

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)

TABLE 11 — MILITARY SPECIFIED POWER TRANSISTORS (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	Case JEDEC/MOT
						t _s μs Max	t _f μs Max	@ I _C Amp			
		NPN/#	PNP/#								
15	400	2N6547J,/525 TX		12/60	5	4.7*		10	6	175	TO-204/1
		2N6675J,/537 TX, TXV**		8/20	10	2.5	0.5	10	15	175	TO-204AA/1
20	75	2N5039J,/439 TX, TXV		30/150	2	2*		10	60	140	TO-204/1
	80	2N5303J,/456A TX, TXV	2N5745J,/433 TX, TXV	15/60	10	3*		10	2	200	TO-204/1
		2N6283J,/504 TX, TXV	2N6286J,/505 TX, TXV	1250/18k	10	10*		10	8	175	TO-204/1
	90	2N5038J,/439 TX, TXV		50/200	2	2*		12	60	140	TO-204/1
25	100	2N6284J,/504 TX, TXV	2N6287J,/505 TX, TXV	1250/18k	10	10*		10	8	175	TO-204/1
	120		2N6437J,/508 TX, TXV	30/120	10	1		10	40	200	TO-204/1
			2N6438J,/509 TX, TXV	30/120	10	1		10	40	200	TO-204/1
30	60	2N5302J,/456A TX, TXV	2N4399J,/433 TX, TXV	15/60	15	3*		10	2	200	TO-204/1
50	60	2N5685J,/464 TX, TXV	2N5683J,/466 TX, TXV	15/60	25	3*		25	2	300	TO-204/197
	80	2N5686J,/464 TX, TXV	2N5684J,/466 TX, TXV	15/60	25	3*		25	2	300	TO-204/197
	100	2N6274J,/514 TX, TXV	2N6378J,/515 TX, TXV	30/120	20	1.05*		20	30	250	TO-204/197
	120		2N6379J,/515 TX, TXV	30/120	20	1.05*		20	30	250	TO-204/197
	150	2N6277J,/514 TX, TXV**		30/120	20	1.05*		20	30	250	TO-204/197

MIL-S-19500 Detailed
Spec. shown by
Device Type

* t_{off}

** Consult
Factory for
qualification
status.

TABLE 12 — POWER DARLINGTONS

I _C Cont Amps Max	V _{CEO(sus)} Volts Min	Device Type		h _{FE} Min/Max	@ I _C Amp	Resistive Switching			h _{fe} @ 1 MHz Min	P _D (Case) Watts @ 25°C	Case JEDEC/MOT
						t _s μs Max	t _f μs Max	@ I _C Amp			
		NPN	PNP								
2	40	MPS-U45	MPS-U95	4k min	1				100	10	/152
	60	TIP110	TIP115	1k min	1	2 typ	1 typ	1	25	50	TO-220/221A
	80	TIP111	TIP116	1k min	1	2 typ	1 typ	1	25	50	TO-220/221A
	100	TIP112 MJD112 MJE270	TIP117 MJD117 MJE271	1k min 1000 min 1.5k min	1 2 0.12	2 typ 1.7 typ	1 typ 1.3 typ	1 2	25 25 6	50 20 25	TO-220/221A TO-252/369A-04 TO-225AA/77

(continued)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

NPN
TIP110
TIP111
TIP112

PNP
TIP115
TIP116
TIP117

PLASTIC MEDIUM-POWER COMPLEMENTARY SILICON TRANSISTORS

... designed for general-purpose amplifier and low-speed switching applications.

- High DC Current Gain —
 $h_{FE} = 2500$ (Typ) @ $I_C = 1.0$ Adc
- Collector-Emitter Sustaining Voltage — @ 30 mAdc
 $V_{CE(sus)} = 60$ Vdc (Min) — TIP110, TIP115
 $= 80$ Vdc (Min) — TIP111, TIP116
 $= 100$ Vdc (Min) — TIP112, TIP117
- Low Collector-Emitter Saturation Voltage —
 $V_{CE(sat)} = 2.5$ Vdc (Max) @ $I_C = 2.0$ Adc
- Monolithic Construction with Built-In Base-Emitter Shunt Resistors
- TO-220AB Compact Package
- TO-66 Leadform Also Available

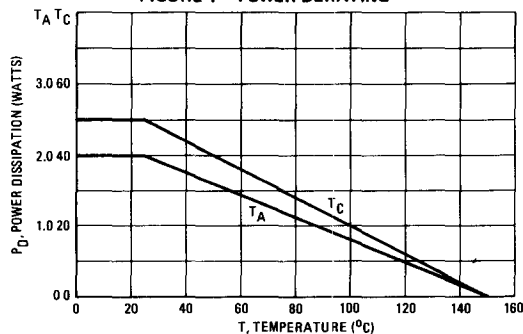
*MAXIMUM RATINGS

Rating	Symbol	TIP110, TIP115	TIP111, TIP116	TIP112, TIP117	Unit
Collector-Emitter Voltage	V_{CE}	60	80	100	Vdc
Collector-Base Voltage	V_{CB}	60	80	100	Vdc
Emitter-Base Voltage	V_{EB}	5.0			Vdc
Collector Current — Continuous	I_C	2.0			Adc
Peak		4.0			
Base Current	I_B	50			mAdc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$	P_D	50			Watts
Derate above 25°C		0.4			W/ $^\circ\text{C}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$	P_D	2.0			Watts
Derate above 25°C		0.016			W/ $^\circ\text{C}$
Unclamped Inductive Load Energy — Figure 13	E	25			mJ
Operating and Storage Junction,	T_J, T_{stg}	-65 to +150			$^\circ\text{C}$

THERMAL CHARACTERISTICS

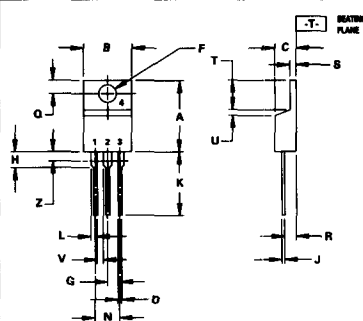
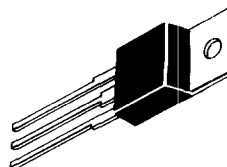
Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	$^\circ\text{C/W}$
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$

FIGURE 1 — POWER DERATING



DARLINGTON 2 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS

60-80-100 VOLTS
50 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.

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.46	15.75	0.570	0.620
B	9.65	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.86	0.025	0.035
F	3.81	3.73	0.142	0.147
G	3.42	2.86	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	0.046	0.055
N	4.83	5.32	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.046	0.055
T	5.87	6.47	0.230	0.255
U	0.95	1.27	0.030	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

TIP110, TIP111, TIP112, NPN, TIP115, TIP116, TIP117, PNP

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)	V _{CEO(sus)}	60 80 100	— — —	V _{dc}
Collector Cutoff Current (V _{CE} = 30 V _{dc} , I _B = 0)	I _{CEO}	—	2.0	mA _{dc}
(V _{CE} = 40 V _{dc} , I _B = 0)		—	2.0	
(V _{CE} = 50 V _{dc} , I _B = 0)		—	2.0	
Collector Cutoff Current (V _{CB} = 60 V _{dc} , I _E = 0)	I _{CBO}	—	1.0	mA _{dc}
(V _{CB} = 80 V _{dc} , I _E = 0)		—	1.0	
(V _{CB} = 100 V _{dc} , I _E = 0)		—	1.0	
Emitter Cutoff Current (V _{BE} = 5.0 V _{dc} , I _C = 0)	I _{EBO}	—	2.0	mA _{dc}
ON CHARACTERISTICS (1)				
DC Current Gain (I _C = 1.0 A _{dc} , V _{CE} = 4.0 V _{dc})	h _{FE}	1000	—	—
(I _C = 2.0 A _{dc} , V _{CE} = 4.0 V _{dc})		500	—	
Collector-Emitter Saturation Voltage (I _C = 2.0 A _{dc} , I _B = 8.0 mA _{dc})	V _{CE(sat)}	—	2.5	V _{dc}
Base-Emitter On Voltage (I _C = 2.0 A _{dc} , V _{CE} = 4.0 V _{dc})	V _{BE(on)}	—	2.8	V _{dc}
DYNAMIC CHARACTERISTICS				
Small-Signal Current Gain (I _C = 0.75 A _{dc} , V _{CE} = 10 V _{dc} , f = 1.0 MHz)	h _{fe}	25	—	—
Output Capacitance (V _{CB} = 10 V _{dc} , I _E = 0, f = 0.1 MHz)	C _{ob}	—	200	pF
		—	100	

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

3

FIGURE 2 – SWITCHING TIMES TEST CIRCUIT

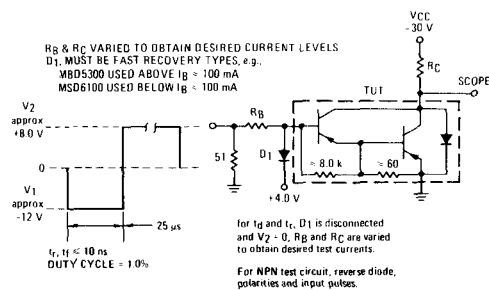
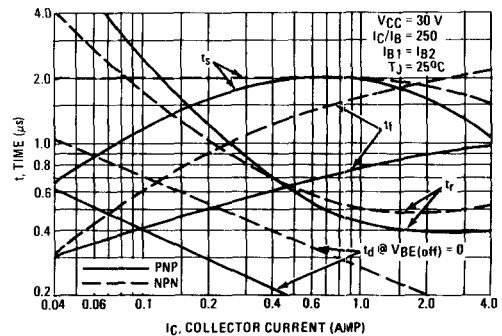
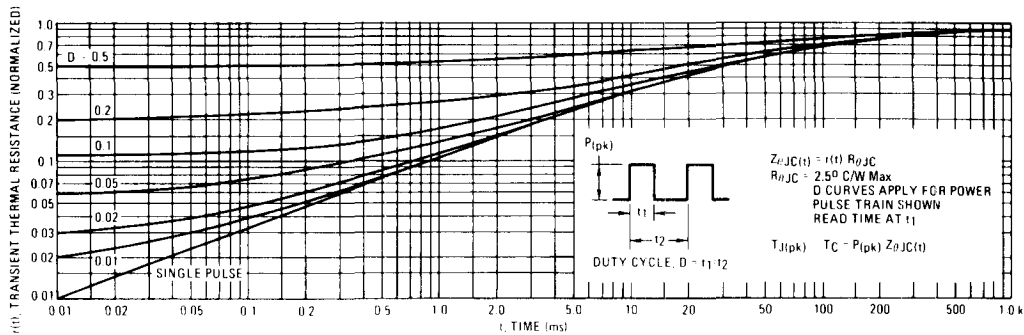


FIGURE 3 – SWITCHING TIMES



TIP110, TIP111, TIP112, NPN, TIP115, TIP116, TIP117, PNP

FIGURE 4 – THERMAL RESPONSE



ACTIVE-REGION SAFE-OPERATING AREA

FIGURE 5 – TIP115, 116, 117

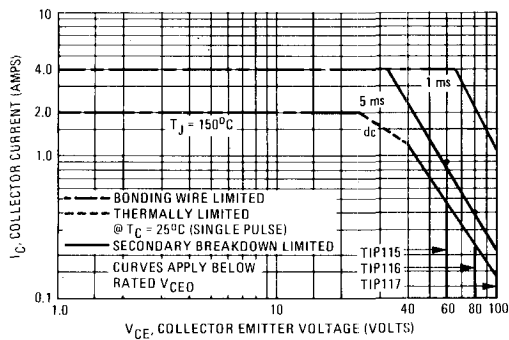
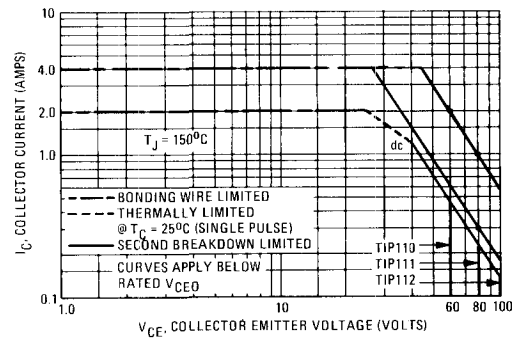


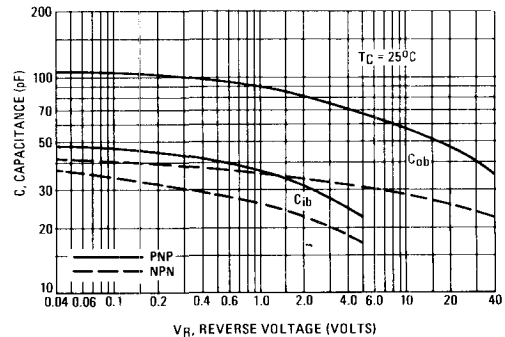
FIGURE 6 – TIP110, 111, 112



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 Figures 5 and 6 is based on $T_{J(pk)} = 150^\circ C$; T_C is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided $T_{J(pk)} < 150^\circ C$. $T_{J(pk)}$ 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 7 – CAPACITANCE



TIP110, TIP111, TIP112, NPN, TIP115, TIP116, TIP117, PNP

NPN
TIP110, 111, 112

PNP
TIP115, 116, 117

FIGURE 8 – DC CURRENT GAIN

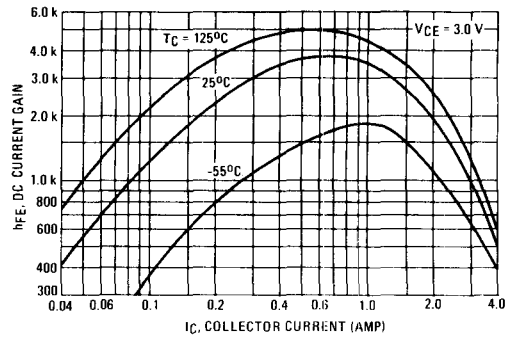
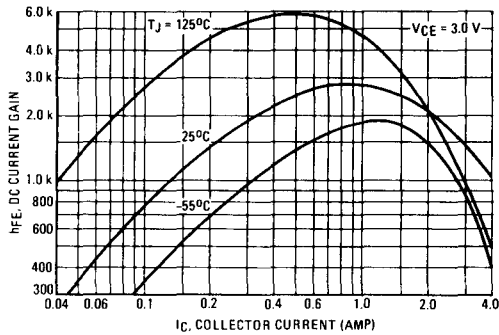


FIGURE 9 – COLLECTOR SATURATION REGION

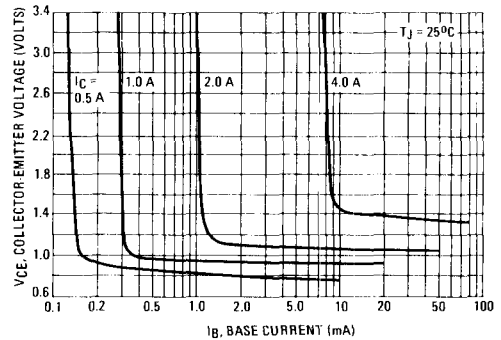
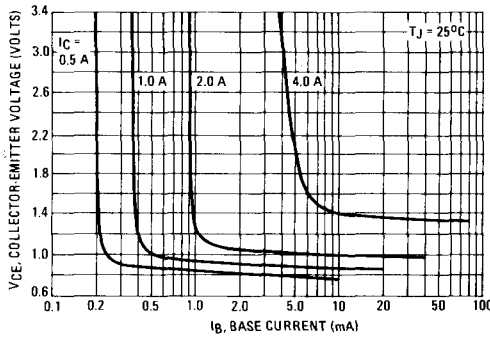
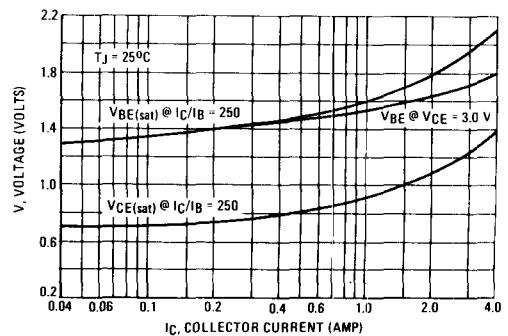
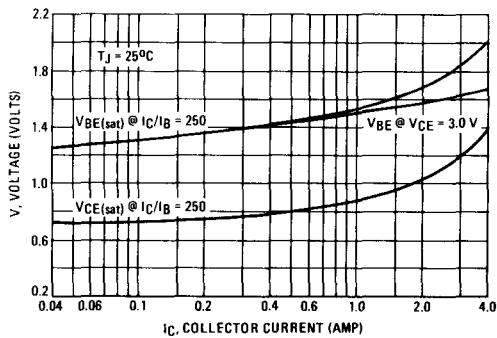


FIGURE 10 – "ON" VOLTAGES



TIP110, TIP111, TIP112, NPN, TIP115, TIP116, TIP117, PNP

NPN
TIP110, 111, 112

PNP
TIP115, 116, 117

FIGURE 11 — TEMPERATURE COEFFICIENTS

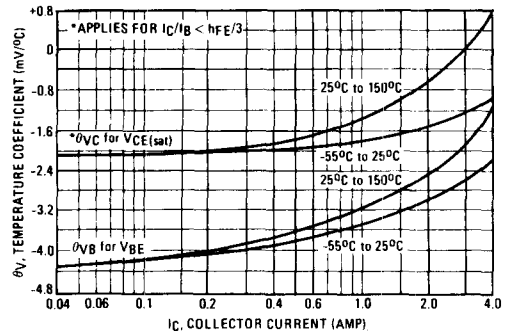
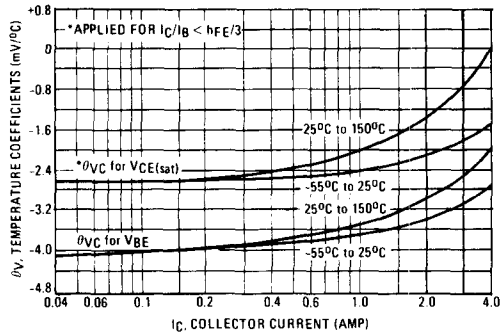


FIGURE 12 — COLLECTOR CUT-OFF REGION

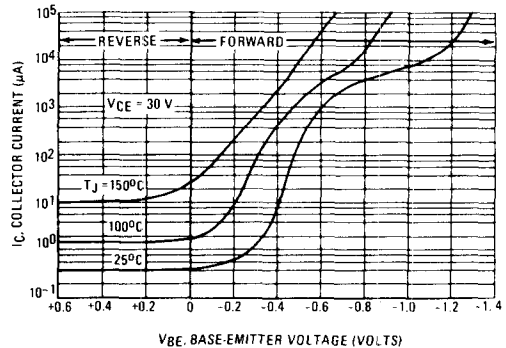
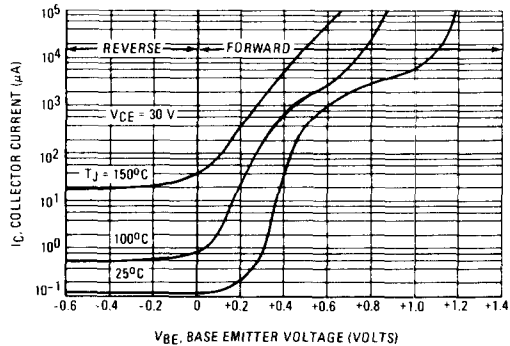
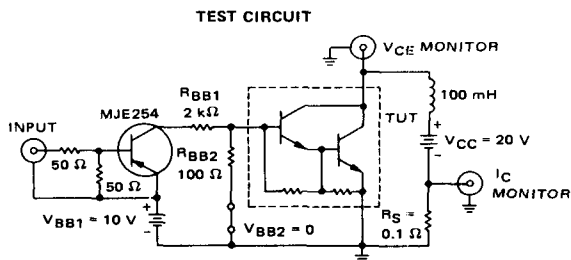


FIGURE 13 — INDUCTIVE LOAD SWITCHING



NOTE A: Input pulse width is increased until $I_{CM} = 0.71$ A.
NPN test shown; for PNP test reverse all polarity and use MJE224 driver.

VOLTAGE AND CURRENT WAVEFORMS

