

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

## Complementary Silicon Plastic Power Transistors

Designed for use in general purpose amplifier and switching applications.

### Features

- 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
- Pb-Free Packages are Available\*

### MAXIMUM RATINGS

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

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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

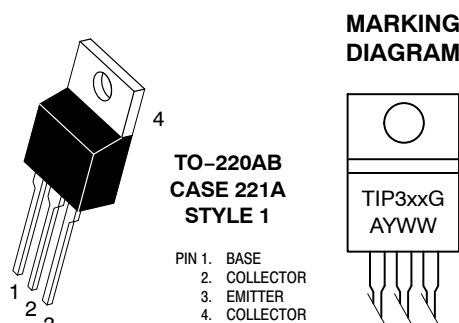
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



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## 3 AMPERE POWER TRANSISTORS COMPLEMENTARY SILICON 40-60-80-100 VOLTS, 40 WATTS



TIP3xx = Device Code  
xx = 1, 1A, 1B, 1C,  
2, 2A, 2B, 2C,  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

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## THERMAL CHARACTERISTICS

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

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

| Characteristic | Symbol | Min | Max | Unit |
|----------------|--------|-----|-----|------|
|----------------|--------|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                                                                                                                                                       |                                                                    |               |                       |                          |                 |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------|---------------|-----------------------|--------------------------|-----------------|
| Collector-Emitter Sustaining Voltage (Note 2)<br>( $I_C = 30\text{ mAdc}$ , $I_B = 0$ )                                                                                                                               | TIP31, TIP32<br>TIP31A, TIP32A<br>TIP31B, TIP32B<br>TIP31C, TIP32C | $V_{CE(sus)}$ | 40<br>60<br>80<br>100 | –<br>–<br>–<br>–         | Vdc             |
| Collector Cutoff Current ( $V_{CE} = 30\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 60\text{ Vdc}$ , $I_B = 0$ )                                                                                                         | TIP31, TIP32, TIP31A, TIP32A<br>TIP31B, TIP31C, TIP32B, TIP32C     | $I_{CEO}$     | –<br>–                | 0.3<br>0.3               | mAdc            |
| Collector Cutoff Current<br>( $V_{CE} = 40\text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 80\text{ Vdc}$ , $V_{EB} = 0$ )<br>( $V_{CE} = 100\text{ Vdc}$ , $V_{EB} = 0$ ) | TIP31, TIP32<br>TIP31A, TIP32A<br>TIP31B, TIP32B<br>TIP31C, TIP32C | $I_{CES}$     | –<br>–<br>–<br>–      | 200<br>200<br>200<br>200 | $\mu\text{Adc}$ |
| Emitter Cutoff Current ( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )                                                                                                                                                      |                                                                    | $I_{EBO}$     | –                     | 1.0                      | mAdc            |

### ON CHARACTERISTICS (Note 2)

|                                                                                                                                  |               |          |         |     |
|----------------------------------------------------------------------------------------------------------------------------------|---------------|----------|---------|-----|
| DC Current Gain ( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )<br>( $I_C = 3.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ ) | $h_{FE}$      | 25<br>10 | –<br>50 | –   |
| Collector-Emitter Saturation Voltage ( $I_C = 3.0\text{ Adc}$ , $I_B = 375\text{ mAdc}$ )                                        | $V_{CE(sat)}$ | –        | 1.2     | Vdc |
| Base-Emitter On Voltage ( $I_C = 3.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )                                                   | $V_{BE(on)}$  | –        | 1.8     | Vdc |

### DYNAMIC CHARACTERISTICS

|                                                                                                                       |          |     |   |     |
|-----------------------------------------------------------------------------------------------------------------------|----------|-----|---|-----|
| Current-Gain – Bandwidth Product ( $I_C = 500\text{ mAdc}$ , $V_{CE} = 10\text{ Vdc}$ , $f_{test} = 1.0\text{ MHz}$ ) | $f_T$    | 3.0 | – | MHz |
| Small-Signal Current Gain ( $I_C = 0.5\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )                | $h_{fe}$ | 20  | – | –   |

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

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

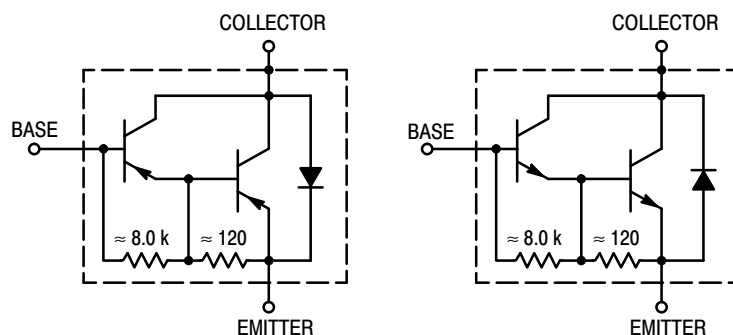


**Figure 1. Darlington Circuit Schematic**

## ORDERING INFORMATION

| Device  | Package             | Shipping        |
|---------|---------------------|-----------------|
| TIP31   | TO-220              | 50 Units / Rail |
| TIP31G  | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31A  | TO-220              | 50 Units / Rail |
| TIP31AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31B  | TO-220              | 50 Units / Rail |
| TIP31BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31C  | TO-220              | 50 Units / Rail |
| TIP31CG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32   | TO-220              | 50 Units / Rail |
| TIP32G  | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32A  | TO-220              | 50 Units / Rail |
| TIP32AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32B  | TO-220              | 50 Units / Rail |
| TIP32BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32C  | TO-220              | 50 Units / Rail |
| TIP32CG | TO-220<br>(Pb-Free) | 50 Units / Rail |

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

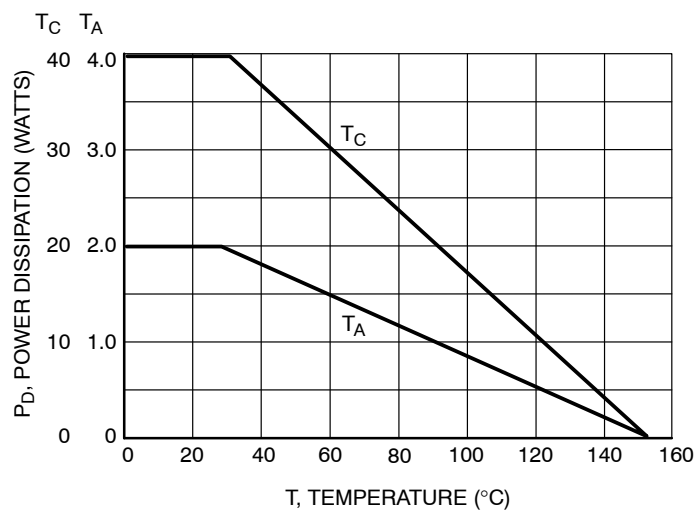
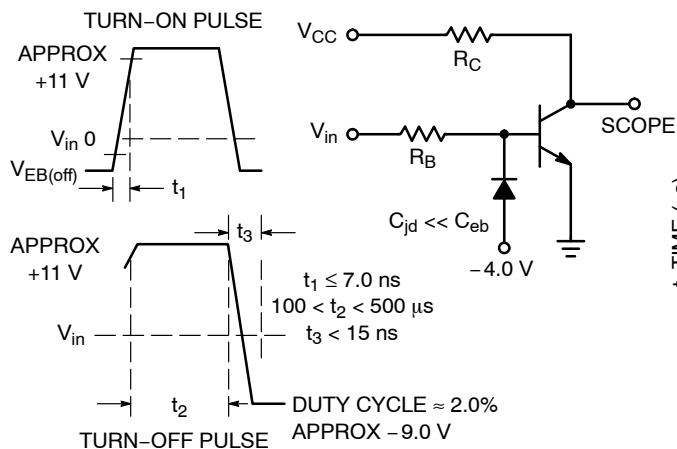


Figure 2. Power Derating



$R_B$  and  $R_C$  VARIED TO OBTAIN DESIRED CURRENT LEVELS.

Figure 3. Switching Time Equivalent Circuit

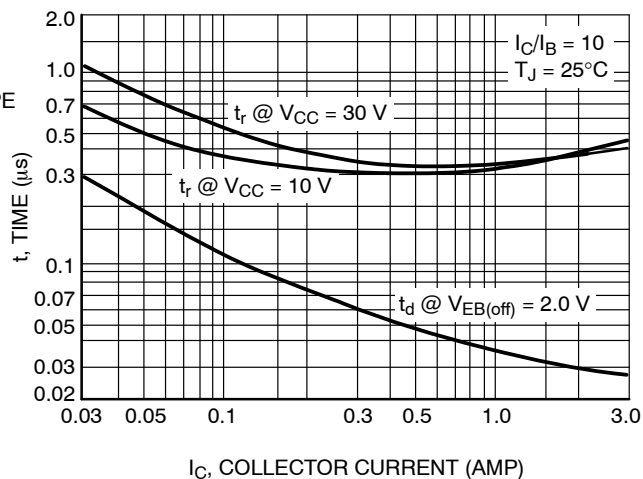


Figure 4. Turn-On Time

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

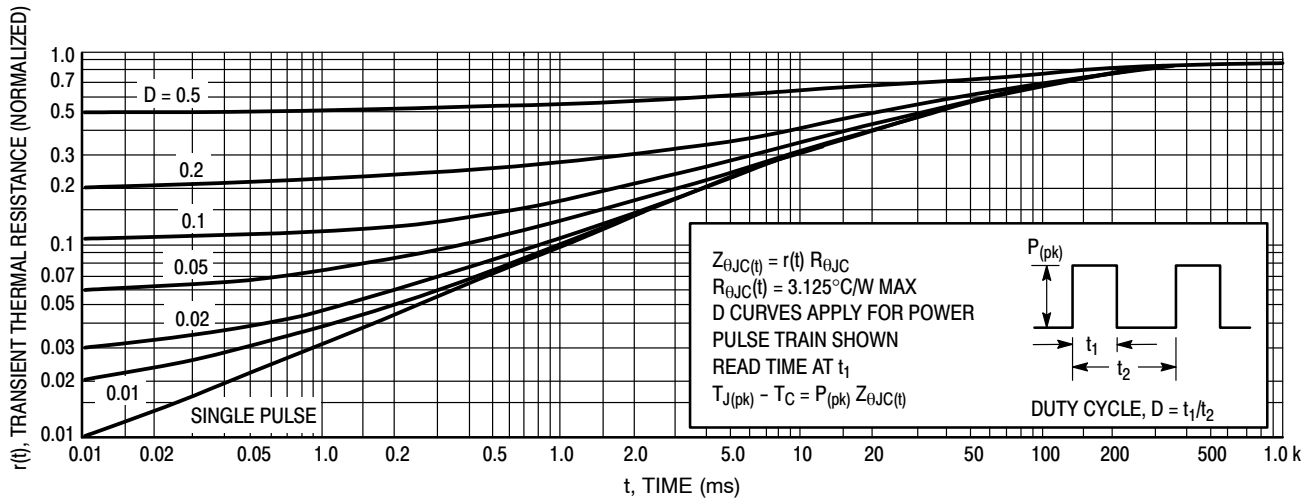


Figure 5. Thermal Response

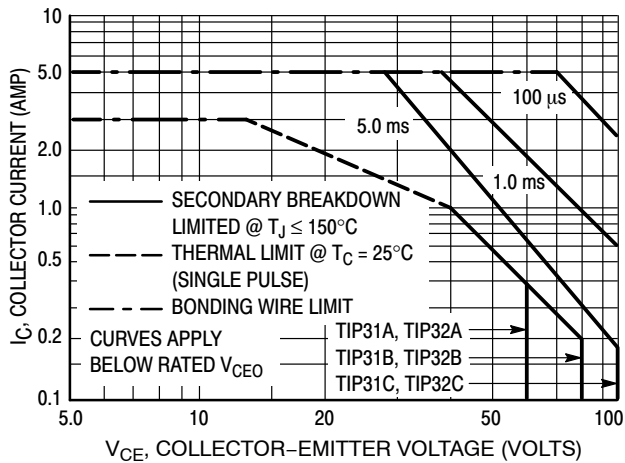


Figure 6. Active Region Safe Operating Area

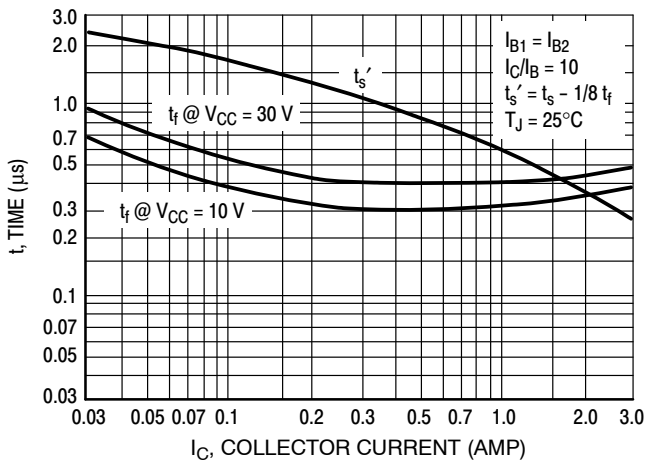


Figure 7. Turn-Off Time

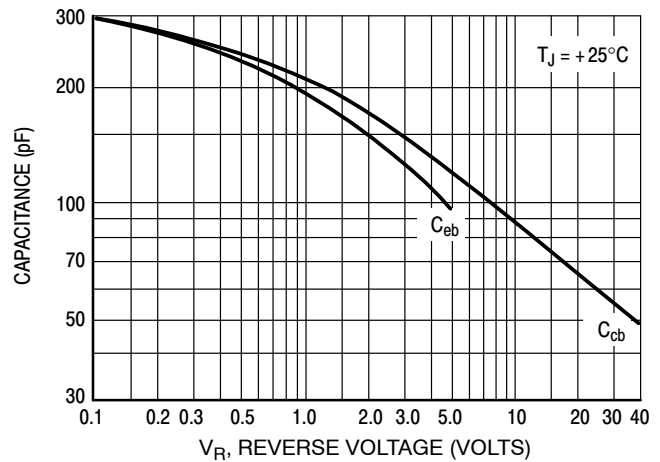


Figure 8. Capacitance

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

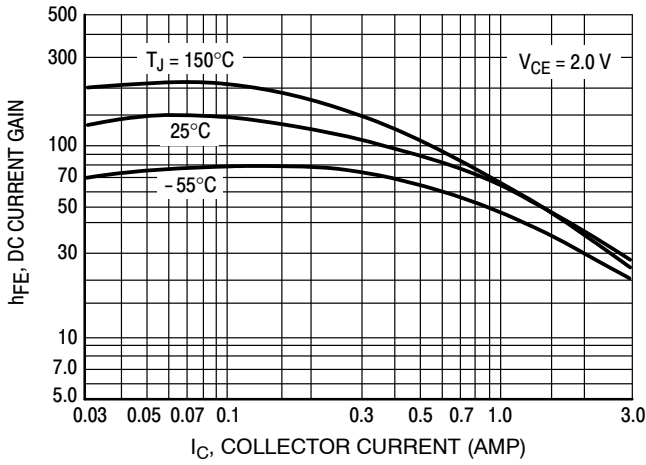


Figure 9. DC Current Gain

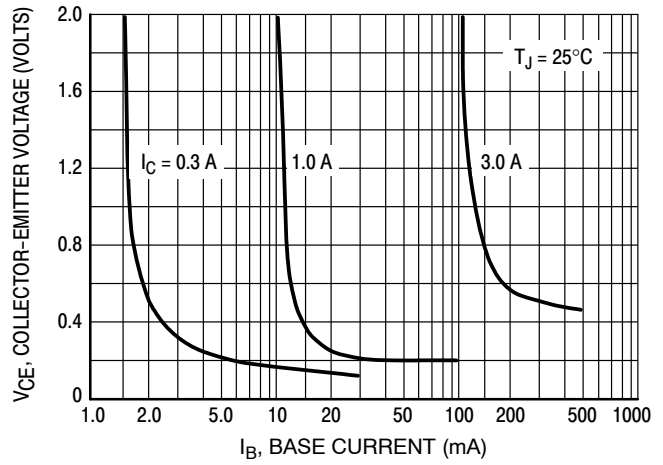


Figure 10. Collector Saturation Region

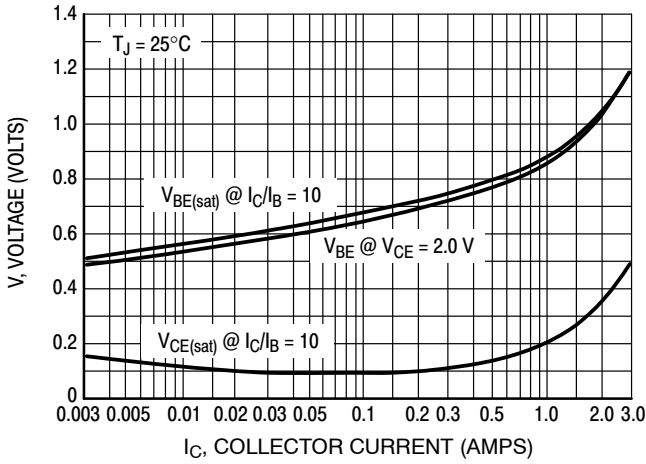


Figure 11. "On" Voltages

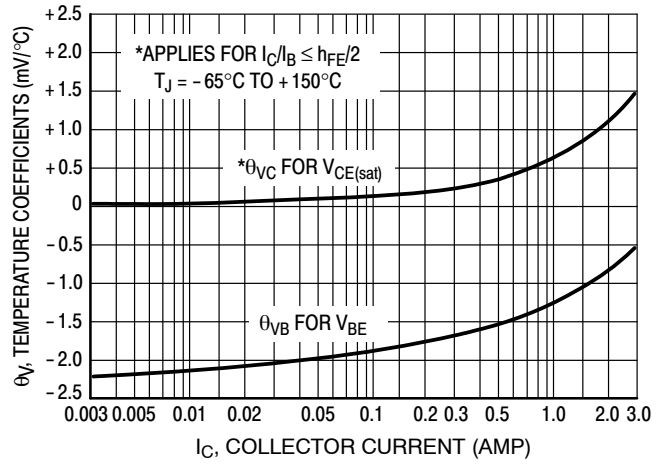


Figure 12. Temperature Coefficients

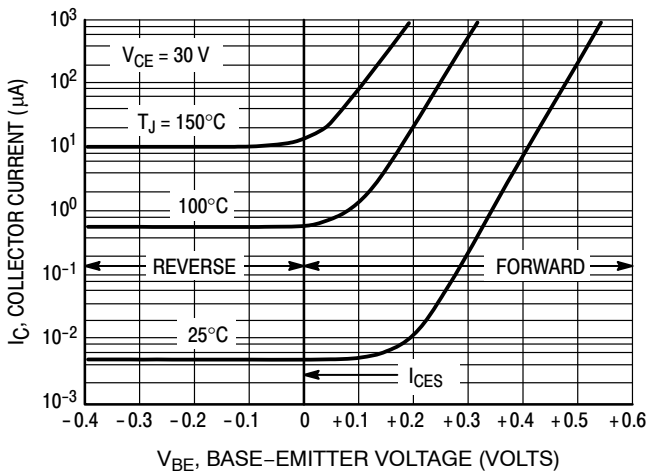


Figure 13. Collector Cut-Off Region

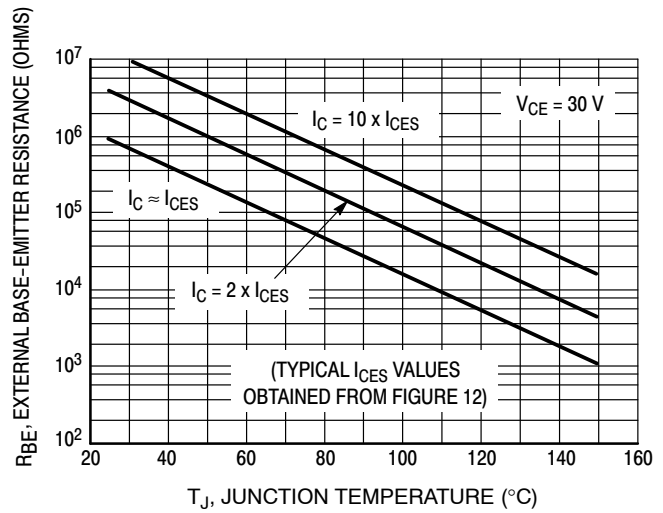
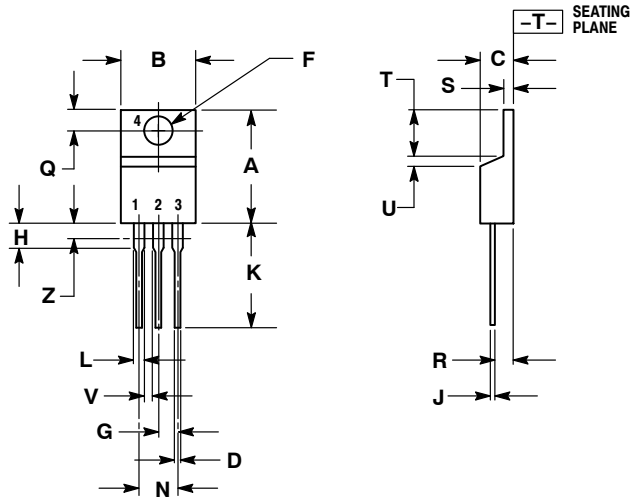


Figure 14. Effects of Base-Emitter Resistance

# TIP31, TIP31A, TIP31B, TIP31C, (NPN), TIP32, TIP32A, TIP32B, TIP32C, (PNP)

## PACKAGE DIMENSIONS

TO-220  
CASE 221A-09  
ISSUE AG



### 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  | 0.036 | 0.64        | 0.91  |
| F   | 0.142  | 0.161 | 3.61        | 4.09  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.161 | 2.80        | 4.10  |
| J   | 0.014  | 0.025 | 0.36        | 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
- COLLECTOR
- EMITTER
- COLLECTOR

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