

## 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 —  
 $V_{CEO(sus)} = 60 \text{ Vdc (Min) — TIP31A, TIP32A}$   
 $= 80 \text{ Vdc (Min) — TIP31B, TIP32B}$   
 $= 100 \text{ Vdc (Min) — TIP31C, TIP32C}$
- High Current Gain — Bandwidth Product  
 $f_T = 3.0 \text{ MHz (Min) @ } I_C = 500 \text{ mAdc}$
- Compact TO–220 AB Package

### \*MAXIMUM RATINGS

Rating	Symbol	TIP31A TIP32A	TIP31B TIP32B	TIP31C TIP32C	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 Peak	$I_C$	3.0 5.0			Adc
Base Current	$I_B$	1.0			Adc
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	40 0.32			Watts W/ $^\circ\text{C}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	2.0 0.016			Watts W/ $^\circ\text{C}$
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

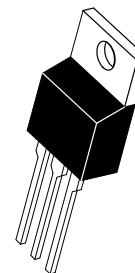
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	62.5	$^\circ\text{C/W}$
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.125	$^\circ\text{C/W}$

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

**NPN**  
**TIP31A**  
**TIP31B\***  
**TIP31C\***  
**PNP**  
**TIP32A**  
**TIP32B\***  
**TIP32C\***

\*Motorola Preferred Device

**3 AMPERE**  
**POWER TRANSISTORS**  
**COMPLEMENTARY**  
**SILICON**  
**60–80–100 VOLTS**  
**40 WATTS**



**CASE 221A–06**  
**TO–220AB**

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

REV 1

# TIP31A TIP31B TIP31C TIP32A TIP32B TIP32C

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
<b>OFF CHARACTERISTICS</b>				
Collector–Emitter Sustaining Voltage (1) (I <sub>C</sub> = 30 mA, I <sub>B</sub> = 0)	V <sub>CEO(sus)</sub>	60 80 100	—	Vdc
Collector Cutoff Current (V <sub>CE</sub> = 30 Vdc, I <sub>B</sub> = 0) (V <sub>CE</sub> = 60 Vdc, I <sub>B</sub> = 0)	I <sub>CEO</sub>	— — —	0.3 0.3 0.3	mA
Collector Cutoff Current (V <sub>CE</sub> = 60 Vdc, V <sub>EB</sub> = 0) (V <sub>CE</sub> = 80 Vdc, V <sub>EB</sub> = 0) (V <sub>CE</sub> = 100 Vdc, V <sub>EB</sub> = 0)	I <sub>CES</sub>	— — —	200 200 200	μA
Emitter Cutoff Current (V <sub>BE</sub> = 5.0 Vdc, I <sub>C</sub> = 0)	I <sub>EBO</sub>	—	1.0	mA

## ON CHARACTERISTICS (1)

DC Current Gain (I <sub>C</sub> = 1.0 A, V <sub>CE</sub> = 4.0 Vdc) (I <sub>C</sub> = 3.0 A, V <sub>CE</sub> = 4.0 Vdc)	h <sub>FE</sub>	25 10	— 50	—
Collector–Emitter Saturation Voltage (I <sub>C</sub> = 3.0 A, I <sub>B</sub> = 375 mA)	V <sub>CE(sat)</sub>	—	1.2	Vdc
Base–Emitter On Voltage (I <sub>C</sub> = 3.0 A, V <sub>CE</sub> = 4.0 Vdc)	V <sub>BE(on)</sub>	—	1.8	Vdc

## DYNAMIC CHARACTERISTICS

Current–Gain — Bandwidth Product (I <sub>C</sub> = 500 mA, V <sub>CE</sub> = 10 Vdc, f <sub>test</sub> = 1.0 MHz)	f <sub>T</sub>	3.0	—	MHz
Small–Signal Current Gain (I <sub>C</sub> = 0.5 A, V <sub>CE</sub> = 10 Vdc, f = 1.0 kHz)	h <sub>fe</sub>	20	—	—

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

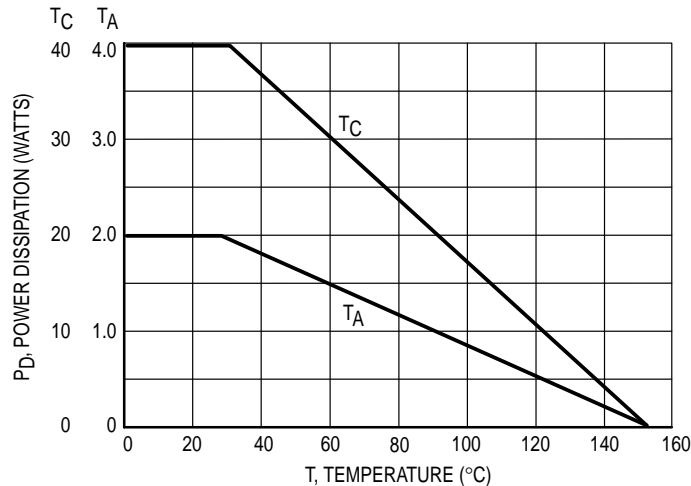
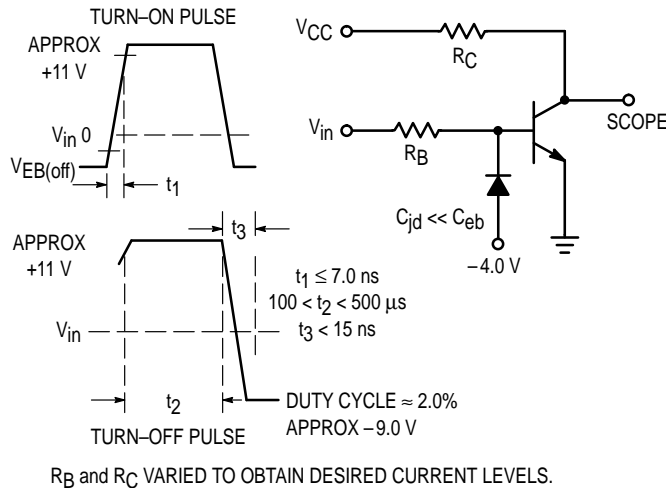


Figure 1. Power Derating



R<sub>B</sub> and R<sub>C</sub> VARIED TO OBTAIN DESIRED CURRENT LEVELS.

Figure 2. Switching Time Equivalent Circuit

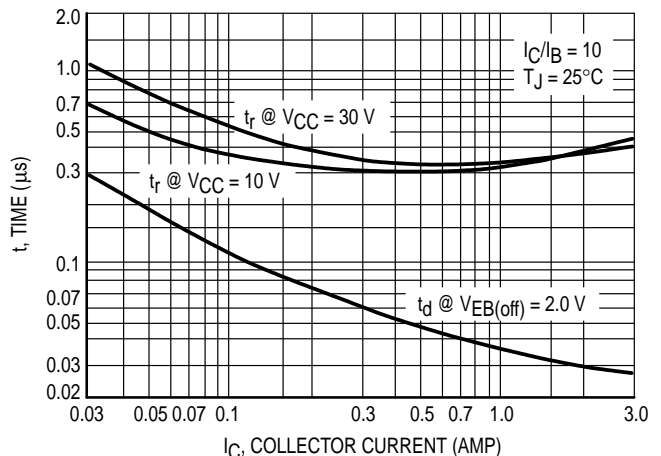


Figure 3. Turn-On Time

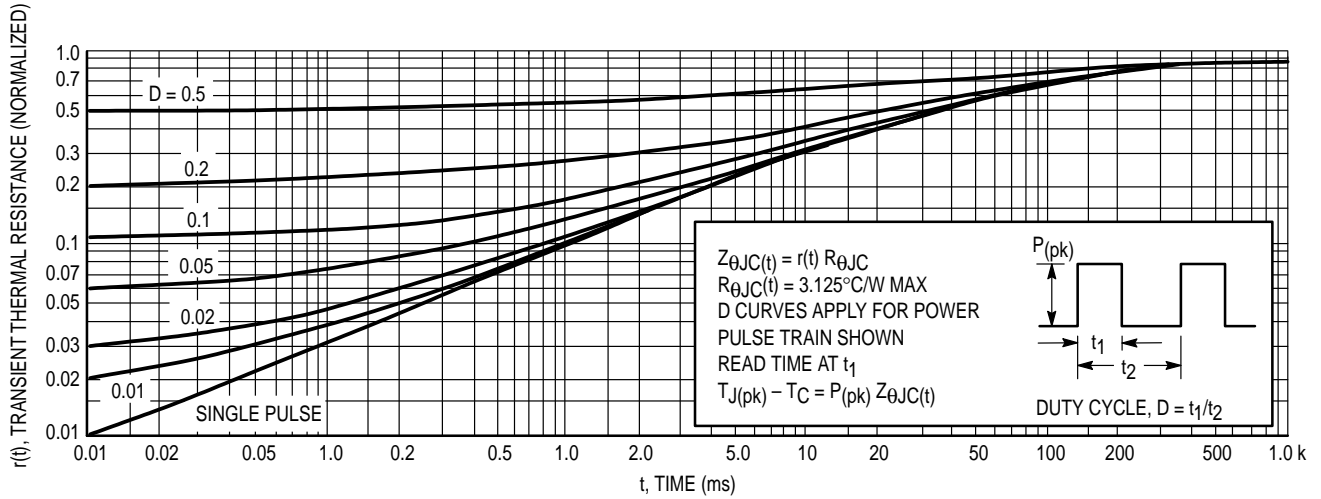


Figure 4. Thermal Response

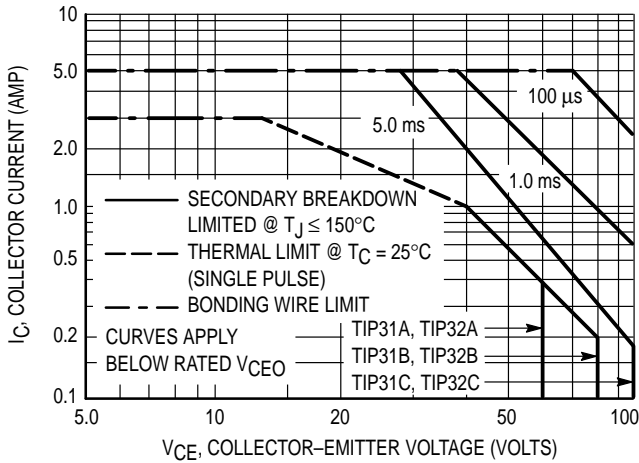


Figure 5. Active Region Safe Operating Area

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.

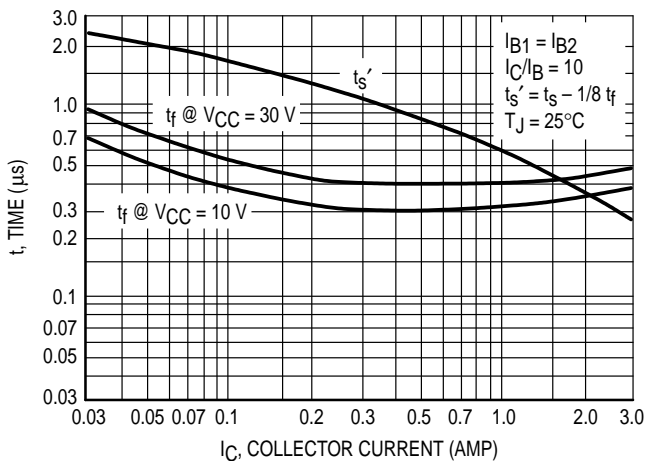


Figure 6. Turn-Off Time

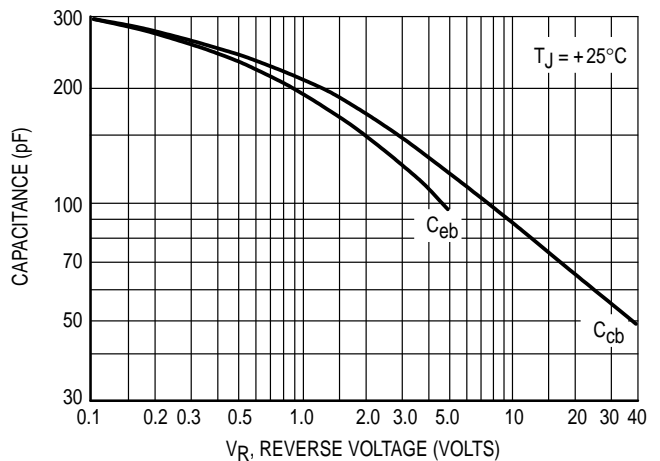
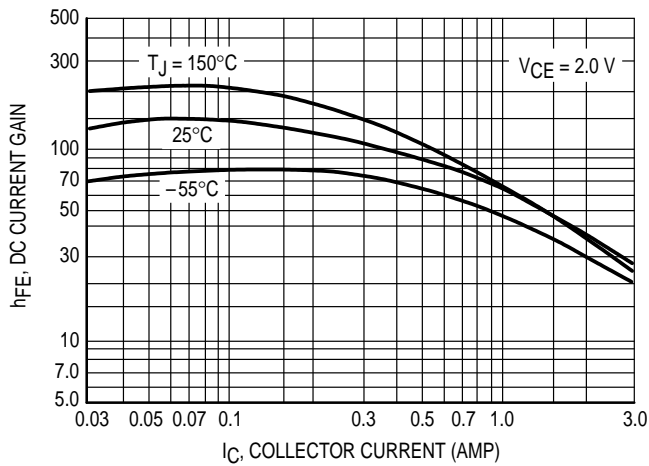
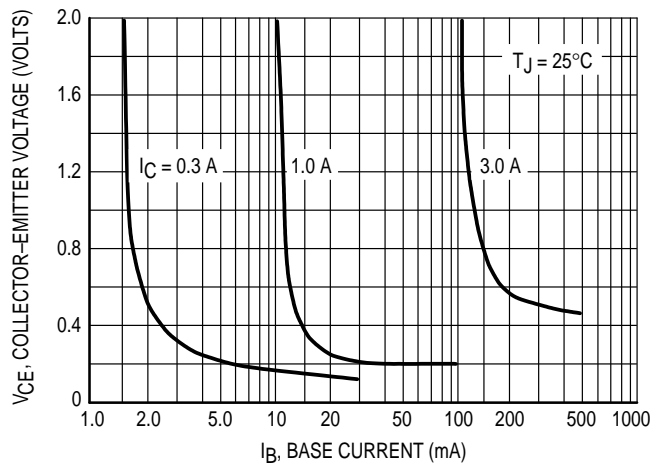


Figure 7. Capacitance

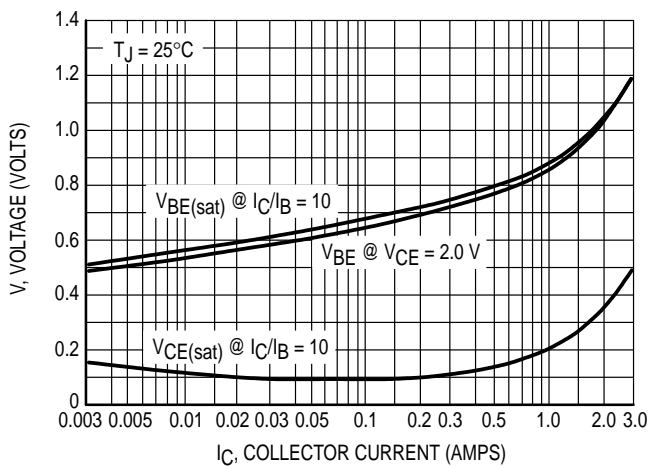
**TIP31A TIP31B TIP31C TIP32A TIP32B TIP32C**



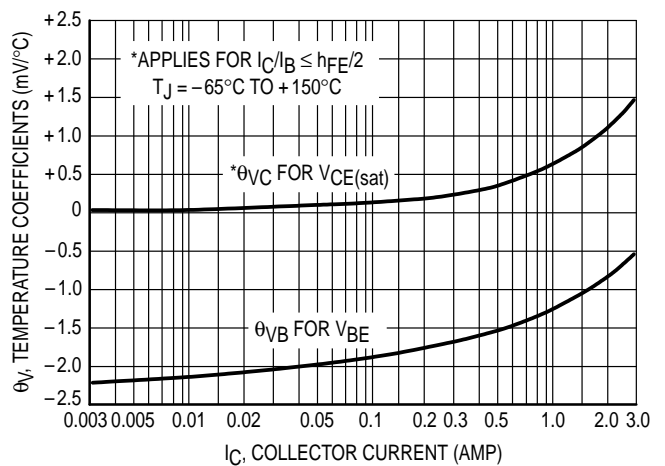
**Figure 8. DC Current Gain**



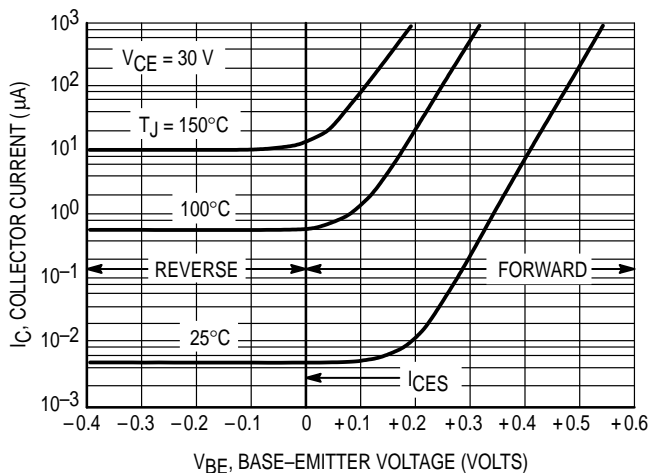
**Figure 9. Collector Saturation Region**



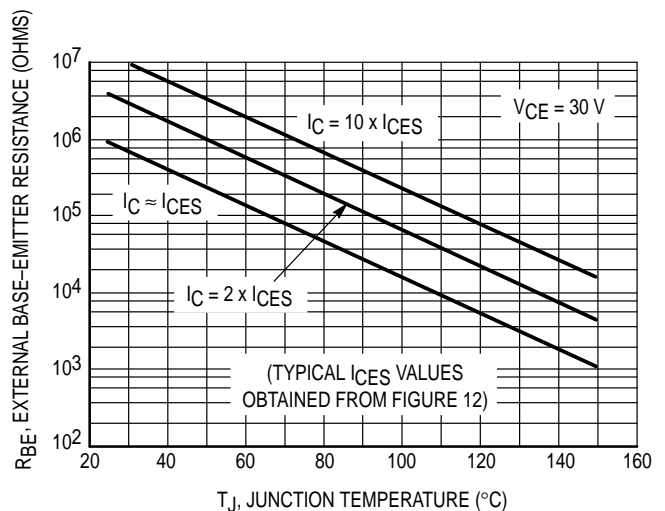
**Figure 10. "On" Voltages**



**Figure 11. Temperature Coefficients**



**Figure 12. Collector Cut-Off Region**



**Figure 13. Effects of Base-Emitter Resistance**

PACKAGE DIMENSIONS




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

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.570	0.620	14.48	15.75
B	0.380	0.405	9.66	10.28
C	0.160	0.190	4.07	4.82
D	0.025	0.035	0.64	0.88
F	0.142	0.147	3.61	3.73
G	0.095	0.105	2.42	2.66
H	0.110	0.155	2.80	3.93
J	0.018	0.025	0.46	0.64
K	0.500	0.562	12.70	14.27
L	0.045	0.060	1.15	1.52
N	0.190	0.210	4.83	5.33
Q	0.100	0.120	2.54	3.04
R	0.080	0.110	2.04	2.79
S	0.045	0.055	1.15	1.39
T	0.235	0.255	5.97	6.47
U	0.000	0.050	0.00	1.27
V	0.045	—	1.15	—
Z	—	0.080	—	2.04

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

CASE 221A-06  
 TO-220AB  
 ISSUE Y

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