

ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

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*Consult Motorola if a direct replacement is necessary.

TABLE 4 — PLASTIC TO-218 (continued)

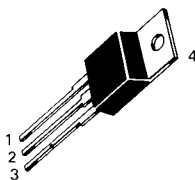
I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
15	400	BUV48†		8 min	10	2	0.4	10		150
		MJH13090		8 min	10	2.5	0.5	10		125
		MJH16110		6/20	10	0.8 typ	0.1 typ	10		135
	450	BUV48A†		8 min	8	2	0.4	10		150
		MJH16010		5 min	15	1.2	0.2	10		150
		MJH16012		7 min	15	0.9	0.15	10		150
	500	BUT51P##†		40 min	5	1.1	0.16	10		125
		MJH16010A		5 min	15	3	0.4	10		150
	16									
16	100	MJE4340	MJE4350	15 min	8	1.2 typ	1.2 typ	8	1	125
	120	MJE4341	MJE4351	15 min	8	1.2 typ	1.2 typ	8	1	125
	140	MJE4342	MJE4352	15 min	8	1.2 typ	1.2 typ	8	1	125
	160	MJE4343	MJE4353	15 min	8	1.2 typ	1.2 typ	8	1	125
20	60	MJH6282##	MJH6285##	750/18k	10				4#	125
	80	MJH6283##	MJH6286##	750/18k	10				4#	125
	100	MJH6284##	MJH6287##	750/18k	10				4#	125
25	40	TIP35	TIP36	10/75	15	0.6 typ	0.3 typ	10	3	125
	45	BD249†	BD250†	10 min	15				3	125
	60	BD249A†	BD250A†	10 min	15				3	125
		TIP35A	TIP36A	10/75	15	0.6 typ	0.3 typ	10	3	125
	80	BD249B†	BD250B†	10 min	15				3	125
		TIP35B	TIP36B	10/75	15	0.6 typ	0.3 typ	10	3	125
	100	BD249C†	BD250C†	10 min	15				3	125
		TIP35C	TIP36C	10/75	15	0.6 typ	0.3 typ	10	3	125

I_{hfe1} at 1 MHz, ## Darlington

† These devices supplied in Case 340D-01. Consult Motorola for details.

TABLE 5 — PLASTIC TO-220

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR


CASE 221A-04 (TO-220AB)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			f _T MHz Min	P _D (Case) Watts @ 25°C
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp		
0.5	350	MJE2360T		15 min	0.1				10 typ	30
		MJE2361T		40 min	0.1				10 typ	30
1	40	TIP29	TIP30	15/75	1	0.6 typ	0.3 typ	1	3	30
	60	TIP29A	TIP30A	15/75	1	0.6 typ	0.3 typ	1	3	30
	80	TIP29B	TIP30B	15/75	1	0.6 typ	0.3 typ	1	3	30
	100	TIP29C	TIP30C	15/75	1	0.6 typ	0.3 typ	1	3	30
	250	TIP47		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	300	TIP48		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	350	TIP49		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	400	TIP50		30/150	0.3	2 typ	0.18 typ	0.3	10	40

(continued)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

NPN
TIP35
TIP35A
TIP35B
TIP35C

PNP
TIP36
TIP36A
TIP36B
TIP36C

COMPLEMENTARY SILICON HIGH-POWER TRANSISTORS

... for general-purpose power amplifier and switching applications.

- 25 A Collector Current
- Low Leakage Current — $I_{CEO} = 1.0 \text{ mA}$ @ 30 and 60 V
- Excellent dc Gain — $h_{FE} = 40 \text{ Typ}$ @ 15 A
- High Current Gain Bandwidth Product — ($h_{fe} = 3.0 \text{ min}$ @ $I_C = 1.0 \text{ A}$, $f = 1.0 \text{ MHz}$)

25 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS

40-100 VOLTS
125 WATTS

MAXIMUM RATINGS

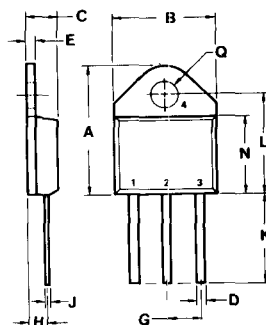
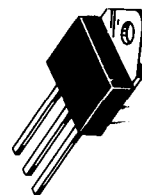
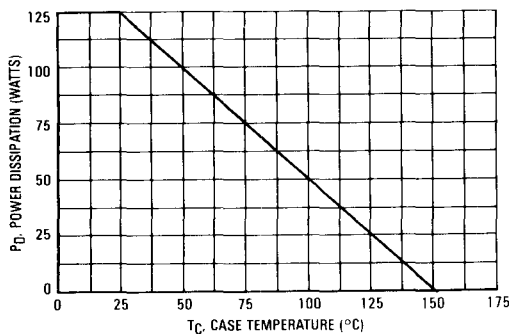
Rating	Symbol	TIP35 TIP36	TIP35A TIP36A	TIP35B TIP36B	TIP35C TIP36C	Unit
Collector-Emitter Voltage	V_{CEO}	40 V	60 V	80 V	100 V	Vdc
Collector-Base Voltage	V_{CB}	40 V	60 V	80 V	100 V	Vdc
Emitter-Base Voltage	V_{EB}	5.0				Vdc
Collector Current — Continuous Peak (1)	I_C	25 40				Adc
Base Current — Continuous	I_B	5.0				Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C	P_D	125 1.0				Watts W/ $^\circ\text{C}$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150				$^\circ\text{C}$
Unclamped Inductive Load	E_{SB}	90				mJ

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	$^\circ\text{C}/\text{W}$
Junction-To-Free-Air Thermal Resistance	$R_{\theta JA}$	35.7	$^\circ\text{C}/\text{W}$

(1) Pulse Test: Pulse Width = 10 ms, Duty Cycle $\leq 10\%$.

FIGURE 1 — POWER DERATING



STYLE 1:

1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.32	21.08	0.800	0.830
B	15.49	15.90	0.610	0.625
C	4.13	5.08	0.165	0.200
D	1.02	1.65	0.040	0.065
E	1.35	1.65	0.053	0.065
G	5.21	5.72	0.205	0.225
H	2.41	3.20	0.095	0.126
J	0.38	0.64	0.015	0.025
K	12.70	15.49	0.500	0.610
L	15.88	16.51	0.625	0.650
N	12.19	12.70	0.480	0.500
Q	4.04	4.22	0.159	0.166

CASE 340-02
TO-218AC

TIP35, TIP35A, TIP35B, TIP35C,NPN, TIP36, TIP36A, TIP36B, TIP36C,PNP

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ\text{C}$ unless otherwise noted)

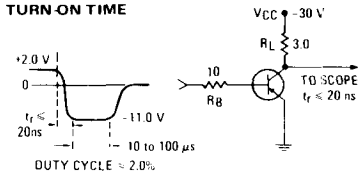
Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (1) ($I_C = 30\text{ mA}$, $I_B = 0$)	$V_{CEO(sus)}$	40 60 80 100	— — — —	Vdc
Collector-Emitter Cutoff Current ($V_{CE} = 30\text{ V}$, $I_B = 0$) ($V_{CE} = 60\text{ V}$, $I_B = 0$)	I_{CEO}	— —	1.0 1.0	mA
Collector-Emitter Cutoff Current ($V_{CE} = \text{Rated } V_{CEO}$, $V_{EB} = 0$)	I_{CES}	—	0.7	mA
Emitter-Base Cutoff Current ($V_{EB} = 5.0\text{ V}$, $I_C = 0$)	I_{EBO}	—	1.0	mA
ON CHARACTERISTICS (1)				
DC Current Gain ($I_C = 1.5\text{ A}$, $V_{CE} = 4.0\text{ V}$) ($I_C = 15\text{ A}$, $V_{CE} = 4.0\text{ V}$)	h_{FE}	25 15	— 75	—
Collector-Emitter Saturation Voltage ($I_C = 15\text{ A}$, $I_B = 1.5\text{ A}$) ($I_C = 25\text{ A}$, $I_B = 5.0\text{ A}$)	$V_{CE(sat)}$	— —	1.8 4.0	Vdc
Base-Emitter On Voltage ($I_C = 15\text{ A}$, $V_{CE} = 4.0\text{ V}$) ($I_C = 25\text{ A}$, $V_{CE} = 4.0\text{ V}$)	$V_{BE(on)}$	— —	2.0 4.0	Vdc
DYNAMIC CHARACTERISTICS				
Small-Signal Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 10\text{ V}$, $f = 1.0\text{ kHz}$)	h_{fe}	25	—	—
Current-Gain—Bandwidth Product (2) ($I_C = 1.0\text{ A}$, $V_{CE} = 10\text{ V}$, $f = 1.0\text{ MHz}$)	f_T	3.0	—	MHz

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

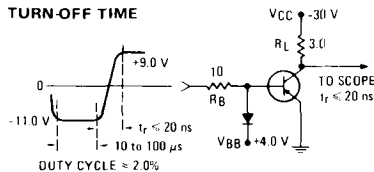
3

FIGURE 2 — SWITCHING TIME EQUIVALENT TEST CIRCUITS

TURN-ON TIME



TURN-OFF TIME



FOR CURVES OF FIGURES 3 & 4, R_B & R_L ARE VARIED.
INPUT LEVELS ARE APPROXIMATELY AS SHOWN.
FOR NPN, REVERSE ALL POLARITIES.

FIGURE 3 — TURN-ON TIME

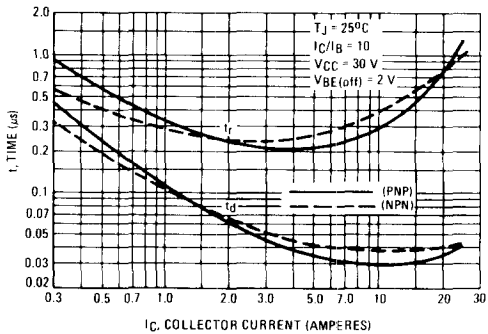


FIGURE 4 — TURN-OFF TIME

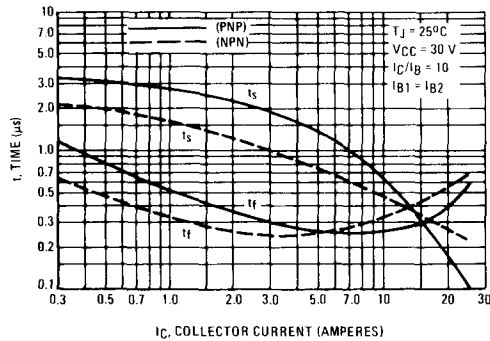
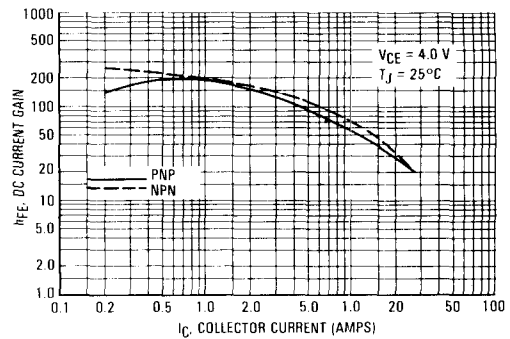


FIGURE 5 — DC CURRENT GAIN



FORWARD BIAS

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 6 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% but must be derated when T_C ≥ 25°C. Second breakdown limitations do not derate the same as thermal limitations.

REVERSE BIAS

For inductive loads, high voltage and high current must be sustained simultaneously during turn-off, in most cases, with the base to emitter junction reverse biased. Under these conditions the collector voltage must be held to a safe level at or below a specific value of collector current. This can be accomplished by several means such as active clamping, RC snubbing, load line shaping, etc. The safe level for these devices is specified as Reverse Bias Safe Operating Area and represents the voltage-current conditions during reverse biased turn-off. This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode. Figure 7 gives RBSOA characteristics.

FIGURE 6 — MAXIMUM RATED FORWARD BIAS SAFE OPERATING AREA

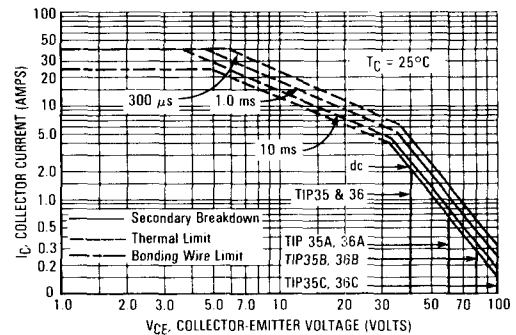


FIGURE 7 — MAXIMUM RATED REVERSE BIAS SAFE OPERATING AREA

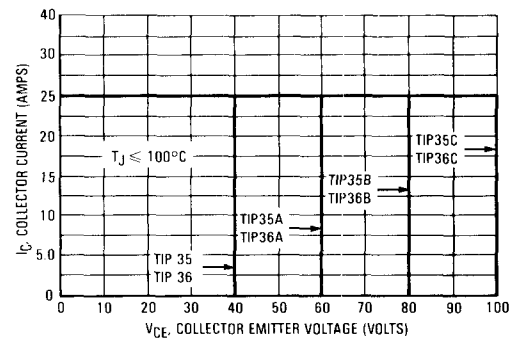
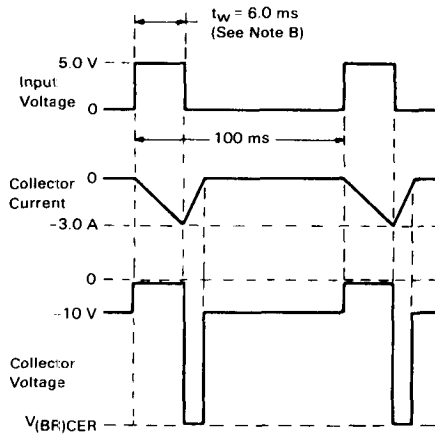
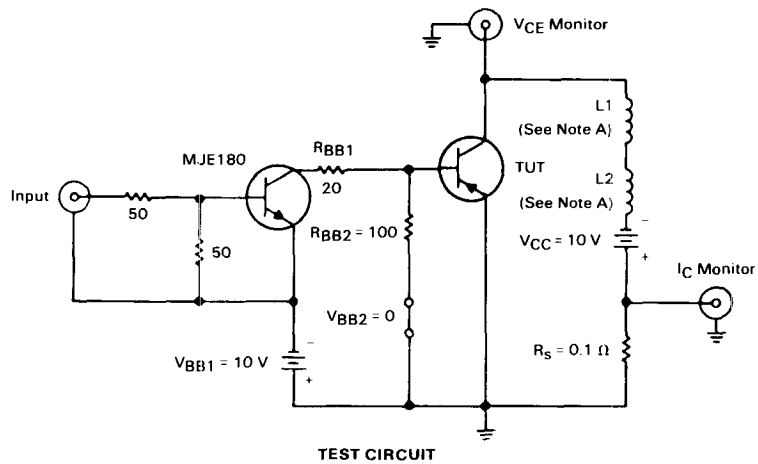


FIGURE 8 — INDUCTIVE LOAD SWITCHING



VOLTAGE AND CURRENT WAVEFORMS

NOTES:

- A. L1 and L2 are 10 mH, 0.11 Ω , Chicago Standard Transformer Corporation C-2688, or equivalent.
- B. Input pulse width is increased until $I_{CM} = -3.0$ A.
- C. For NPN, reverse all polarities.