

# Complementary Silicon Plastic Power Transistors

## TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG, TIP32CG (PNP)

Designed for use in general purpose amplifier and switching applications.

### Features

- High Current Gain – Bandwidth Product
- Compact TO-220 Package
- These Devices are Pb-Free and are RoHS Compliant\*

### MAXIMUM RATINGS

| Symbol         | Rating                                                                                                    | Value                 | Unit                     |
|----------------|-----------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| $V_{CEO}$      | Collector – Emitter Voltage<br>TIP31G, TIP32G<br>TIP31AG, TIP32AG<br>TIP31BG, TIP32BG<br>TIP31CG, TIP32CG | 40<br>60<br>80<br>100 | Vdc                      |
| $V_{CB}$       | Collector–Base Voltage<br>TIP31G, TIP32G<br>TIP31AG, TIP32AG<br>TIP31BG, TIP32BG<br>TIP31CG, TIP32CG      | 40<br>60<br>80<br>100 | Vdc                      |
| $V_{EB}$       | Emitter–Base Voltage                                                                                      | 5.0                   | Vdc                      |
| $I_C$          | Collector Current – Continuous                                                                            | 3.0                   | Adc                      |
| $I_{CM}$       | Collector Current – Peak                                                                                  | 5.0                   | Adc                      |
| $I_B$          | Base Current                                                                                              | 1.0                   | Adc                      |
| $P_D$          | Total Power Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$                  | 40<br>0.32            | W<br>W/ $^\circ\text{C}$ |
| $P_D$          | Total Power Dissipation<br>@ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$                  | 2.0<br>0.016          | W<br>W/ $^\circ\text{C}$ |
| E              | Unclamped Inductive Load Energy<br>(Note 1)                                                               | 32                    | mJ                       |
| $T_J, T_{stg}$ | Operating and Storage Junction<br>Temperature Range                                                       | –65 to +150           | $^\circ\text{C}$         |

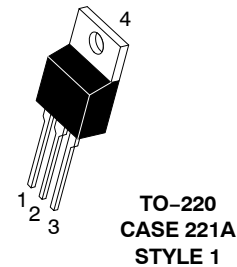
Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

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

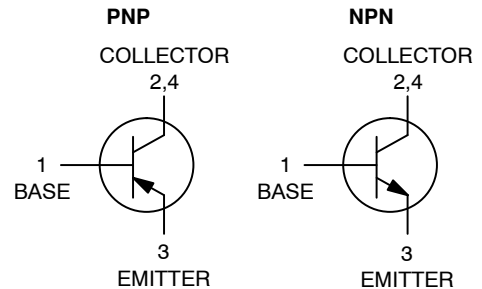
### THERMAL CHARACTERISTICS

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

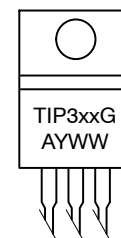
\*For additional information on our Pb-Free strategy and soldering details, please download the [onsemi Soldering and Mounting Techniques Reference Manual, SOLDERRM/D](#).



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



### MARKING DIAGRAM



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 on page 6 of this data sheet.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 6.

# TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG, TIP32CG (PNP)

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

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

### OFF CHARACTERISTICS

|               |                                                                                                                                                                                                                                                                                                         |                       |                          |                 |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------------------|-----------------|
| $V_{CE(sus)}$ | Collector-Emitter Sustaining Voltage (Note 2)<br>( $I_C = 30 \text{ mAdc}$ , $I_B = 0$ )<br>TIP31G, TIP32G<br>TIP31AG, TIP32AG<br>TIP31BG, TIP32BG<br>TIP31CG, TIP32CG                                                                                                                                  | 40<br>60<br>80<br>100 | –<br>–<br>–<br>–         | Vdc             |
| $I_{CEO}$     | Collector Cutoff Current<br>( $V_{CE} = 30 \text{ Vdc}$ , $I_B = 0$ )<br>TIP31G, TIP32G, TIP31AG, TIP32AG<br>( $V_{CE} = 60 \text{ Vdc}$ , $I_B = 0$ )<br>TIP31BG, TIP31CG, TIP32BG, TIP32CG                                                                                                            | –<br>–                | 0.3<br>0.3               | mAdc            |
| $I_{CES}$     | Collector Cutoff Current<br>( $V_{CE} = 40 \text{ Vdc}$ , $V_{EB} = 0$ )<br>TIP31G, TIP32G<br>( $V_{CE} = 60 \text{ Vdc}$ , $V_{EB} = 0$ )<br>TIP31AG, TIP32AG<br>( $V_{CE} = 80 \text{ Vdc}$ , $V_{EB} = 0$ )<br>TIP31BG, TIP32BG<br>( $V_{CE} = 100 \text{ Vdc}$ , $V_{EB} = 0$ )<br>TIP31CG, TIP32CG | –<br>–<br>–<br>–      | 200<br>200<br>200<br>200 | $\mu\text{Adc}$ |
| $I_{EBO}$     | Emitter Cutoff Current<br>( $V_{BE} = 5.0 \text{ Vdc}$ , $I_C = 0$ )                                                                                                                                                                                                                                    | –                     | 1.0                      | mAdc            |

### ON CHARACTERISTICS (Note 2)

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

### DYNAMIC CHARACTERISTICS

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

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

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

# TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG, TIP32CG (PNP)

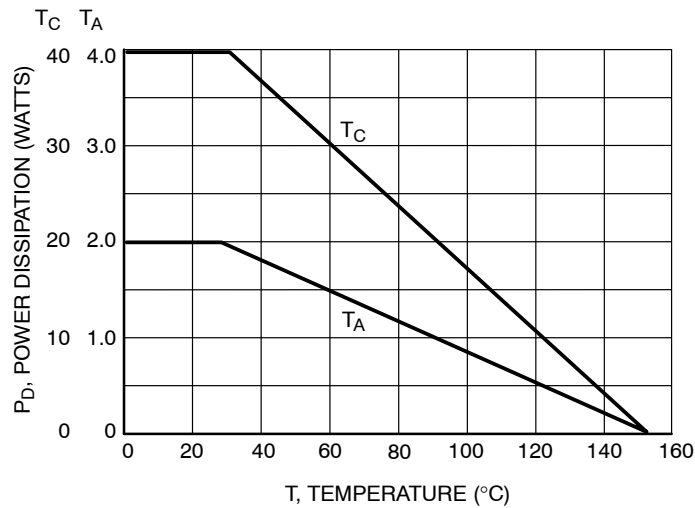
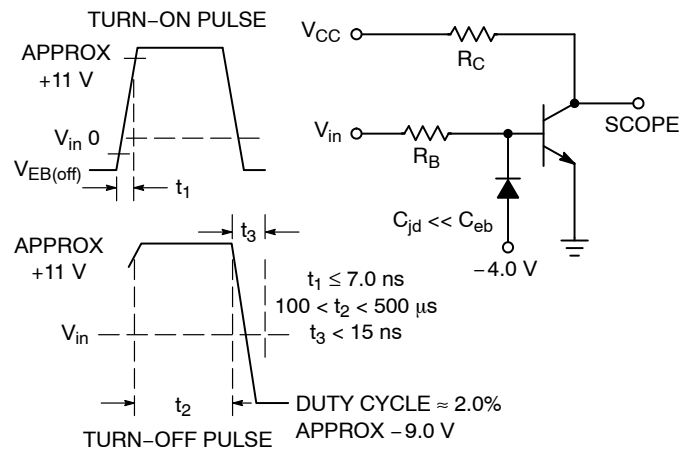


Figure 1. Power Derating



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

Figure 2. Switching Time Equivalent Circuit

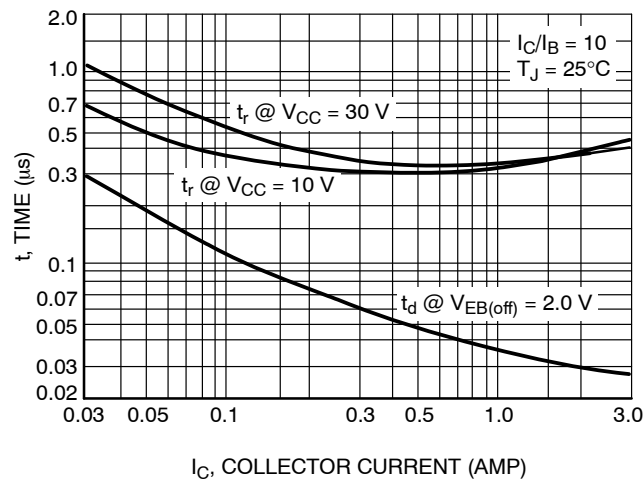


Figure 3. Turn-On Time

# TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG, TIP32CG (PNP)

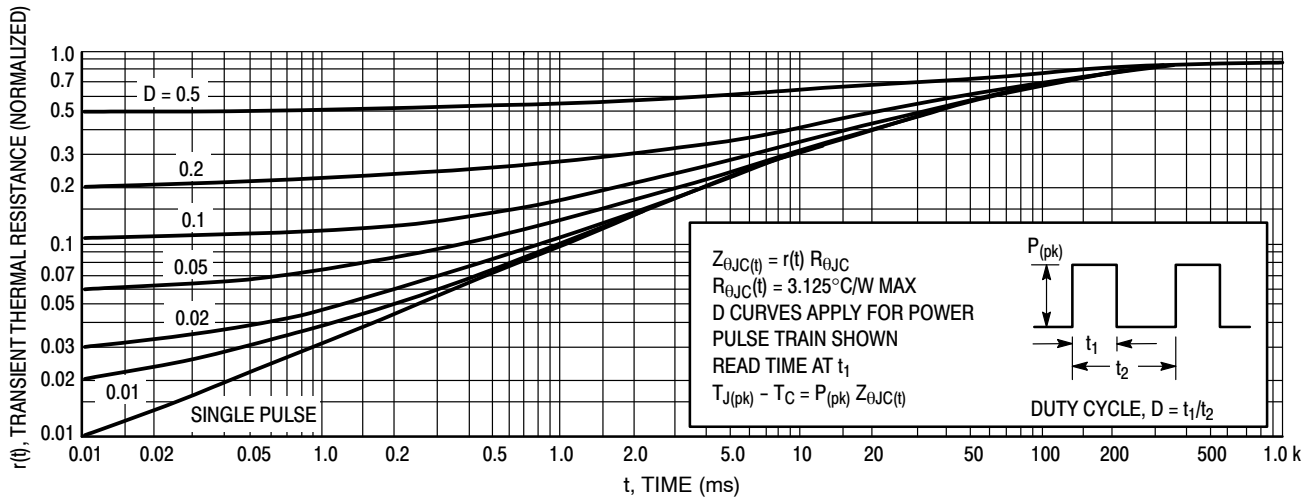


Figure 4. Thermal Response

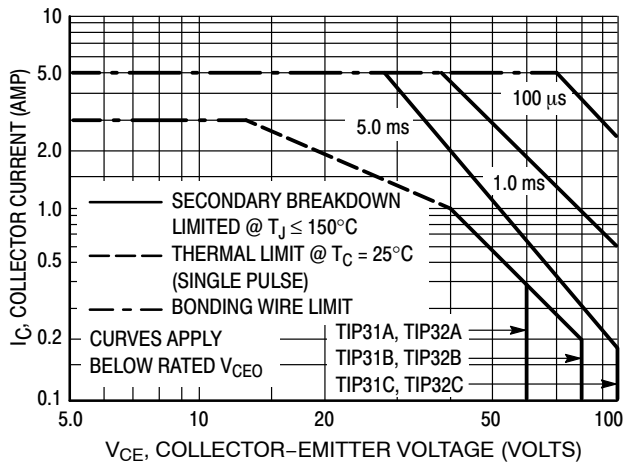


Figure 5. Active Region Safe Operating Area

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.

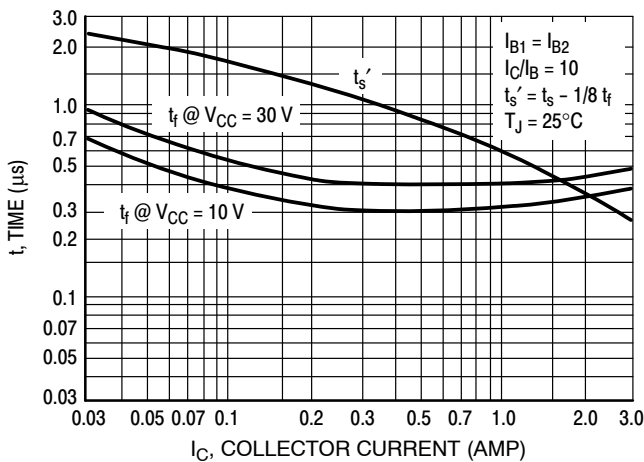


Figure 6. Turn-Off Time

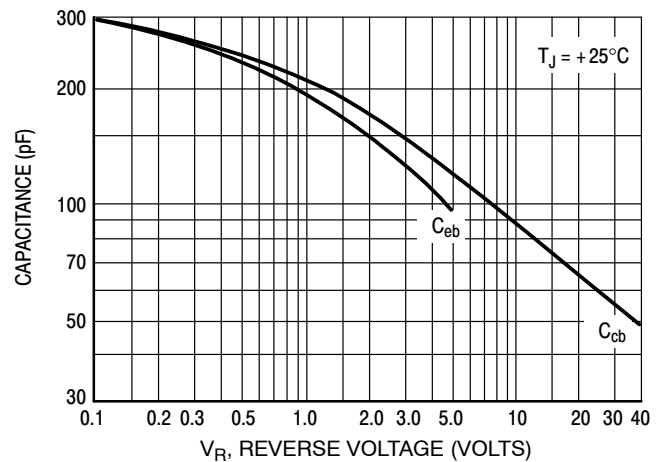
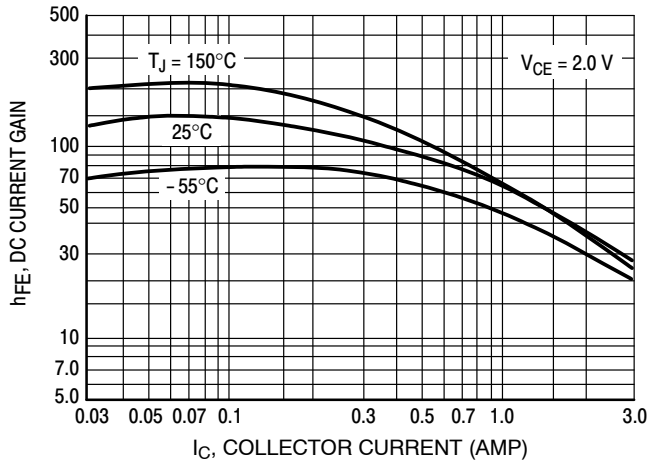
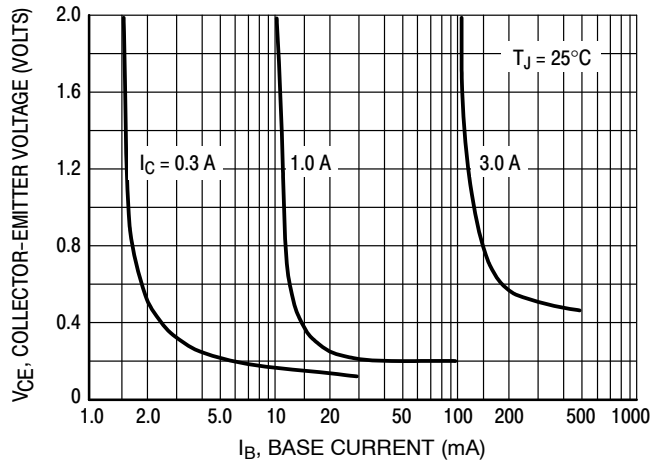


Figure 7. Capacitance

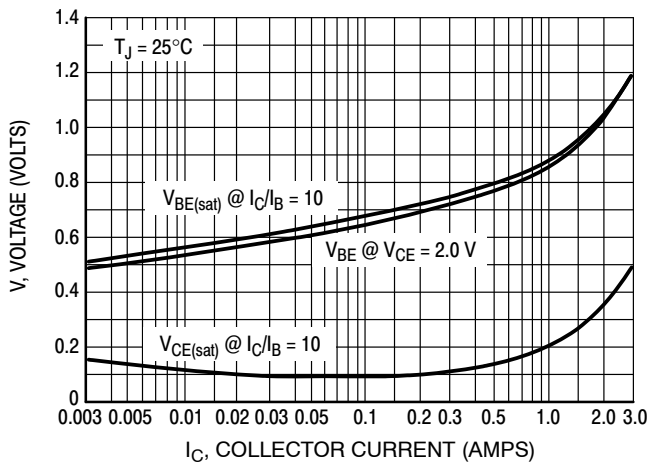
**TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG, TIP32CG (PNP)**



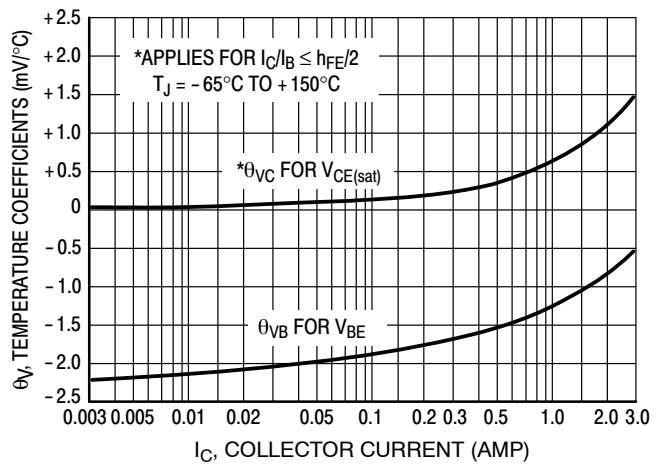
**Figure 8. DC Current Gain**



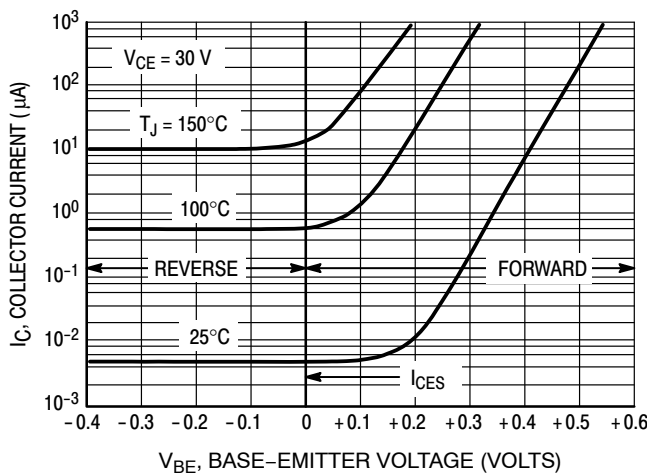
**Figure 9. Collector Saturation Region**



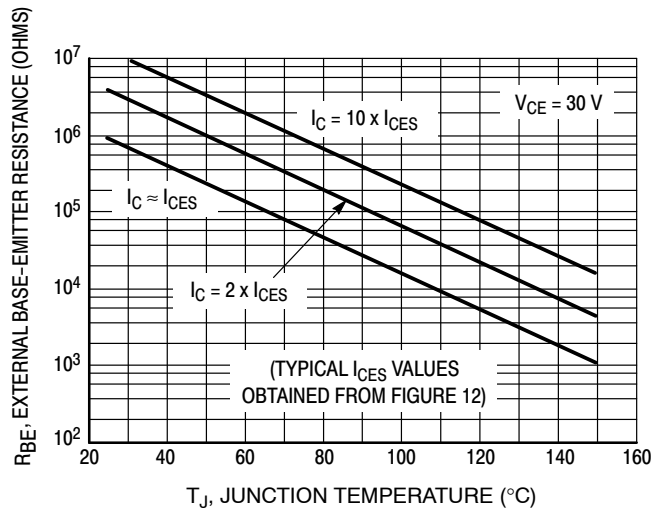
**Figure 10. "On" Voltages**



**Figure 11. Temperature Coefficients**



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



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

**TIP31G, TIP31AG, TIP31BG, TIP31CG (NPN), TIP32G, TIP32AG, TIP32BG,  
TIP32CG (PNP)**

**ORDERING INFORMATION**

| Device  | Package             | Shipping        |
|---------|---------------------|-----------------|
| TIP31AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP31CG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32G  | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32AG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32BG | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP32CG | TO-220<br>(Pb-Free) | 50 Units / Rail |

**DISCONTINUED** (Note 3)

|        |                     |                 |
|--------|---------------------|-----------------|
| TIP31G | TO-220<br>(Pb-Free) | 50 Units / Rail |
|--------|---------------------|-----------------|

3. **DISCONTINUED:** This device is not recommended for new design. Please contact your **onsemi** representative for information. The most current information on this device may be available on [www.onsemi.com](http://www.onsemi.com).



TO-220-3 10.10x15.12x4.45, 2.54P

CASE 221A

ISSUE AL

DATE 05 FEB 2025



| MILLIMETERS |          |       |       |
|-------------|----------|-------|-------|
| DIM         | MIN      | NOM   | MAX   |
| A           | 4.07     | 4.45  | 4.83  |
| A1          | 1.15     | 1.28  | 1.41  |
| A2          | 2.04     | 2.42  | 2.79  |
| b           | 1.15     | 1.34  | 1.52  |
| b1          | 0.64     | 0.80  | 0.96  |
| c           | 0.36     | 0.49  | 0.61  |
| D           | 9.66     | 10.10 | 10.53 |
| D1          | 8.43     | 8.63  | 8.83  |
| E           | 14.48    | 15.12 | 15.75 |
| E1          | 12.58    | 12.78 | 12.98 |
| E2          | 1.27 REF |       |       |

| MILLIMETERS |       |       |       |
|-------------|-------|-------|-------|
| DIM         | MIN   | NOM   | MAX   |
| e           | 2.42  | 2.54  | 2.66  |
| e1          | 4.83  | 5.08  | 5.33  |
| H1          | 5.97  | 6.22  | 6.47  |
| L           | 12.70 | 13.49 | 14.27 |
| L1          | 2.80  | 3.45  | 4.10  |
| Q           | 2.54  | 2.79  | 3.04  |
| øP          | 3.60  | 3.85  | 4.09  |
| Z           | ---   | ---   | 3.48  |

NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2018.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

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

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

STYLE 3:  
PIN 1. CATHODE  
2. ANODE  
3. GATE  
4. ANODE

STYLE 4:  
PIN 1. MAIN TERMINAL 1  
2. MAIN TERMINAL 2  
3. GATE  
4. MAIN TERMINAL 2

STYLE 5:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE  
4. DRAIN

STYLE 6:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE  
4. CATHODE

STYLE 7:  
PIN 1. CATHODE  
2. ANODE  
3. CATHODE  
4. ANODE

STYLE 8:  
PIN 1. CATHODE  
2. ANODE  
3. EXTERNAL TRIP/DELAY  
4. ANODE

STYLE 9:  
PIN 1. GATE  
2. COLLECTOR  
3. EMITTER  
4. COLLECTOR

STYLE 10:  
PIN 1. GATE  
2. SOURCE  
3. DRAIN  
4. SOURCE

STYLE 11:  
PIN 1. DRAIN  
2. SOURCE  
3. GATE  
4. SOURCE

STYLE 12:  
PIN 1. MAIN TERMINAL 1  
2. MAIN TERMINAL 2  
3. GATE  
4. NOT CONNECTED

|                  |                                  |                                                                                                                                                                                  |
|------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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