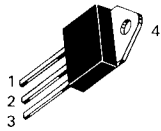


ALPHANUMERIC INDEX — CROSS-REFERENCE (Continued)

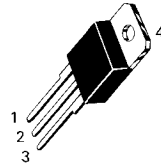
Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number	Industry Part Number	Motorola Direct Replacement	Motorola Similar Replacement	Page Number
TIP107	TIP107		3-1091	TIP32F		MJE15031	3-972
TIP110	TIP110		3-1095	TIP33	TIP33		3-1077
TIP111	TIP111		3-1095	TIP33A	TIP33A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

*Consult Motorola if a direct replacement is necessary.

TABLE 4 — PLASTIC TO-218



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



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

CASE 340-02 (TO-218AC)

IC 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		
3	750	MJH16032		4 min	3	2	1.5	2		125
	850	MJH16034		4 min	3	2	1.5	2		125
5	400	BUW11		6 min	3	4	0.8	3		125
	450	BUW11A		6 min	2.5	4	0.8	2.5		125
		MJH16002		5 min	5	3	0.3	3		100
		MJH16004		7 min	5	2.7	0.35	3		100
	500	MJH16002A		5 min	5	3	0.3	3		100
6	1500*	MJH12004		2.5 min	4.5	—	1	4.5	4	100
	375	BU426†		30 typ	0.6	2 typ	0.5 typ	2.5	6 typ	113
8	400	BUW12		6 min	6	4	0.8	5		125
		MJH16106		6/25	8	2 typ	0.1 typ	5		125
	450	BUW12A		6 min	5	4	0.8	5		125
		MJH16006		5 min	8	2.5	0.25	5		125
		MJH16008		7 min	8	2.2	0.25	5		125
		BUT50P##†		30 min	2	0.75 typ	0.1 typ	5		100
	700	MJH16006A		5 min	8	2.5	0.25	5		125
		BU508,A		2.25 min	4.5	8 typ	0.5 typ	4.5	7	125
	750	BU508D,AD		2.25 min	4.5	8 typ	0.5 typ	4.5	7	125
		MJH12005					0.4 typ	5	4	100
9	400	BUV47†		7 min	5	2	0.4	6		128
	450	BUV47A†		7 min	6	2	0.4	6		128
10	40	TIP33	TIP34	20 min	3				3	80
	60	BDV65##†	BDV64##†	1k min	5					125
		TIP33A	TIP34A	20 min	3				3	80
		TIP140##	TIP145##	500 min	10	2.5 typ	2.5 typ	5	4#	125
	80	BDV65A##†	BDV64A##†	1k min	5					125
		TIP33B	TIP34B	20 min	3				3	80
		TIP141##	TIP146##	500 min	10	2.5 typ	2.5 typ	5	4#	125
	100	BDV65B##†	BDV64B##†	1k min	5					125
		TIP33C	TIP34C	20 min	3				3	80
		TIP142##	TIP147##	500 min	10	2.5 typ	2.5 typ	5	4#	125
	120	BDV65C##†	BDV64C##†	1k min	5					125
	200	BU323P##†		150 min	6	15	15	6		125
15	250	BU323AP##†		150 min	6	15	15	6		125
	400	MJH10012##		100/2k	6	15	15	6		118
	800	MJH16018		4 min	5	4.5 typ	0.2 typ	5		150
	60	TIP3055	TIP2955	5 min	10				2.5	80
	150	MJH11018##	MJH11017##	400/15k	10				3#	150
	200	MJH11020##	MJH11019##	400/15k	10				3#	150
	250	MJH11022##	MJH11021##	400/15k	10				3#	150

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

* V_{(BR)CEX} or V_{(BR)CES}

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

(continued)

TABLE 12 — POWER DARLINGTONS (continued)

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
		NPN	PNP			t _s μs Max	t _f μs Max	@ I _C Amp			
8	80	MJ1001	MJ901	1k min	3					90	TO-204/1
		TIP101	TIP106	1k/20k	3	1.5 typ	1.5 typ	3	4	80	TO-220/221A
		2N6044	2N6041	1k/10k	4	1.5 typ	1.5 typ	3	4	75	TO-220/221A
		2N6301	2N6299	750k/18k	4	1.5 typ	1.5 typ	4	4	75	TO-213A/80
		2N6056	2N6054	750k/18k	4	1.5 typ	1.5 typ	4	4	100	TO-204A/1
	100	MJE6044	MJE6041	1k/20k	4	1.5 typ	1.5 typ	4	2	75	TO-225AB/90
		BDX53C	BDX54C	750 min	3				4	60	TO-220/221A
		BD901	BD902	750 min	3				1	70	TO-220/221A
		MJE6045		1k/20k	4	1.5 typ	1.5 typ	4	2	75	TO-225AB/90
		MJD122	MJD127	1k/12k	4	1.5 typ	2 typ	4	4	20	TO-252/369A-04
		MJF102	MJF107	3k min	3	1.5 typ	1.5 typ	3	4	35	—/221C-02
		TIP102	TIP107	1k/20k	3	1.5 typ	1.5 typ	3	4	80	TO-220/221A
		2N6045	2N6042	1k/10k	4	1.5 typ	1.5 typ	3	4	75	TO-220/221A
	120	BDX53D	BDX54D	750 min	3				4	60	TO-220/221A
	150	BU807●		100 min	5	0.55 typ	0.2 typ	5		60	TO-220/221A
	200	BU806●		100 min	5	0.55 typ	0.2 typ	5		60	TO-220/221A
	300	MJE5740		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	350	MJE5741		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	400	MJE5742		200/400	4	8 typ	2 typ	6		80	TO-220/221A
	500	BUT50P●		30 min	2	0.75 typ	0.1 typ	5		100	TO-218/340D
	1400*	MJ10011		20 min	4			1	4	80	TO-204/1
10	40	2N6383	2N6648	1k/20k	5				20	100	TO-204/1
		D44E1		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
	45	BDX33	BDX34	750 min	4				3	70	TO-220/221A
	60	BDV65	BDV64	1k min	5					125	TO-218/340D
		BDX33A	BDX34A	750 min	4				3	70	TO-220/221A
		MJ3000	MJ2500	1k min	5					150	TO-204/1
		2N6387	2N6667	1k/20k	5				20	65	TO-220/221A
		2N6384		1k/20k	5				20	100	TO-204/1
		D44E2		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
	80	TIP140	TIP145	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
		2N6388	2N6668	1k/20k	5				20	65	TO-220/221A
		2N6385		1k/20k	5				20	100	TO-204/1
		BDV65A	BDV64A	1k min	5					125	TO-218/340D
		BDX33B	BDX34B	750 min	3				3	70	TO-220/221A
		D44E3		1000 min	5	2 typ	0.5 typ	10		50	TO-220/221A
	100	MJD44E3		1k min	5	2 typ	0.5 typ	10		20	TO-252/369A-04
		TIP141	TIP146	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
		BDV65B	BDV64B	1k min	5					125	TO-218/340D
		BDX33C	BDX34C	750 min	3				3	70	TO-220/221A
		TIP142	TIP147	500 min	10	2.5 typ	2.5 typ	5	4	125	TO-218/340
		BDV65C	BDV64C	1k min	5					125	TO-218/340D
	120	BDX33D	BDX34D	750 min	3				3	70	TO-220/221A
	200	BU323P		150 min	6	15	15	6		125	TO-218/340D
	250	BU323AP		150 min	6	15	15	6		125	TO-218/340D
	350	BU323		150 min	6	7.5 typ	5.2 typ	6		175	TO-204/1
		MJ10002		30/300	5	2.5	1	5	10	150	TO-204/1
	400	MJ10006●		30/300	5	1.5	0.5	5	10	150	TO-204/1
		BU323A		150 min	6	7.5 typ	5.2 typ	6		175	TO-204/1
		MJH10012		100/2k	6	15	15	6		118	TO-218/340
		MJ10007●		30/300	5	1.5	0.5	5	10	150	TO-204/1

● Darlington with speed-up diode.

(continued)

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

NPN
TIP140
TIP141
TIP142

PNP
TIP145
TIP146
TIP147

DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

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

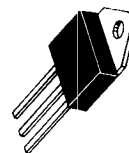
- High DC Current Gain — Min $h_{FE} = 1000$ @ $I_C = 5$ A, $V_{CE} = 4$ V
- Collector-Emitter Sustaining Voltage — @ 30 mA

$V_{CE(sus)} = 60$ Vdc (Min) — TIP140, TIP145
80 Vdc (Min) — TIP141, TIP146
100 Vdc (Min) — TIP142, TIP147

- Monolithic Construction with Built-In Base-Emitter Shunt Resistor

10 AMPERE DARLINGTON COMPLEMENTARY SILICON POWER TRANSISTORS

60-100 VOLTS
125 WATTS



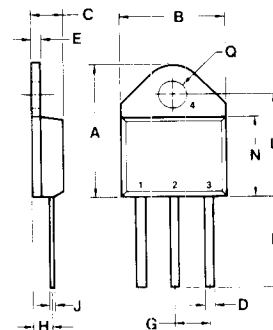
MAXIMUM RATINGS

Rating	Symbol	TIP140 TIP145	TIP141 TIP146	TIP142 TIP147	Unit
Collector-Emitter Voltage	V_{CEO}	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	10			Adc
Peak (1)		15			
Base Current — Continuous	I_B	0.5			Adc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$	P_D	125			Watts
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	$R_{\theta JC}$	1.0	$^\circ\text{C/W}$
Thermal Resistance, Case to Ambient	$R_{\theta JA}$	35.7	$^\circ\text{C/W}$

(1) 5 ms, $\leq 10\%$ Duty Cycle



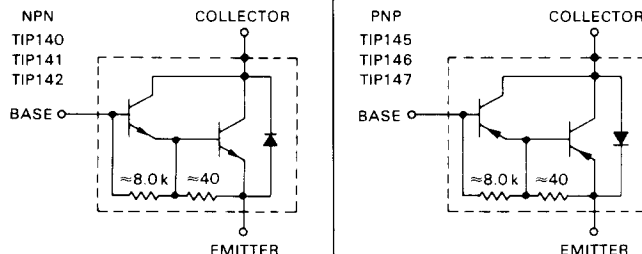
STYLE 1:

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

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.32	21.38	0.800	0.830
B	15.49	15.30	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	3.94	4.19	0.155	0.165

CASE 340-02
TO-218AC

DARLINGTON SCHEMATICS



TIP140, TIP141, TIP142 NPN, TIP145, TIP146, TIP147 PNP

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage (1) (I _C = 30 mA, I _B = 0)	TIP140, TIP145 TIP141, TIP146 TIP142, TIP147	V _{CEO(sus)}	60 80 100	— — —	— — —	Vdc
Collector Cutoff Current (V _{CE} = 30 Vdc, I _B = 0) (V _{CE} = 40 Vdc, I _B = 0) (V _{CE} = 50 Vdc, I _B = 0)	TIP140, TIP145 TIP141, TIP146 TIP142, TIP147	I _{CEO}	— — —	— — —	2.0 2.0 2.0	mA
Collector Cutoff Current (V _{CB} = 60 V, I _E = 0) (V _{CB} = 80 V, I _E = 0) (V _{CB} = 100 V, I _E = 0)	TIP140, TIP145 TIP141, TIP146 TIP142, TIP147	I _{CBO}	— — —	— — —	1.0 1.0 1.0	mA
Emitter Cutoff Current V _{BE} = 5.0 V		I _{EBO}	—	—	2.0	mA

ON CHARACTERISTICS (1)

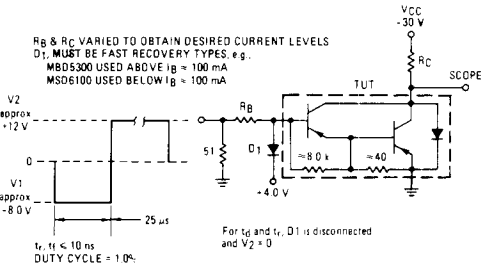
DC Current Gain (I _C = 5.0 A, V _{CE} = 4.0 V) (I _C = 10 A, V _{CE} = 4.0 V)	h _{FE}	1000 500	— —	— —	—
Collector-Emitter Saturation Voltage (I _C = 5.0 A, I _B = 10 mA) (I _C = 10 A, I _B = 40 mA)	V _{CE(sat)}	— —	— —	2.0 3.0	Vdc
Base-Emitter Saturation Voltage (I _C = 10 A, I _B = 40 mA)	V _{BE(sat)}	—	—	3.5	Vdc
Base-Emitter On Voltage (I _C = 10 A, V _{CE} = 4.0 Vdc)	V _{BE(on)}	—	—	3.0	Vdc

SWITCHING CHARACTERISTICS

Resistive Load (See Figure 1)					
Delay Time	V _{CC} = 30 V, I _C = 5.0 A, I _B = 20 mA, Duty Cycle ≤ 2.0%, I _{B1} = I _{B2} , R _C & R _B Varied, T _J = 25°C	t _d	—	0.15	μs
Rise Time		t _r	—	0.55	μs
Storage Time		t _s	—	2.5	μs
Fall Time		t _f	—	2.5	μs

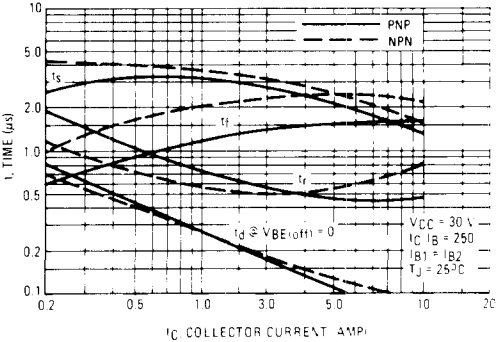
(1) Pulse Test: Pulse Width = 300 μs, Duty Cycle ≤ 2.0%

FIGURE 1 — SWITCHING TIMES TEST CIRCUIT



For NPN test circuit reverse diode and voltage polarities.

FIGURE 2 — SWITCHING TIMES



TIP140, TIP141, TIP142 NPN, TIP145, TIP146, TIP147 PNP

TYPICAL CHARACTERISTICS

NPN
TIP140, TIP141, TIP142

PNP
TIP145, TIP146, TIP147

FIGURE 3 — DC CURRENT GAIN versus COLLECTOR CURRENT

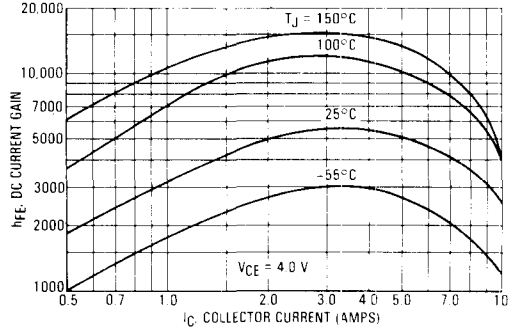
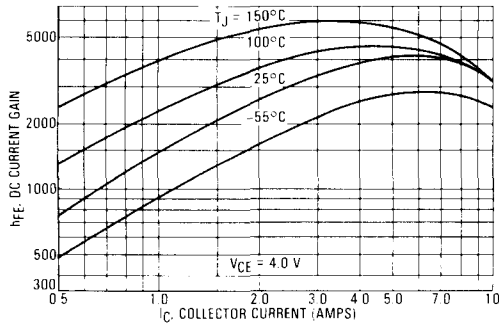


FIGURE 4 — COLLECTOR-EMITTER SATURATION VOLTAGE

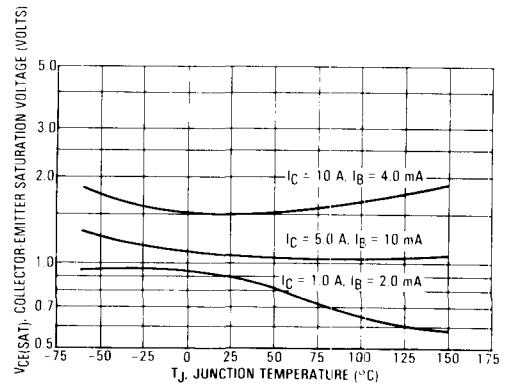
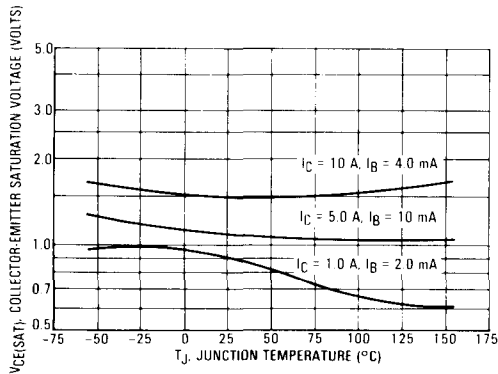
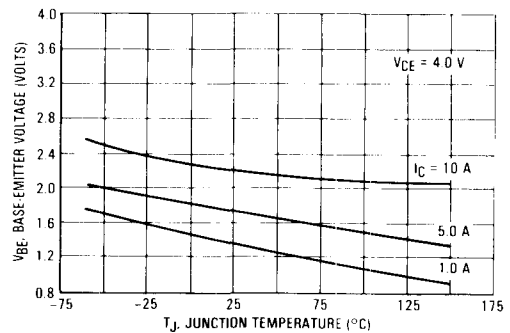
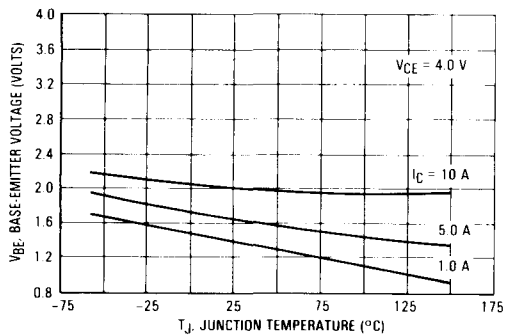


FIGURE 5 — BASE-EMITTER VOLTAGE



TIP140, TIP141, TIP142 NPN, TIP145, TIP146, TIP147 PNP

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 6 is based on $T_{J(pk)} = 150^\circ\text{C}$; T_C is variable depending on conditions. 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 — ACTIVE-REGION SAFE OPERATING AREA

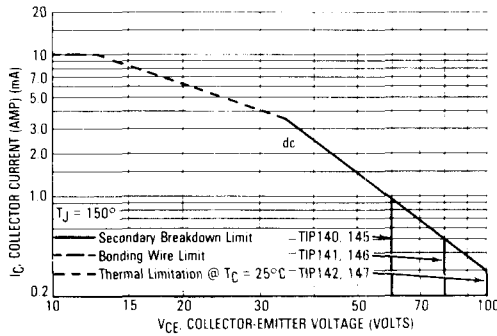


FIGURE 7 — UNCLAMPED INDUCTIVE LOAD

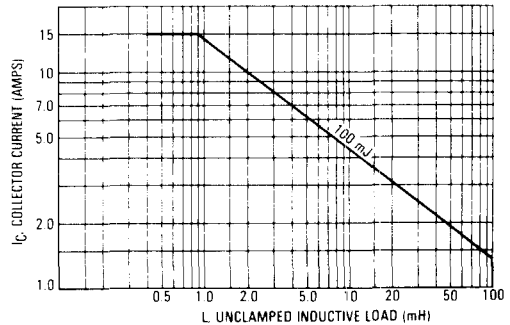
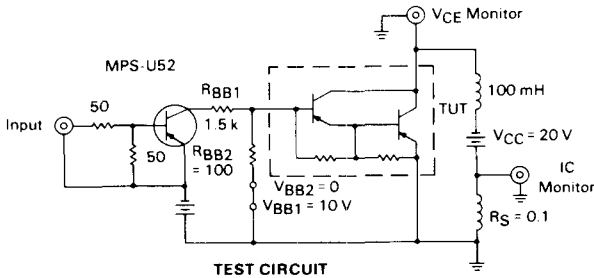
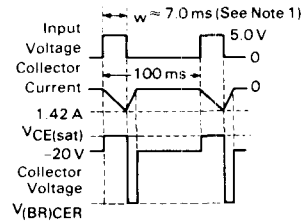
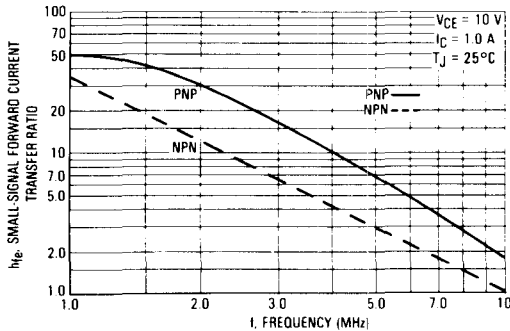


FIGURE 8 — INDUCTIVE LOAD



NOTE 1: Input pulse width is increased until $I_{CM} = 1.42\text{ A}$.
NOTE 2: For NPN test circuit reverse polarities.

FIGURE 9 — MAGNITUDE OF COMMON EMITTER SMALL-SIGNAL SHORT-CIRCUIT FORWARD CURRENT TRANSFER RATIO



VOLTAGE AND CURRENT WAVEFORMS

FIGURE 10 — FREE-AIR TEMPERATURE POWER DERATING

