

TABLE 5 — PLASTIC TO-220 (Continued)

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		hFE 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		
2	45	BD239	BD240	15 min	1				3	30
	60	BD239A TIP110##	BD240A TIP115##	15 min 500 min	1 2	1.7 typ	1.3 typ	2	3 25#	30 50
	80	BD239B TIP111##	BD240B TIP116##	15 min 500 min	1 2	1.7 typ	1.3 typ	2	3 25#	30 50
	100	BD239C TIP112##	BD240C TIP117##	25 min 500 min	1 2	1.7 typ	1.3 typ	2	3 25#	30 50
	400	BUX84		30 min	0.1	3.5	1.4	1	4	50
	450	BUX85		30 min	0.1	3.5	1.4	1	4	50
	900	MJE1320		3 min	1	4 typ	0.8 typ	1		80
2.5	700	MJE8500		7.5 min	0.5	4	2	1		65
	750	MJE12007		1.1 min	2		1	2	4 typ	65
	800	MJE8501		7.5 min	0.5	4	2	1		65
3	40	TIP31	TIP32	25 min	1	0.6 typ	0.3 typ	1	3	40
	45	BD241	BD242	25 min	1				3	40
	60	BD241A TIP31A	BD242A TIP32A	25 min 25 min	1 1	0.6 typ	0.3 typ	1	3 3	40 40
	80	BD241B TIP31B	BD242B TIP32B	25 min 25 min	1 1	0.6 typ	0.3 typ	1	3 3	40 40
	100	BD241C TIP31C	BD242C TIP32C	25 min 25 min	1 1	0.6 typ	0.3 typ	1	3 3	40 40
	750	MJE16032		4 min	3	2	1.5	2		80
	850	MJE16034		4 min	3	2	1.5	2		80
4	45	2N6121	2N6124	25/100	1.5	0.4 typ	0.3 typ	1.5	2.5	40
	60	2N6122 BD535 MJE800T##	2N6125 MJE700T##	25/100 25 min 750 min	1.5 2 1.5	0.4 typ	0.3 typ	1.5	2.5 3 1#	40 50 40
	80	2N6123		20/80	1.5	0.4 typ	0.3 typ	1.5	2.5	40
	300	MJE13004		6/30	3	3	0.7	3	4	60
	400	MJE13005		6/30	3	3	0.7	3	4	60
5	60	TIP120##	TIP125##	1k min	3	1.5 typ	1.5 typ	3	4#	65
	80	TIP121##	TIP126##	1k min	3	1.5 typ	1.5 typ	3	4#	65
	100	TIP122##	TIP127##	1k min	3	1.5 typ	1.5 typ	4	4#	75
	250	2N6497		10/75	2.5	1.8	0.8	2.5	5	80
	300	2N6498		10/75	2.5	1.8	0.8	2.5	5	80
	400	MJE13070		8 min	3	1.5	0.5	3		80
	450	MJE16002 MJE16004		5 min 7 min	5 5	3 2.7	0.3 0.35	3 3		80 80
	700	MJE8502		7.5 min	1	4	2	2.5		80
	800	MJE8503		7.5 min	1	4	2	2.5		80
6	40	TIP41	TIP42	15/75	3	0.4 typ	0.15 typ	3	3	65
	45	BD243	BD244	15 min	3				3	65
	60	BD243A TIP41A	BD244A TIP42A	15 min 15/75	3 3	0.4 typ	0.15 typ	3	3 3	65 65
	80	BD243B TIP41B	BD244B TIP42B	15 min 15/75	3 3	0.4 typ	0.15 typ	3	3 3	65 65
	100	BD243C TIP41C	BD244C TIP42C	15 min 15/75	3 3	0.4 typ	0.15 typ	3	3 3	65 65
7	30	2N6288	2N6111	30/150	3	0.4 typ	0.15 typ	3	4	40

[h_{FE}] @ 1 MHz, ## Darlington

(continued)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

PNP
TIP31
TIP31A
TIP31B
TIP31C

PNP
TIP32
TIP32A
TIP32B
TIP32C

COMPLEMENTARY SILICON PLASTIC POWER TRANSISTORS

... designed for use in general purpose amplifier and switching applications.

- Collector-Emitter Saturation Voltage —
 $V_{CE(sat)} = 1.2 \text{ Vdc (Max) @ } I_C = 3.0 \text{ Adc}$
- Collector-Emitter Sustaining Voltage —
 $V_{CEO(sus)} = 40 \text{ Vdc (Min) — TIP31, TIP32}$
 $= 60 \text{ Vdc (Min) — TIP31A, TIP32A}$
 $= 80 \text{ Vdc (Min) — TIP31B, TIP32B}$
 $= 100 \text{ Vdc (Min) — TIP31C, TIP32C}$
- High Current Gain — Bandwidth Product
 $f_T = 3.0 \text{ MHz (Min) @ } I_C = 500 \text{ mAdc}$
- Compact TO-220 AB Package
- TO-66 Leadform Also Available

*MAXIMUM RATINGS

Rating	Symbol	TIP31 TIP32	TIP31A TIP32A	TIP31B TIP32B	TIP31C TIP32C	Unit
Collector-Emitter Voltage	V_{CEO}	40	60	80	100	V _{dc}
Collector-Base Voltage	V_{CB}	40	60	80	100	V _{dc}
Emitter-Base Voltage	V_{EB}	5.0				V _{dc}
Collector Current - Continuous Peak	I_C	3.0				A _{dc}
		5.0				
Base Current	I_B	1.0				A _{dc}
Total Power Dissipation @ $T_C = 25^{\circ}\text{C}$ Derate above 25°C	P_D	40				Watts W/ $^{\circ}\text{C}$
		0.32				
Total Power Dissipation @ $T_A = 25^{\circ}\text{C}$ Derate above 25°C	P_D	2.0				Watts W/ $^{\circ}\text{C}$
		0.016				
Unclamped Inductive Load Energy (1)	E	32				mJ
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150				$^{\circ}\text{C}$

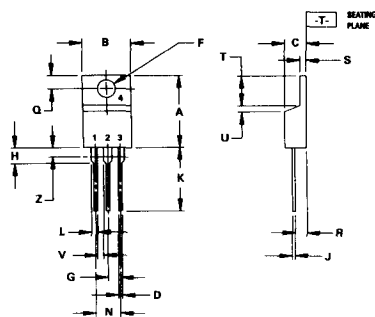
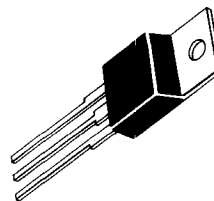
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$

(1) $I_C = 1.8 \text{ A}$, $L = 20 \text{ mH}$, P.R.F. = 10 Hz, $V_{CC} = 10 \text{ V}$, $R_{BE} = 100 \Omega$.

3 AMPERE POWER TRANSISTORS COMPLEMENTARY SILICON

40-60-80-100 VOLTS
40 WATTS



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI
Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND
LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.40	15.75	0.571	0.620
B	9.66	10.29	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.46	0.71	0.018	0.028
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.75	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

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

CASE 221A-04
TO-220AB

TIP31, TIP31A, TIP31B, TIP31C, NPN, TIP32, TIP32A, TIP32B, TIP32C, PNP

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

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (1) ($I_C = 30\text{ mA}$, $I_B = 0$)	$V_{CE(sus)}$	40 60 80 100	— — — —	Vdc
Collector Cutoff Current ($V_{CE} = 30\text{ Vdc}$, $I_B = 0$)	I_{CEO}	—	0.3	mA
($V_{CE} = 60\text{ Vdc}$, $I_B = 0$)		—	0.3	
Collector Cutoff Current ($V_{CE} = 40\text{ Vdc}$, $V_{EB} = 0$)	I_{CES}	—	200	μA
($V_{CE} = 60\text{ Vdc}$, $V_{EB} = 0$)		—	200	
($V_{CE} = 80\text{ Vdc}$, $V_{EB} = 0$)		—	200	
($V_{CE} = 100\text{ Vdc}$, $V_{EB} = 0$)		—	200	
Emitter Cutoff Current ($V_{BE} = 5.0\text{ Vdc}$, $I_C = 0$)	I_{EBO}	—	1.0	mA
ON CHARACTERISTICS (1)				
DC Current Gain ($I_C = 1.0\text{ A}$, $V_{CE} = 4.0\text{ Vdc}$)	h_{FE}	25	—	—
($I_C = 3.0\text{ A}$, $V_{CE} = 4.0\text{ Vdc}$)		10	50	
Collector-Emitter Saturation Voltage ($I_C = 3.0\text{ A}$, $I_B = 375\text{ mA}$)	$V_{CE(sat)}$	—	1.2	Vdc
Base-Emitter On Voltage ($I_C = 3.0\text{ A}$, $V_{CE} = 4.0\text{ Vdc}$)	$V_{BE(on)}$	—	1.8	Vdc
DYNAMIC CHARACTERISTICS				
Current Gain — Bandwidth Product (2) ($I_C = 500\text{ mA}$, $V_{CE} = 10\text{ Vdc}$, $f_{test} = 1\text{ MHz}$)	f_T	3.0	—	MHz
Small-Signal Current Gain ($I_C = 0.5\text{ A}$, $V_{CE} = 10\text{ Vdc}$, $f = 1\text{ kHz}$)	$ h_{fe} $	20	—	—

(1) Pulse Test: Pulse Width $\leq 300\text{ }\mu\text{s}$, Duty Cycle $\leq 2.0\%$.

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

FIGURE 1 — POWER DERATING

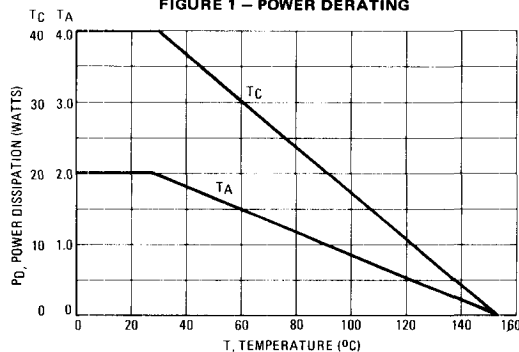


FIGURE 2 — SWITCHING TIME EQUIVALENT CIRCUIT

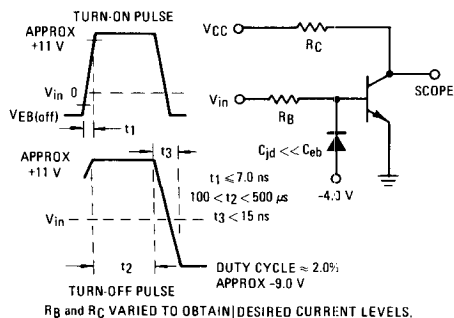


FIGURE 3 — TURN-ON TIME

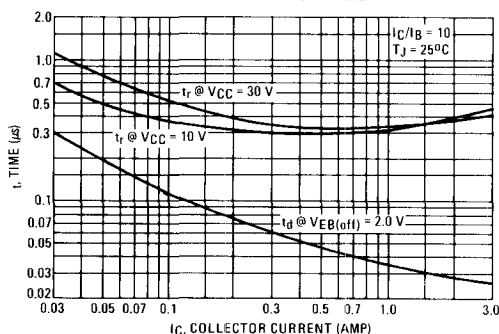


FIGURE 4 – THERMAL RESPONSE

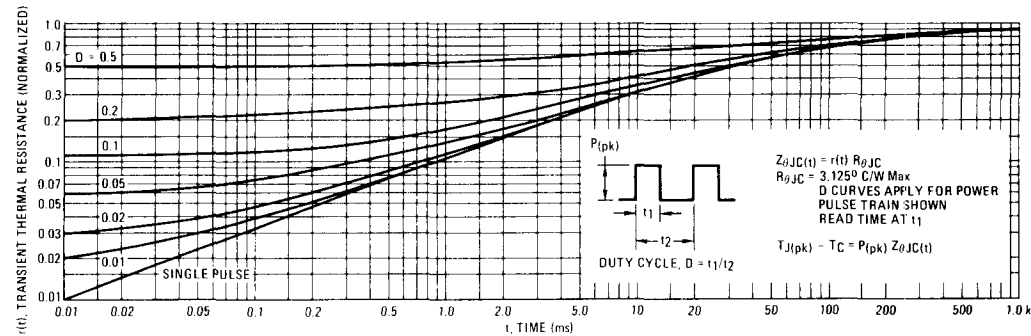
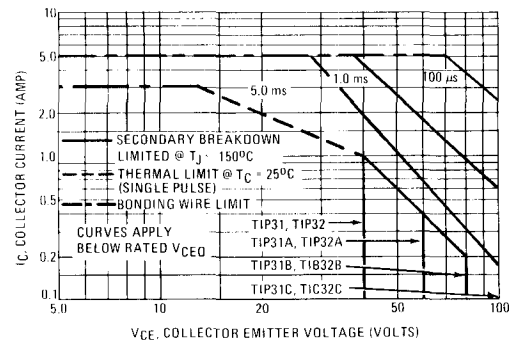


FIGURE 5 – ACTIVE REGION SAFE OPERATING AREA



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 5 is based on $T_{J(pk)} = 150^{\circ}\text{C}$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} \leq 150^{\circ}\text{C}$. $T_{J(pk)}$ may be calculated from the data in Figure 4. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

FIGURE 6 – TURN-OFF TIME

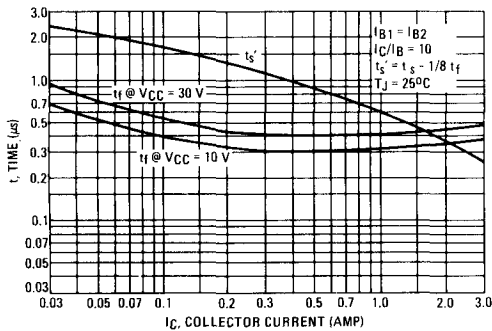
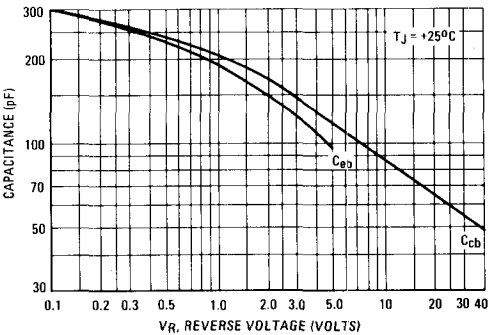


FIGURE 7 – CAPACITANCE



TIP31, TIP31A, TIP31B, TIP31C, NPN, TIP32, TIP32A, TIP32B, TIP32C, PNP

FIGURE 8 – DC CURRENT GAIN

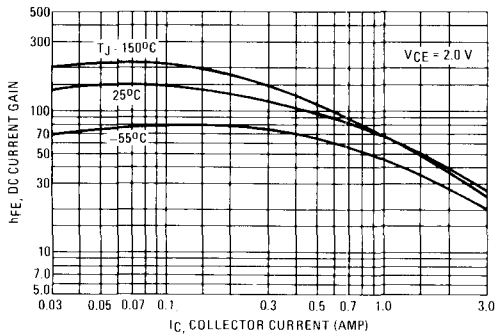


FIGURE 9 – COLLECTOR SATURATION REGION

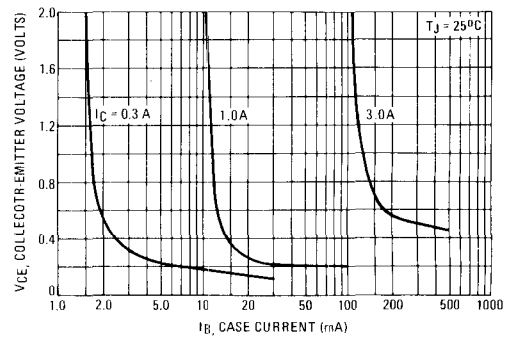


FIGURE 10 – "ON" VOLTAGES

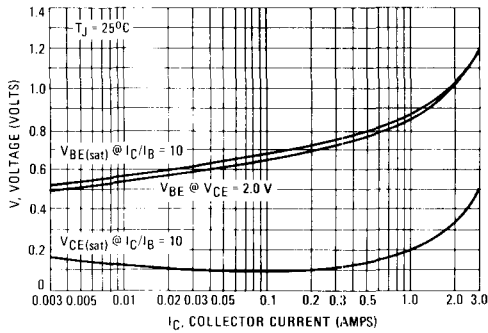


FIGURE 11 – TEMPERATURE COEFFICIENTS

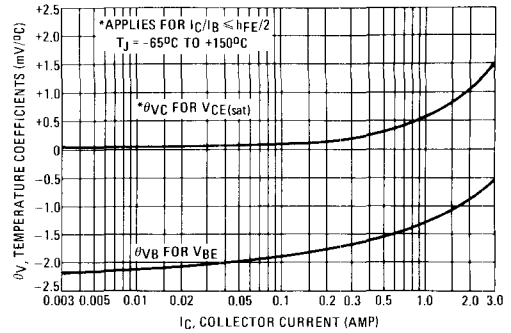


FIGURE 12 – COLLECTOR CUT-OFF REGION

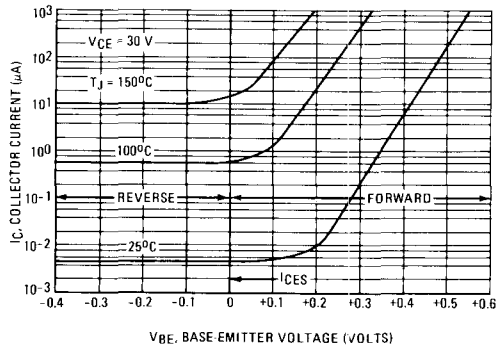


FIGURE 13 – EFFECTS OF BASE-EMITTER RESISTANCE

