

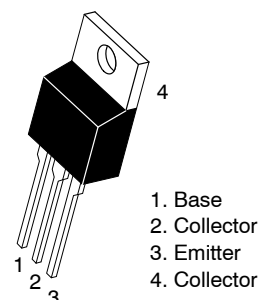
# Plastic Medium-Power Complementary Silicon Transistors

## TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

Designed for general-purpose amplifier and low-speed switching applications.

### Features

- High DC Current Gain –  
 $h_{FE} = 2500$  (Typ) @  $I_C$   
 $= 1.0$  Adc
- Collector-Emitter Sustaining Voltage – @ 30 mAdc  
 $V_{CEO(sus)} = 60$  Vdc (Min) – TIP110, TIP115  
 $= 80$  Vdc (Min) – TIP111, TIP116  
 $= 100$  Vdc (Min) – TIP112, TIP117
- Low Collector-Emitter Saturation Voltage –  
 $V_{CE(sat)} = 2.5$  Vdc (Max) @  $I_C$   
 $= 2.0$  Adc
- Monolithic Construction with Built-in Base-Emitter Shunt Resistors
- Pb-Free Packages are Available\*–



TO-220AB  
CASE 221A  
STYLE 1

## DARLINGTON 2 AMPERE COMPLEMENTARY SILICON POWER TRANSISTORS 60–80–100 VOLTS, 50 WATTS

### MARKING DIAGRAM



TIP11x = Device Code  
x = 0, 1, 2, 5, 6, or 7  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

NOTE: Some of the devices on this data sheet have been **DISCONTINUED**. Please refer to the table on page 8.

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

# TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

## MAXIMUM RATINGS

| Symbol         | Rating                                                                                | TIP110,<br>TIP115 | TIP111,<br>TIP116 | TIP112,<br>TIP117 | Unit                     |
|----------------|---------------------------------------------------------------------------------------|-------------------|-------------------|-------------------|--------------------------|
| $V_{CEO}$      | Collector–Emitter Voltage                                                             | 60                | 80                | 100               | Vdc                      |
| $V_{CB}$       | Collector–Base Voltage                                                                | 60                | 80                | 100               | Vdc                      |
| $V_{EB}$       | Emitter–Base Voltage                                                                  | 5.0               |                   |                   | Vdc                      |
| $I_C$          | Collector Current – Continuous<br>– Peak                                              | 2.0<br>4.0        |                   |                   | Adc                      |
| $I_B$          | Base Current                                                                          | 50                |                   |                   | mAdc                     |
| $P_D$          | Total Power Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | 50<br>0.4         |                   |                   | W<br>W/ $^\circ\text{C}$ |
| $P_D$          | Total Power Dissipation @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | 2.0<br>0.016      |                   |                   | W<br>W/ $^\circ\text{C}$ |
| E              | Unclamped Inductive Load Energy – Figure 13                                           | 25                |                   |                   | mJ                       |
| $T_J, T_{stg}$ | Operating and Storage Junction                                                        | –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.

## THERMAL CHARACTERISTICS

| Symbol          | Characteristics                         | Max  | Unit                      |
|-----------------|-----------------------------------------|------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction–to–Case    | 2.5  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction–to–Ambient | 62.5 | $^\circ\text{C}/\text{W}$ |

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

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

### OFF CHARACTERISTICS

|                |                                                                                                                                                               |                                                    |                 |                   |      |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|-----------------|-------------------|------|
| $V_{CEO(sus)}$ | Collector–Emitter Sustaining Voltage (Note 1)<br>( $I_C = 30\text{ mAdc}$ , $I_B = 0$ )                                                                       | TIP110, TIP115<br>TIP111, TIP116<br>TIP112, TIP117 | 60<br>80<br>100 | –<br>–<br>–       | Vdc  |
| $I_{CEO}$      | Collector Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 40\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 50\text{ Vdc}$ , $I_B = 0$ )  | TIP110, TIP115<br>TIP111, TIP116<br>TIP112, TIP117 | –<br>–<br>–     | 2.0<br>2.0<br>2.0 | mAdc |
| $I_{CBO}$      | Collector Cutoff Current<br>( $V_{CB} = 60\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 80\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 100\text{ Vdc}$ , $I_E = 0$ ) | TIP110, TIP115<br>TIP111, TIP116<br>TIP112, TIP117 | –<br>–<br>–     | 1.0<br>1.0<br>1.0 | mAdc |
| $I_{EBO}$      | Emitter Cutoff Current<br>( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )                                                                                           |                                                    | –               | 2.0               | mAdc |

### ON CHARACTERISTICS (Note 1)

|               |                                                                                                                                     |             |        |     |
|---------------|-------------------------------------------------------------------------------------------------------------------------------------|-------------|--------|-----|
| $h_{FE}$      | DC Current Gain<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )<br>( $I_C = 2.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ ) | 1000<br>500 | –<br>– | –   |
| $V_{CE(sat)}$ | Collector–Emitter Saturation Voltage ( $I_C = 2.0\text{ Adc}$ , $I_B = 8.0\text{ mAdc}$ )                                           | –           | 2.5    | Vdc |
| $V_{BE(on)}$  | Base–Emitter On Voltage ( $I_C = 2.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )                                                      | –           | 2.8    | Vdc |

### DYNAMIC CHARACTERISTICS

|          |                                                                                                         |                                                  |        |            |
|----------|---------------------------------------------------------------------------------------------------------|--------------------------------------------------|--------|------------|
| $h_{fe}$ | Small-Signal Current Gain ( $I_C = 0.75\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ MHz}$ ) | 25                                               | –      | –          |
| $C_{ob}$ | Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 0.1\text{ MHz}$ )                   | TIP115, TIP116, TIP117<br>TIP110, TIP111, TIP112 | –<br>– | 200<br>100 |
|          |                                                                                                         |                                                  |        | pF         |

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.

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

## TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

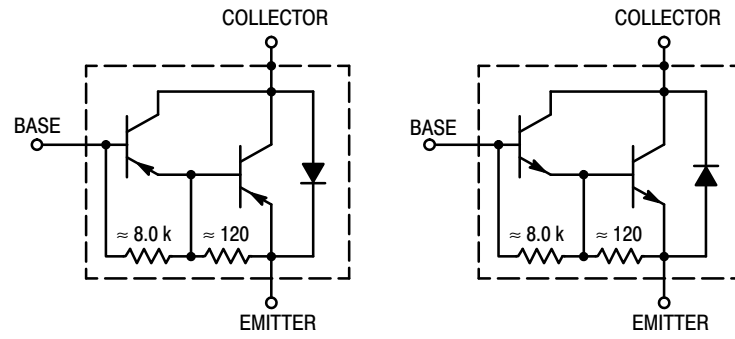


Figure 1. Darlington Circuit Schematic

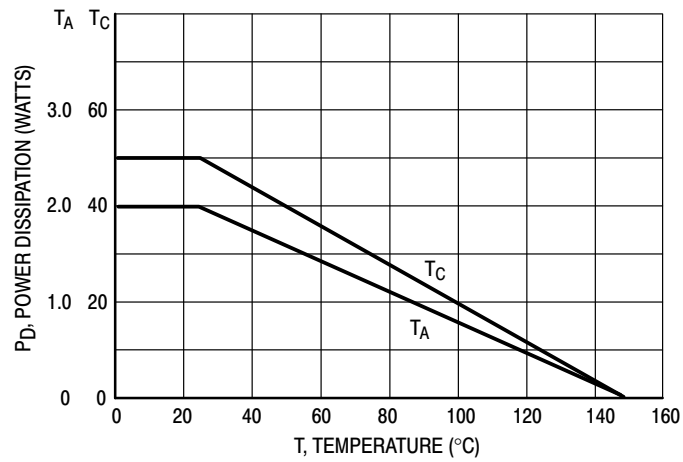


Figure 2. Power Derating

# TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

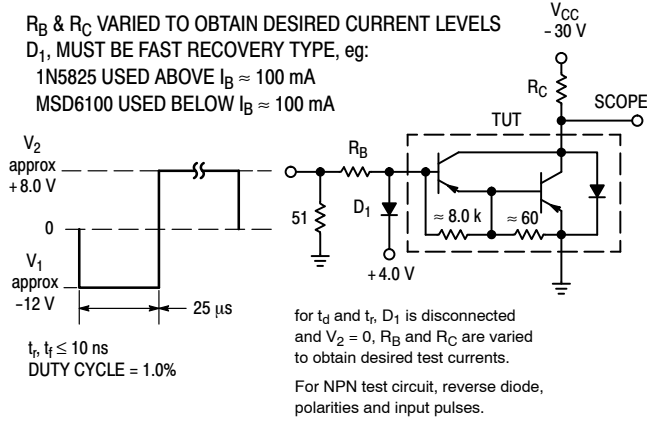


Figure 3. Switching Times Test Circuit

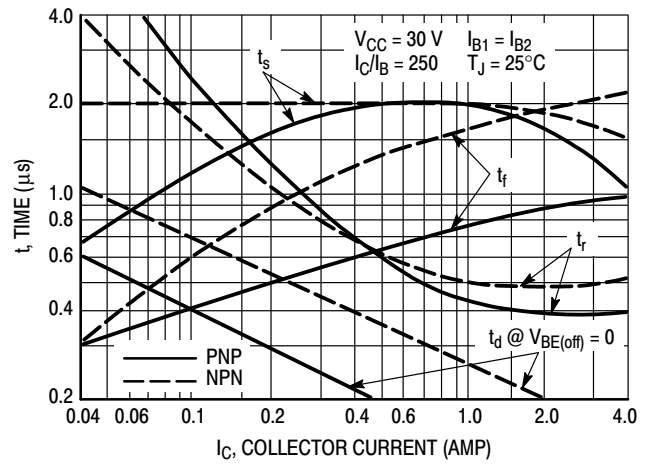


Figure 4. Switching Times

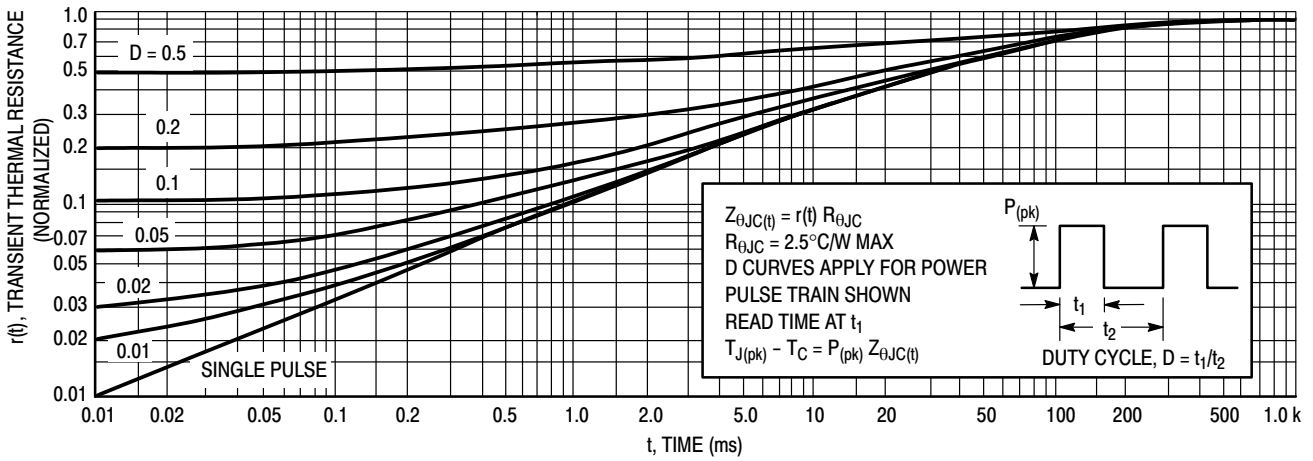


Figure 5. Thermal Response

# TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

## ACTIVE-REGION SAFE-OPERATING AREA

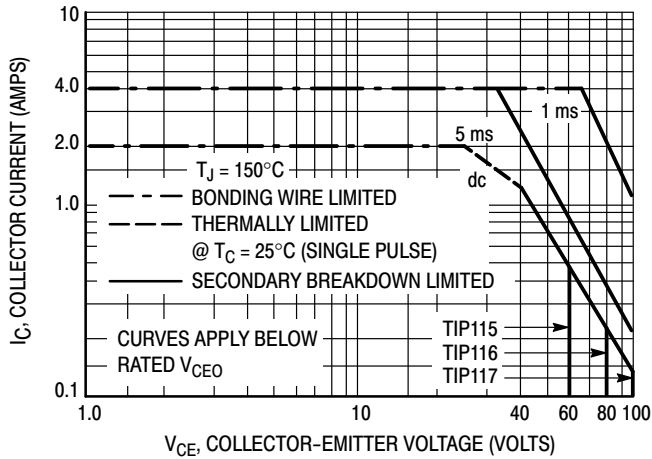


Figure 6. TIP115, 116, 117

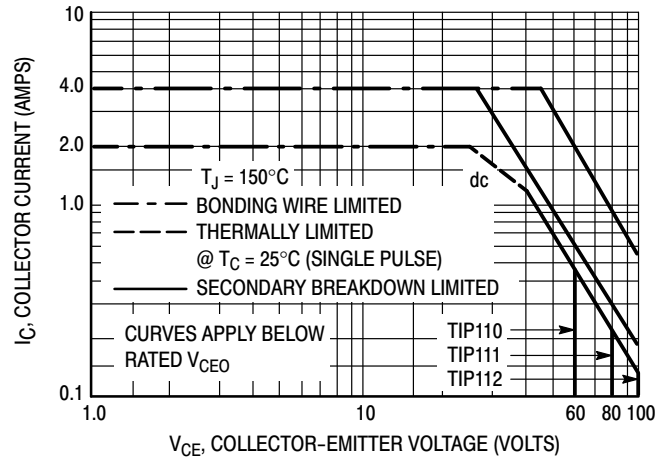


Figure 7. TIP110, 111, 112

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 Figures 6 and 7 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  $T_{J(pk)} < 150^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 5. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

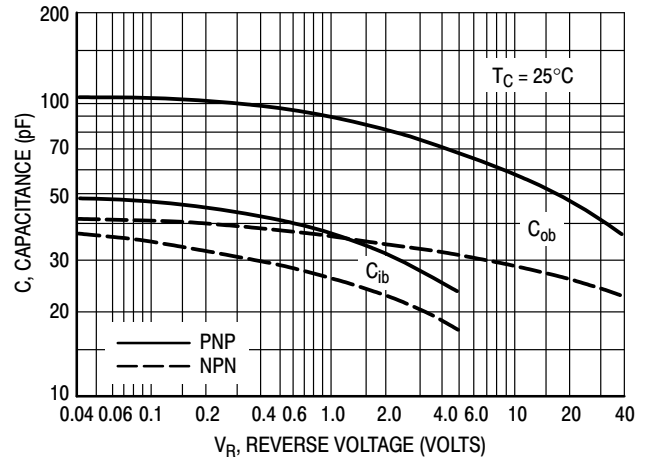


Figure 8. Capacitance

# TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

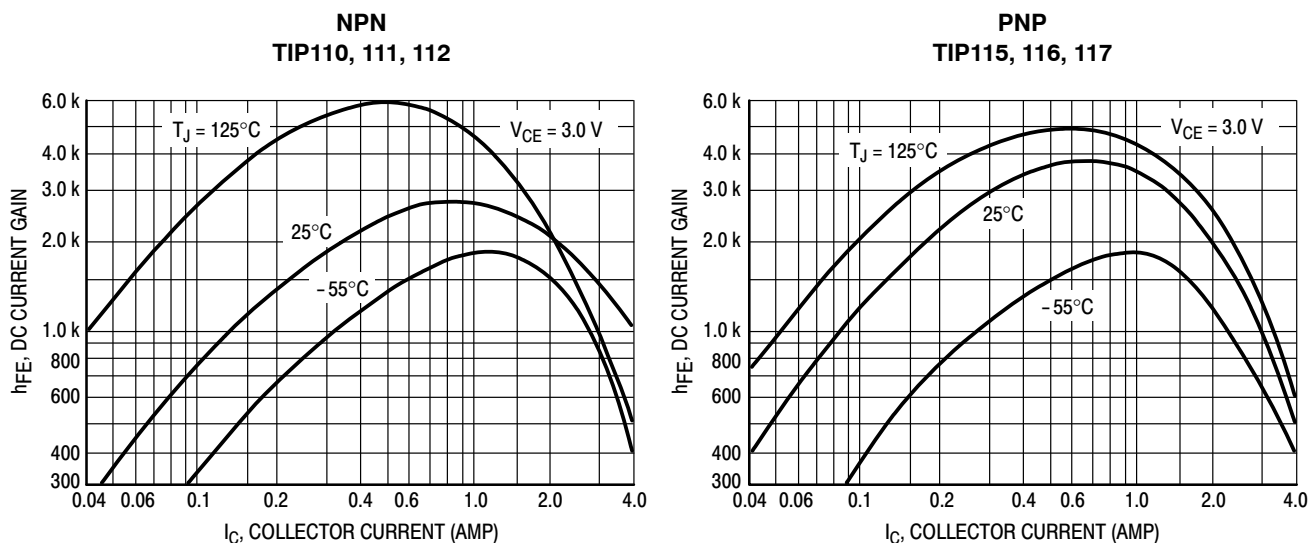


Figure 9. DC Current Gain

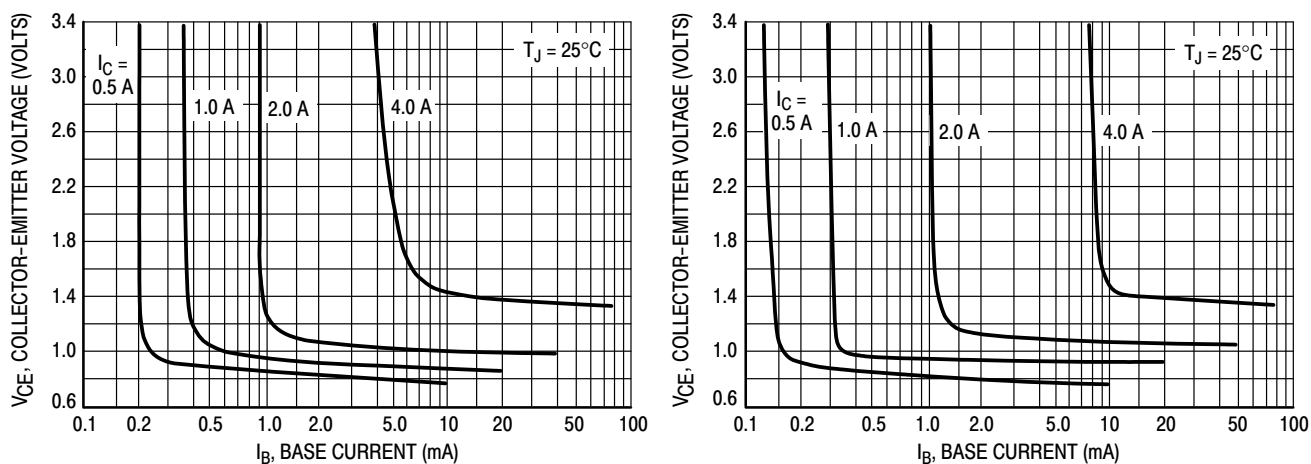


Figure 10. Collector Saturation Region

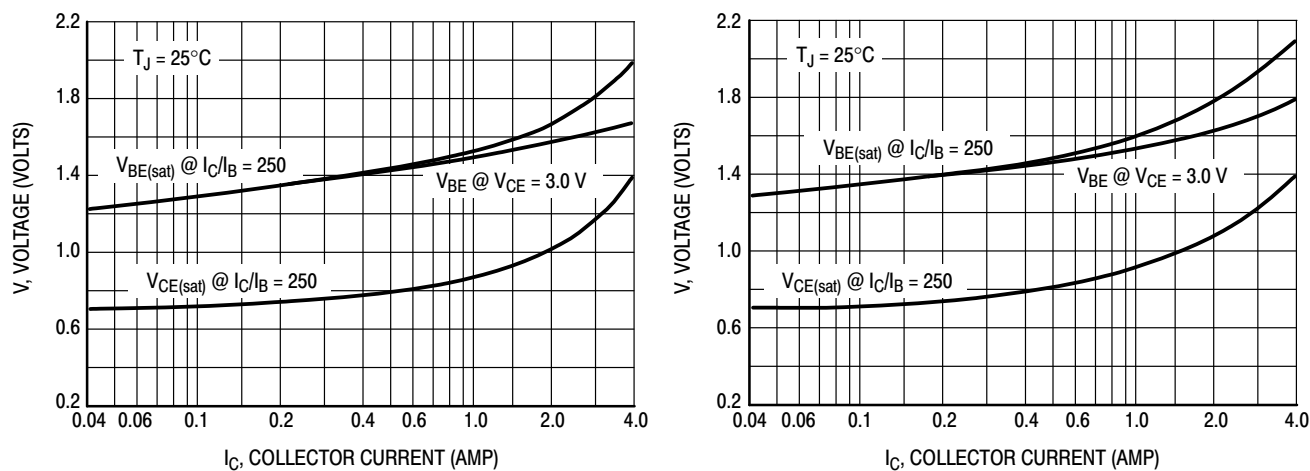


Figure 11. "On" Voltages

# TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

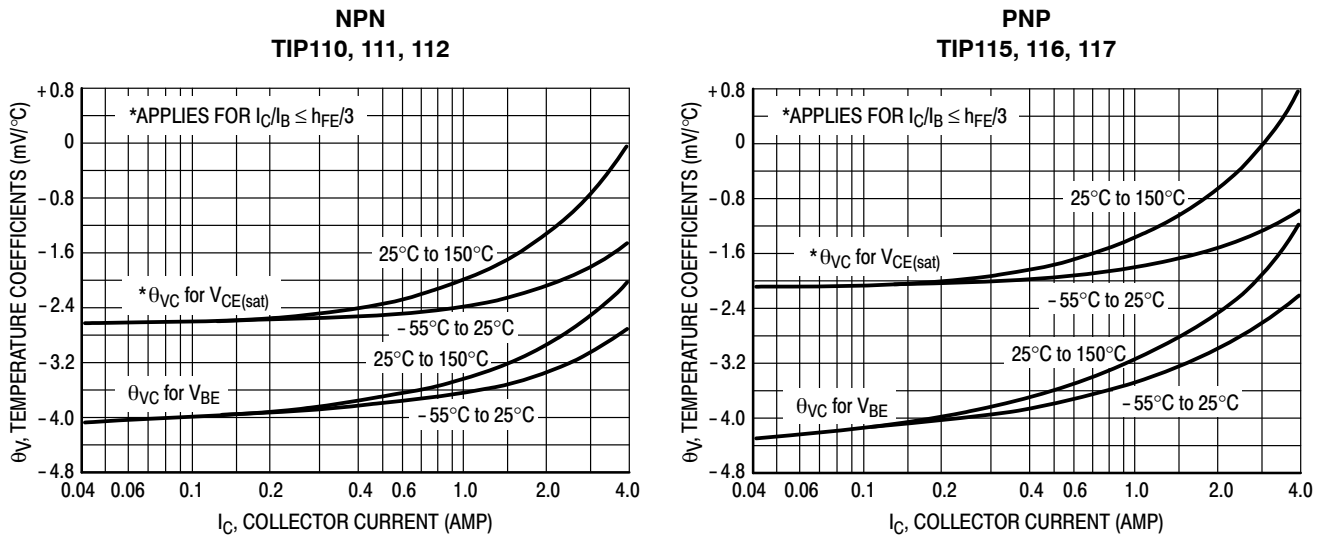


Figure 12. Temperature Coefficients

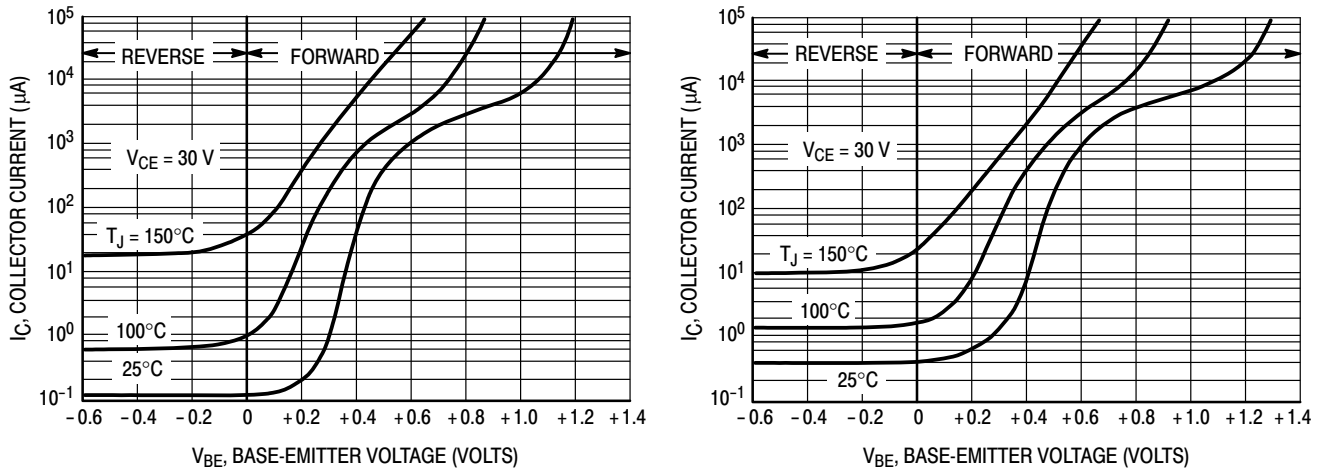
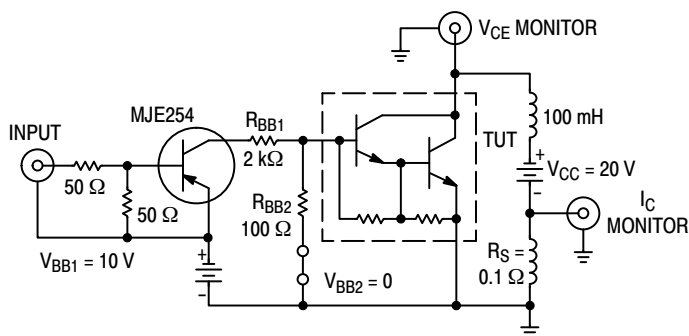


Figure 13. Collector Cut-Off Region

## TEST CIRCUIT



Note A: Input pulse width is increased until  $I_{CM} = 0.71$  A, NPN test shown; for PNP test reverse all polarity and use MJE224 driver.

## VOLTAGE AND CURRENT WAVEFORMS

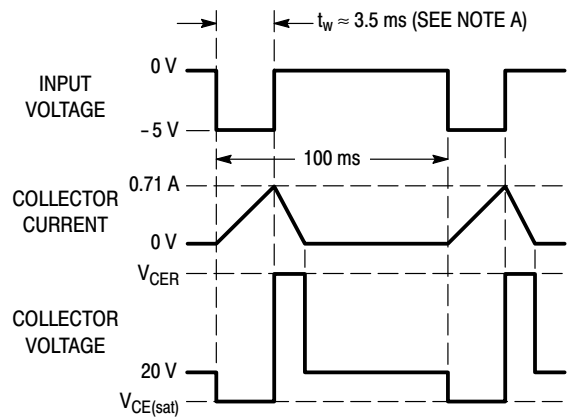


Figure 14. Inductive Load Switching

## TIP110, TIP111, TIP112 (NPN); TIP115, TIP116, TIP117 (PNP)

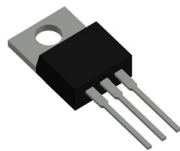
### ORDERING INFORMATION

| Device  | Package             | Shipping        |
|---------|---------------------|-----------------|
| TIP110G | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP111G | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP112G | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP115G | TO-220<br>(Pb-Free) | 50 Units / Rail |
| TIP117G | TO-220<br>(Pb-Free) | 50 Units / Rail |

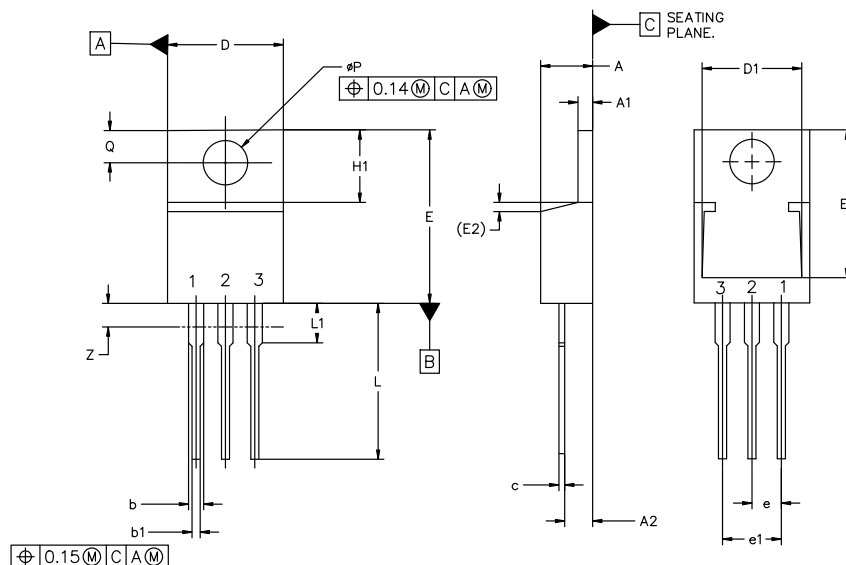
### DISCONTINUED (Note 2)

|         |                     |                 |
|---------|---------------------|-----------------|
| TIP110  | TO-220              | 50 Units / Rail |
| TIP111  | TO-220              | 50 Units / Rail |
| TIP112  | TO-220              | 50 Units / Rail |
| TIP115  | TO-220              | 50 Units / Rail |
| TIP116  | TO-220              | 50 Units / Rail |
| TIP117  | TO-220              | 50 Units / Rail |
| TIP116G | TO-220<br>(Pb-Free) | 50 Units / Rail |

2. **DISCONTINUED:** These devices are not recommended for new design. Please contact your **onsemi** representative for information. The most current information on these devices 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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