results of previous inspection lots.

Quality — A measure of the degree to which a product conforms to specification and workmanship requirements.

Rejection Number (Re) — The smallest number of defectives in an inspection sample under consideration that will prevent acceptance of the lot.

Reliability — A measure of the performance of a product over a specified period of time.

Sample — One or more devices selected at random from an inspection lot to represent that lot for acceptance purposes.

Sampling Plan — A specific plan which defines the sample size and the criteria for accepting or rejecting a lot.

Screening Tests — Tests employing nondestructive environmental, electrical, thermal and/or mechanical stresses, for the purpose of identifying anomalous devices.

Single Sampling — Sampling inspection in which a decision to accept or to reject is reached after the inspection of a single sample.

Wearout Failures — Those failures which occur as a result of deterioration processes and whose probability of occurrence increases with time.

100% Inspection — Inspection of every device, in which each device is accepted or rejected individually for the characteristic concerned, on the basis of its own inspection only.

1 **Selector Guides**

2 **Plastic-Encapsulated Transistors**

3 **Metal-Can Transistors**

4 **Field-Effect Transistors**

5 **Small-Signal Tuning, Switching and Zener Diodes**

6 **Tape and Reel Specifications**

7 **Package Outline Dimensions and Application Literature**

8 **Reliability and Quality Assurance**

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