ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
TIP107	TIP107		3-1091
TIP110	TIP110		3-1095
TIP111	TIP111		3-1095
TIP112	TIP112		3-1095
TIP115	TIP115		3-1095
TIP116	TIP116		3-1095
TIP117	TIP117		3-1095
TIP120	TIP120		3-1098
TIP121	TIP121		3-1098
TIP122	TIP122		3-1098
TIP125	TIP125		3-1098
TIP126	TIP126		3-1098
TIP127	TIP127		3-1098
TIP140	TIP140		3-1104
TIP140T		TIP100	3-1091
TIP141	TIP141		3-1104
TIP141T		TIP101	3-1091
TIP142	TIP142		3-1104
TIP142T		TIP102	3-1091
TIP145	TIP145		3-1104
TIP145T		TIP105	3-1091
TIP146	TIP146		3-1104
TIP146T		TIP106	3-1091
TIP147	TIP147		3-1104
TIP147T		TIP107	3-1091
TIP150		MJE13006	3-950
TIP151		MJE13007	3-950
TIP152		MJE13007	3-950
TIP160		MJE5740	3-914
TIP161		MJE5741	3-914
TIP162		MJE5742	3-914
TIP29	TIP29		3-1071
TIP2955	TIP2955		3-1108
TIP29A	TIP29A		3-1071
TIP29B	TIP29B		3-1071
TIP29C	TIP29C		3-1071
TIP29D		MJE15030	3-972
TIP29E		MJE15030	3-972
TIP29F		MJE15030	3-972
TIP30	TIP30		3-1071
TIP3055	TIP3055		3-1108
TIP30A	TIP30A		3-1071
TIP30B	TIP30B		3-1071
TIP30C	TIP30C		3-1071
TIP30D		MJE15031	3-972
TIP30E		MJE15031	3-972
TIP30F		MJE15031	3-972
TIP31	TIP31		3-1073
TIP31A	TIP31A		3-1073
TIP31B	TIP31B		3-1073
TIP31C	TIP31C		3-1073
TIP31D		MJE15030	3-972
TIP31E		MJE15030	3-972
TIP31F		MJE15030	3-972
TIP32	TIP32		3-1073
TIP32A	TIP32A		3-1073
TIP32B	TIP32B		3-1073
TIP32C	TIP32C		3-1073
TIP32D		MJE15031	3-972
TIP32E		MJE15031	3-972
TIP32F		MJE15031	3-972
TIP33	TIP33		3-1077
TIP33A	TIP33A		3-1077
TIP33B	TIP33B		3-1077
TIP33C	TIP33C		3-1077
TIP34	TIP34		3-1077
TIP34A	TIP34A		3-1077
TIP34B	TIP34B		3-1077
TIP34C	TIP34C		3-1077
TIP35	TIP35		3-1079
TIP35A	TIP35A		3-1079
TIP35B	TIP35B		3-1079
TIP35C	TIP35C		3-1079
TIP36	TIP36		3-1079
TIP36A	TIP36A		3-1079
TIP36B	TIP36B		3-1079
TIP36C	TIP36C		3-1079
TIP41	TIP41		3-1083
TIP41A	TIP41A		3-1083
TIP41B	TIP41B		3-1083
TIP41C	TIP41C		3-1083
TIP41D		MJE15030	3-972
TIP41E		MJE15030	3-972
TIP41F		MJE15030	3-972
TIP42	TIP42		3-1083
TIP42A	TIP42A		3-1083
TIP42B	TIP42B		3-1083
TIP42C	TIP42C		3-1083
TIP42D		MJE15031	3-972
TIP42E		MJE15031	3-972
TIP42F		MJE15031	3-972
TIP47	TIP47		3-1087
TIP48	TIP48		3-1087
TIP49	TIP49		3-1087
TIP50	TIP50		3-1087
TIP510		MJ15011	3-716
TIP511		MJ15011	3-716
TIP512		MJ15011	3-716
TIP513		MJ15012	3-716
TIP514		MJE15030	3-972
TIP517		2N6339	3-188
TIP518		2N6341	3-188
TIP519		MJ15012	3-716
TIP520		MJ15012	3-716
TIP521		2N6211	3-161
TIP522		2N6211	3-161
TIP523		MJ15012	3-716
TIP524		2N6497	3-211
TIP525		MJ15011	3-716
TIP526		MJ15011	3-716
TIP527		MJ15012	3-716
TIP528		MJ15012	3-716
TIP536		MJ16006	3-742
TIP545		MJ15016	3-9
TIP546		MJ15016	3-9
TIP550		MJ12002	3-637
TIP551		MJ12003	3-642
TIP552		MJ12004	3-644
TIP553		MJ12004	3-644
TIP554		MJ13080	3-682

*Consult Motorola if a direct replacement is necessary.

TABLE 4 — PLASTIC TO-218 (continued)

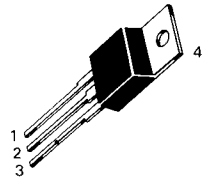
I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s μs Max	Resistive Switching t_f μs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
15	400	BUV48†		8 min	10	2	0.4	10		150
		MJH13090		8 min	10	2.5	0.5	10		125
		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	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

$|h_{fe}|$ @ 1 MHz, ## Darlington
† These devices supplied in Case 340D-01. Consult Motorola for details.

2

TABLE 5 — PLASTIC TO-220

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



CASE 221A-04 (TO-220AB)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s μs Max	Resistive Switching t_f μs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
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	PNP
TIP35	TIP36
TIP35A	TIP36A
TIP35B	TIP36B
TIP35C	TIP36C

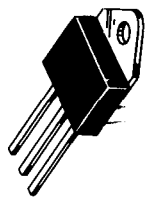
COMPLEMENTARY SILICON HIGH-POWER TRANSISTORS

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

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

25 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS

40-100 VOLTS
125 WATTS



MAXIMUM RATINGS

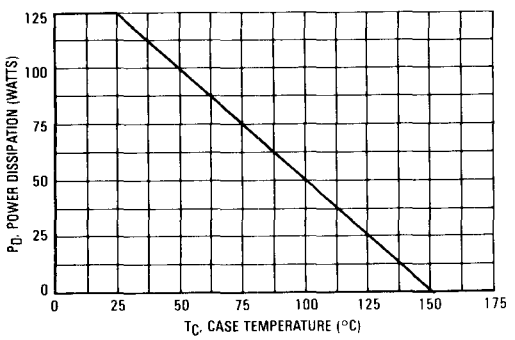
Rating	Symbol	TIP35 TIP36	TIP35A TIP36A	TIP35B TIP36B	TIP35C TIP36C	Unit
Collector-Emitter Voltage	V_{CEO}	40 V	60 V	80 V	100 V	Vdc
Collector-Base Voltage	V_{CB}	40 V	60 V	80 V	100 V	Vdc
Emitter-Base Voltage	V_{EB}	5.0				Vdc
Collector Current — Continuous	I_C	25				Adc
Peak (1)		40				
Base Current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

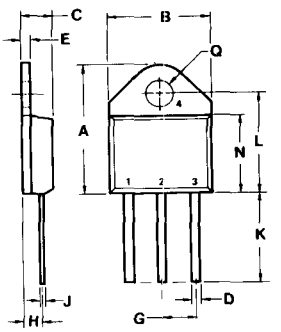
THERMAL CHARACTERISTICS

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

(1) Pulse Test: Pulse Width = 10 ms, Duty Cycle ≤10%.

FIGURE 1 — POWER DERATING





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

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.32	21.08	0.800	0.830
B	15.49	15.90	0.610	0.626
C	4.19	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

3

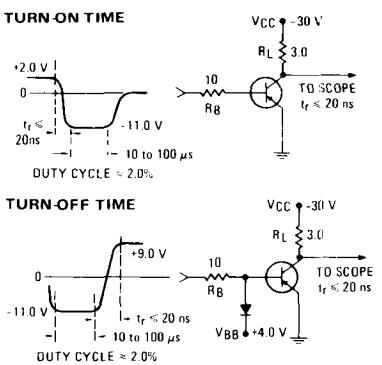
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1) (I_C = 30 mA, I_B = 0)	TIP35, TIP36	$V_{CEO(sus)}$	40	—	Vdc
	TIP35A, TIP36A		60	—	
	TIP35B, TIP36B		80	—	
	TIP35C, TIP36C		100	—	
Collector-Emitter Cutoff Current		I_{CEO}			mA
(V_{CE} = 30 V, I_B = 0)	TIP35, TIP35A, TIP36, TIP36A		—	1.0	
(V_{CE} = 60 V, I_B = 0)	TIP35B, TIP35C, TIP36B, TIP36C		—	1.0	
Collector-Emitter Cutoff Current (V_{CE} = Rated V_{CEO}, V_{EB} = 0)		I_{CES}	—	0.7	mA
Emitter-Base Cutoff Current (V_{EB} = 5.0 V, I_C = 0)		I_{EBO}	—	1.0	mA
ON CHARACTERISTICS (1)					
DC Current Gain		h_{FE}			—
(I_C = 1.5 A, V_{CE} = 4.0 V)			25	—	
(I_C = 15 A, V_{CE} = 4.0 V)			15	75	
Collector-Emitter Saturation Voltage		$V_{CE(sat)}$			Vdc
(I_C = 15 A, I_B = 1.5 A)			—	1.8	
(I_C = 25 A, I_B = 5.0 A)			—	4.0	
Base-Emitter On Voltage		$V_{BE(on)}$			Vdc
(I_C = 15 A, V_{CE} = 4.0 V)			—	2.0	
(I_C = 25 A, V_{CE} = 4.0 V)			—	4.0	
DYNAMIC CHARACTERISTICS					
Small-Signal Current Gain (I_C = 1.0 A, V_{CE} = 10 V, f = 1.0 kHz)		h_{fe}	25	—	—
Current-Gain—Bandwidth Product (2) (I_C = 1.0 A, V_{CE} = 10 V, f = 1.0 MHz)		f_T	3.0	—	MHz

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

3

FIGURE 2 — SWITCHING TIME EQUIVALENT TEST CIRCUITS



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

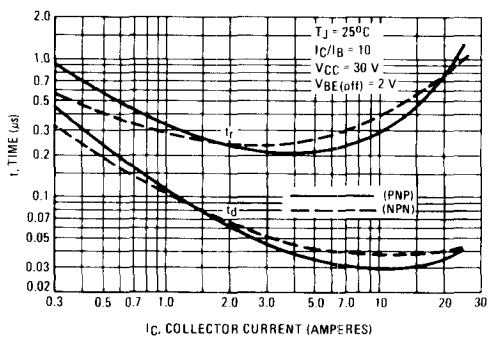


FIGURE 4 — TURN-OFF TIME

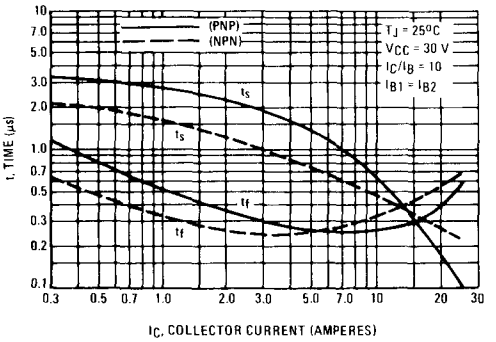
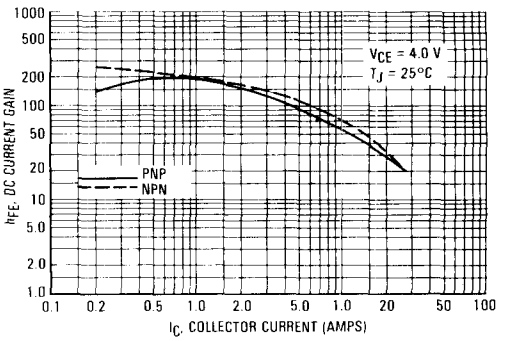


FIGURE 5 — DC CURRENT GAIN



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 $T_C \geqslant 25°C$. 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

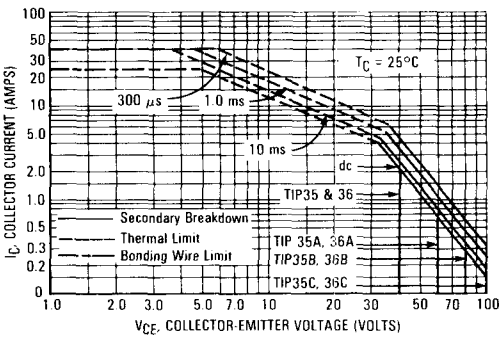
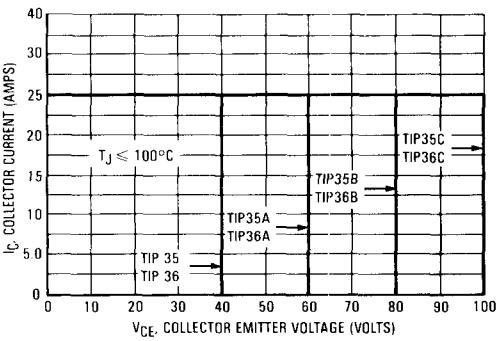
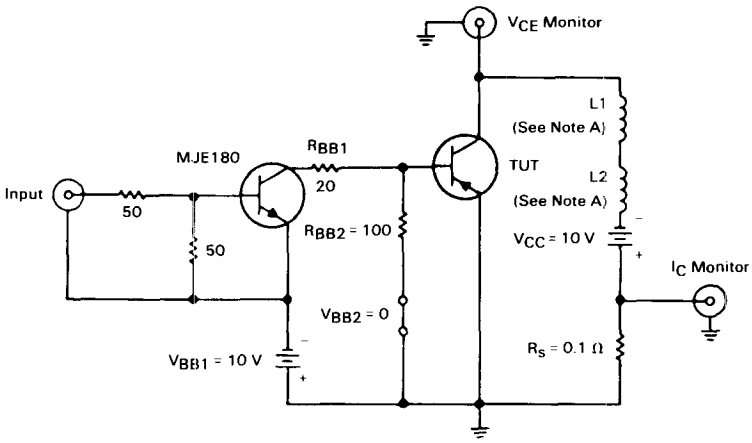


FIGURE 7 — MAXIMUM RATED REVERSE BIAS SAFE OPERATING AREA

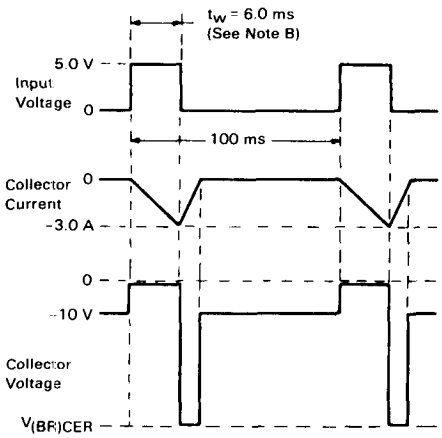


3

FIGURE 8 — INDUCTIVE LOAD SWITCHING



TEST CIRCUIT



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.

3