

# 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 —  $|h_{fe}| = 3.0 \text{ min}$  @  $I_C = 1.0 \text{ A}$ ,  $f = 1.0 \text{ MHz}$

## MAXIMUM RATINGS

Rating	Symbol	TIP35A TIP36A	TIP35B TIP36B	TIP35C TIP36C	Unit
Collector-Emitter Voltage	$V_{CEO}$	60 V	80 V	100 V	Vdc
Collector-Base Voltage	$V_{CB}$	60 V	80 V	100 V	Vdc
Emitter-Base Voltage	$V_{EB}$	5.0			Vdc
Collector Current — Continuous Peak (1)	$I_C$	25 40			A <sub>dc</sub>
Base Current — Continuous	$I_B$	5.0			A <sub>dc</sub>
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	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	$^\circ\text{C/W}$
Junction-To-Free-Air Thermal Resistance	$R_{\theta JA}$	35.7	$^\circ\text{C/W}$

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

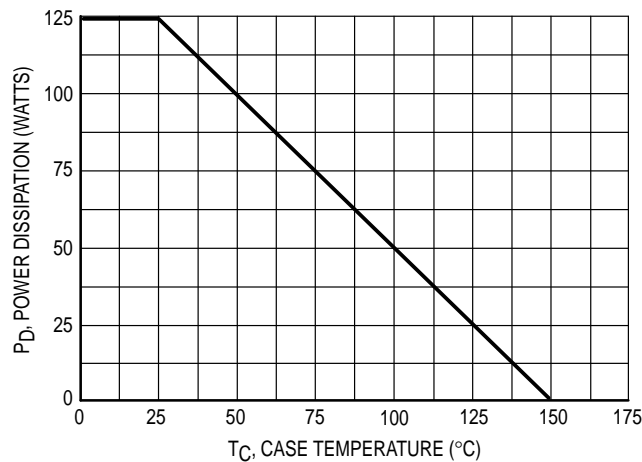


Figure 1. Power Derating

Preferred devices are Motorola recommended choices for future use and best overall value.

REV 1

**NPN**  
**TIP35A**  
**TIP35B\***  
**TIP35C\***  
**PNP**  
**TIP36A**  
**TIP36B\***  
**TIP36C\***

\*Motorola Preferred Device

**25 AMPERE**  
**COMPLEMENTARY**  
**SILICON**  
**POWER TRANSISTORS**  
**60-100 VOLTS**  
**125 WATTS**

**CASE 340D-02**  
**TO-218AC**

**TIP35A TIP35B TIP35C TIP36A TIP36B TIP36C**

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

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Sustaining Voltage (1) ( $I_C = 30\text{ mA}$ , $I_B = 0$ )	$V_{CE(sus)}$	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

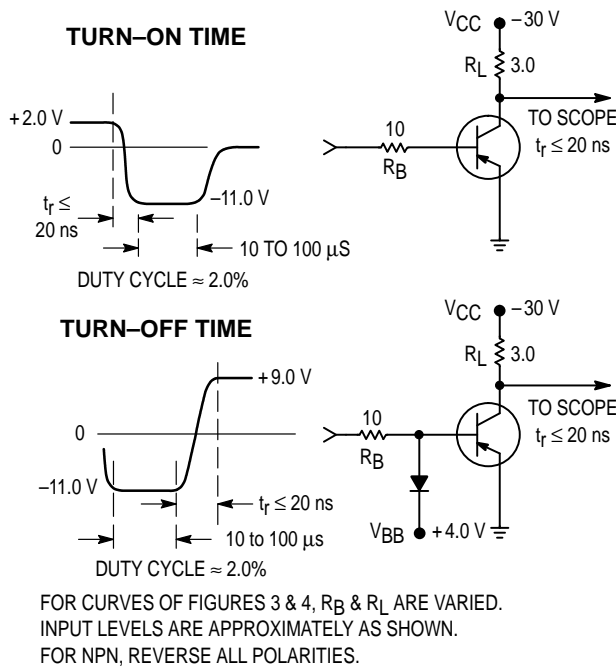
**ON CHARACTERISTICS (1)**

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

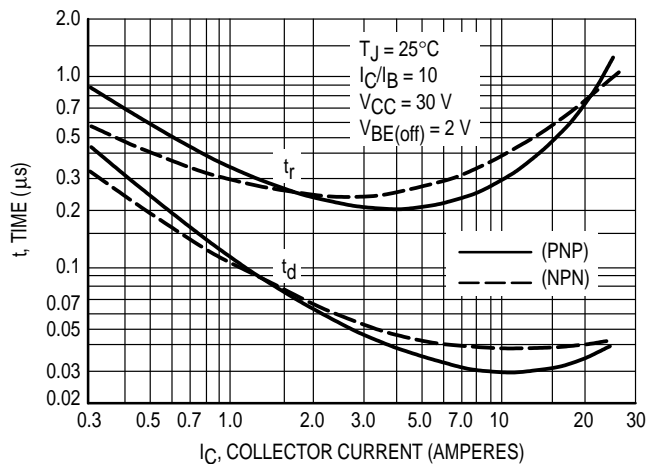
**DYNAMIC CHARACTERISTICS**

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 ( $I_C = 1.0\text{ A}$ , $V_{CE} = 10\text{ V}$ , $f = 1.0\text{ MHz}$ )	$f_T$	3.0	—	MHz

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



**Figure 2. Switching Time Equivalent Test Circuits**



**Figure 3. Turn–On Time**

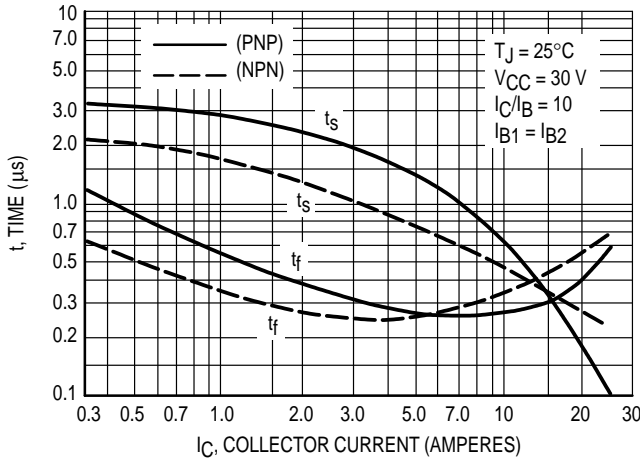


Figure 4. Turn-Off Time

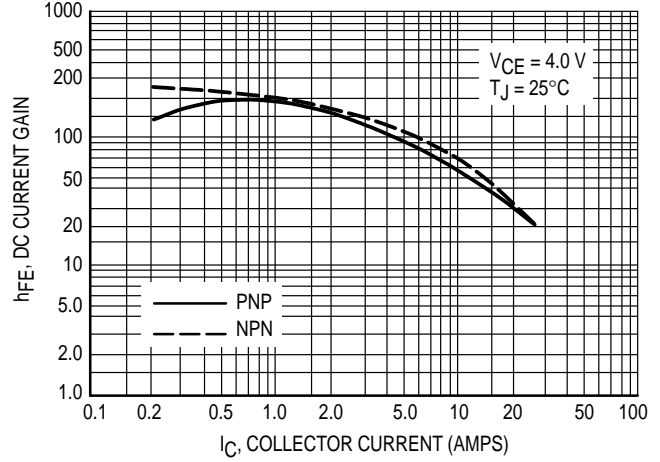


Figure 5. DC Current Gain

**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  $T_C = 25^\circ\text{C}$ ;  $T_{J(pk)}$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when  $T_C \geq 25^\circ\text{C}$ . 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.

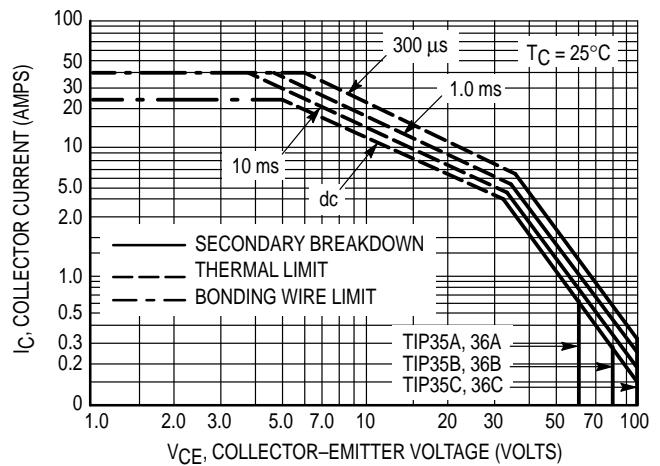


Figure 6. Maximum Rated Forward Bias Safe Operating Area

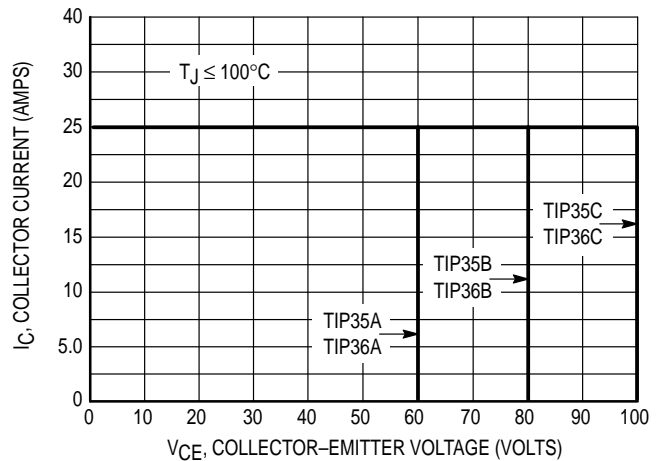
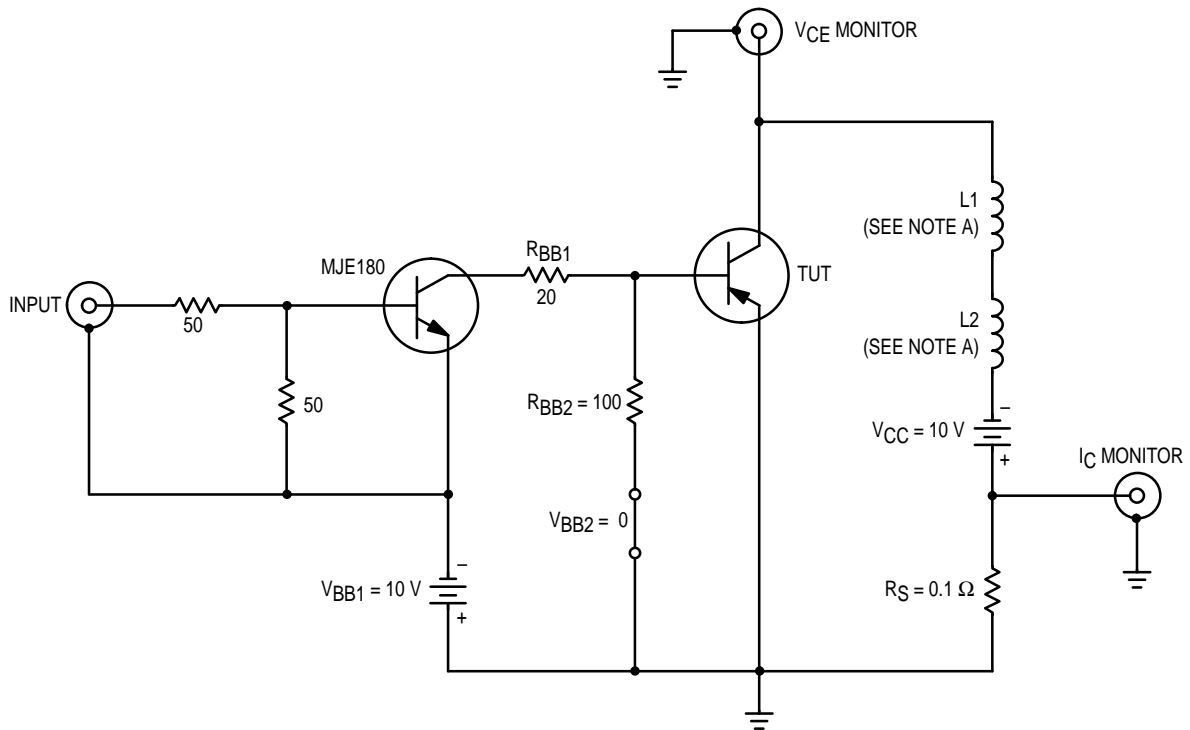
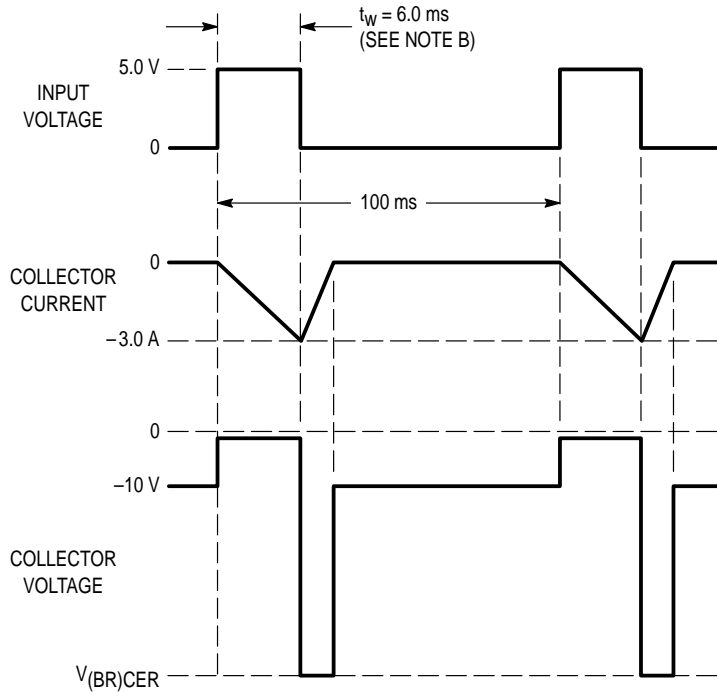


Figure 7. Maximum Rated Forward Bias Safe Operating Area

TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

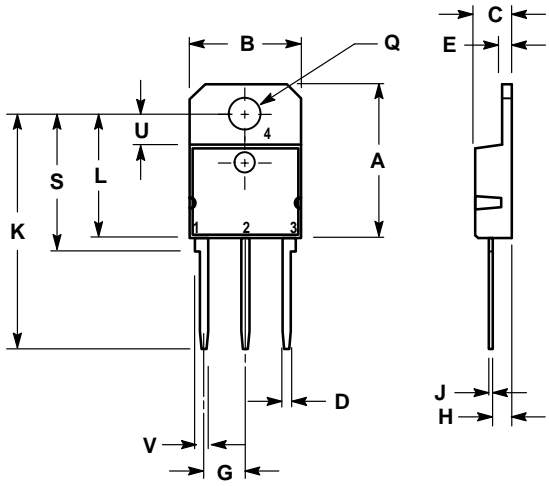


NOTES:

- A. L1 and L2 are 10 mH, 0.11  $\Omega$ , 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.

Figure 8. Inductive Load Switching

PACKAGE DIMENSIONS




- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: MILLIMETER.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	—	20.35	—	0.801
B	14.70	15.20	0.579	0.598
C	4.70	4.90	0.185	0.193
D	1.10	1.30	0.043	0.051
E	1.17	1.37	0.046	0.054
G	5.40	5.55	0.213	0.219
H	2.00	3.00	0.079	0.118
J	0.50	0.78	0.020	0.031
K	31.00 REF		1.220 REF	
L	—	16.20	—	0.638
Q	4.00	4.10	0.158	0.161
S	17.80	18.20	0.701	0.717
U	4.00 REF		0.157 REF	
V	1.75 REF		0.069	

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

CASE 340D-02  
 ISSUE B

**TIP35A TIP35B TIP35C TIP36A TIP36B TIP36C**

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TIP35/D

