

# Plastic Medium-Power Complementary Silicon Transistors

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

- 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
- TO-220AB Compact Package

**\*MAXIMUM RATINGS**

| Rating  | Symbol         | TIP110,<br>TIP115 | TIP111,<br>TIP116 | TIP112,<br>TIP117 | 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<br>Peak  | $I_C$          | 2.0<br>4.0        |                   |                   | Adc                          |
| Base Current  | $I_B$          | 50                |                   |                   | mAdc                         |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 50<br>0.4         |                   |                   | Watts<br>W/ $^\circ\text{C}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 2.0<br>0.016      |                   |                   | Watts<br>W/ $^\circ\text{C}$ |
| Unclamped Inductive Load Energy —<br>Figure 13  | E              | 25                |                   |                   | mJ                           |
| Operating and Storage Junction  | $T_J, T_{stg}$ | -65 to +150       |                   |                   | $^\circ\text{C}$             |

**THERMAL CHARACTERISTICS**

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

**NPN**  
**TIP110**  
**TIP111\***  
**TIP112\***  
**PNP**  
**TIP115**  
**TIP116\***  
**TIP117\***

\*ON Semiconductor Preferred Device

**DARLINGTON**  
**2 AMPERE**  
**COMPLEMENTARY SILICON**  
**POWER TRANSISTORS**  
**60-80-100 VOLTS**  
**50 WATTS**

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

**CASE 221A-09**  
**TO-220AB**

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

TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

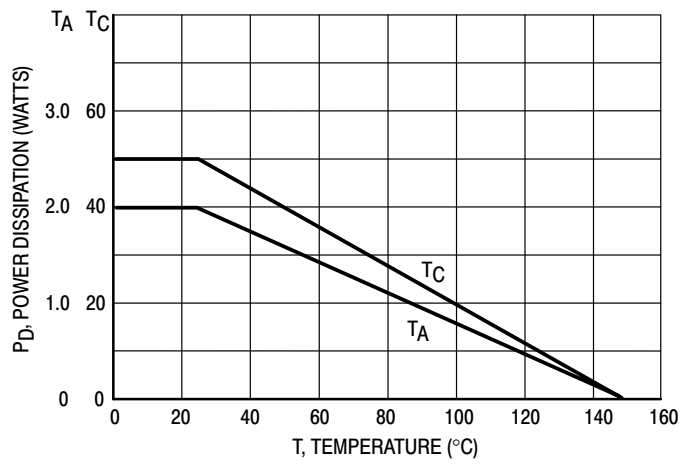


Figure 1. Power Derating

# TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

## 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)<br>( $I_C = 30\text{ mAdc}$ , $I_B = 0$ )  | $V_{CEO(sus)}$ | 60<br>80<br>100 | —                 | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = 30\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 40\text{ Vdc}$ , $I_B = 0$ )<br>( $V_{CE} = 50\text{ Vdc}$ , $I_B = 0$ )  | $I_{CEO}$      | —<br>—<br>—     | 2.0<br>2.0<br>2.0 | mAdc |
| Collector Cutoff Current<br>( $V_{CB} = 60\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 80\text{ Vdc}$ , $I_E = 0$ )<br>( $V_{CB} = 100\text{ Vdc}$ , $I_E = 0$ ) | $I_{CBO}$      | —<br>—<br>—     | 1.0<br>1.0<br>1.0 | mAdc |
| Emitter Cutoff Current<br>( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )   | $I_{EBO}$      | —               | 2.0               | mAdc |

## ON CHARACTERISTICS (1)

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

## DYNAMIC CHARACTERISTICS

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

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

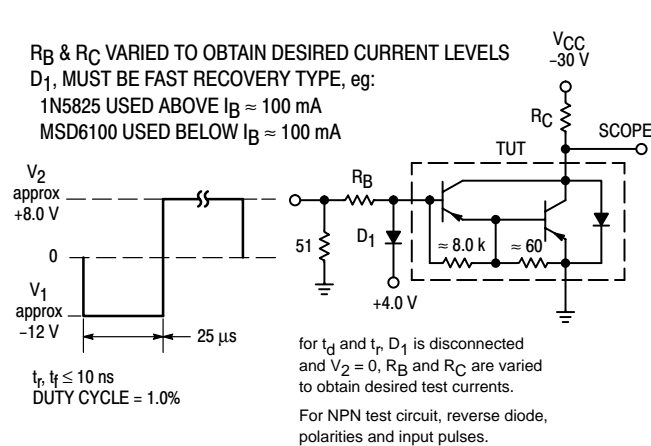


Figure 2. Switching Times Test Circuit

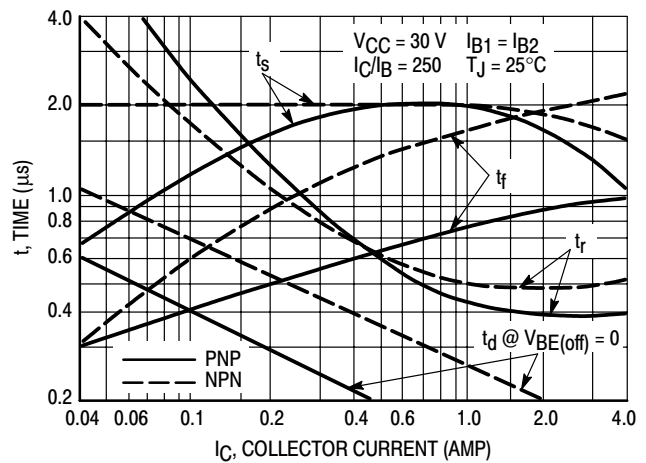


Figure 3. Switching Times

# TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

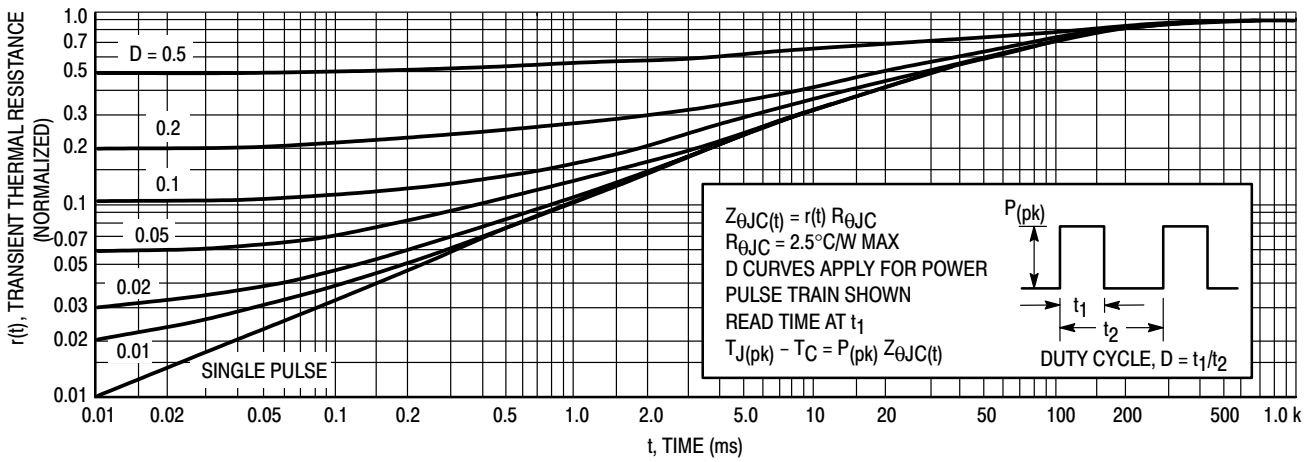


Figure 4. Thermal Response

## ACTIVE-REGION SAFE-OPERATING AREA

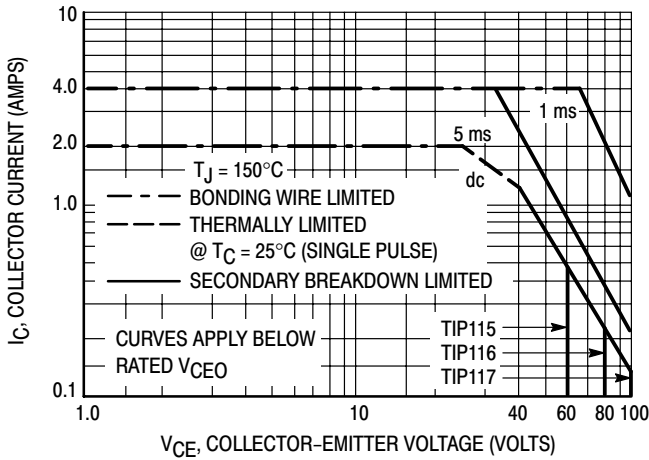


Figure 5. TIP115, 116, 117

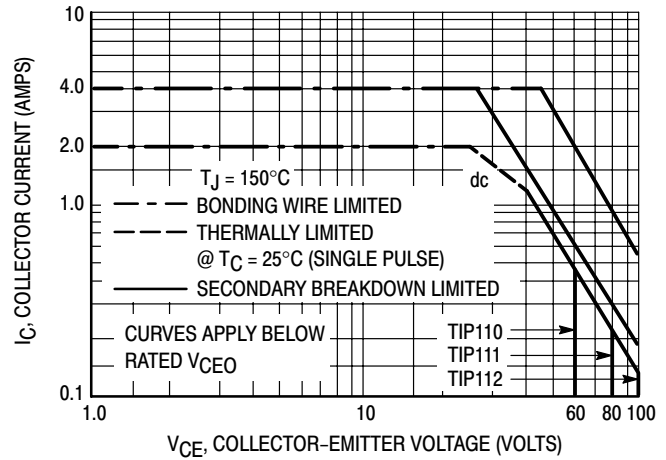


Figure 6. TIP110, 111, 112

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 5 and 6 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 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.

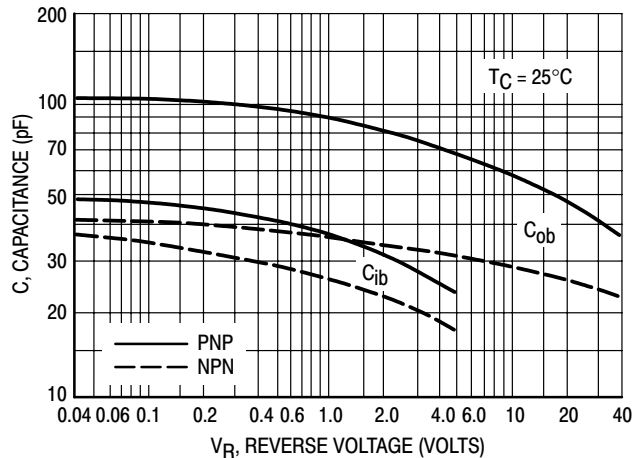


Figure 7. Capacitance

TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

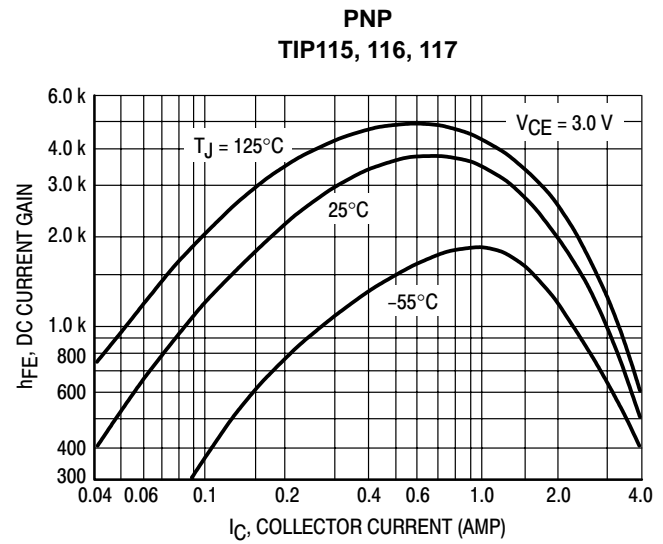
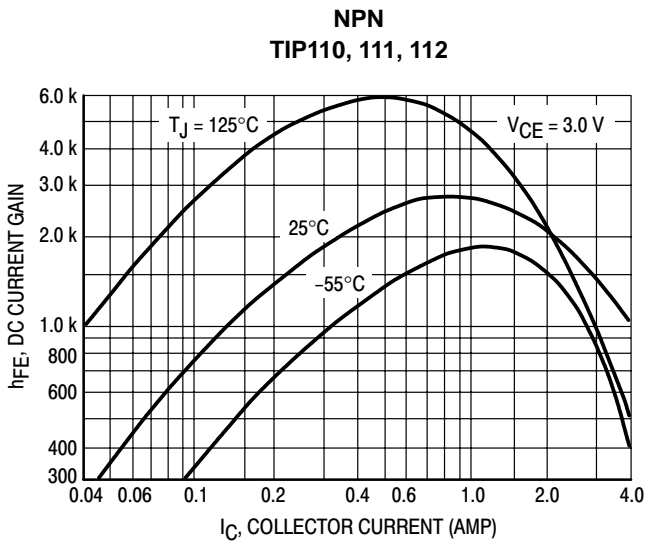


Figure 8. DC Current Gain

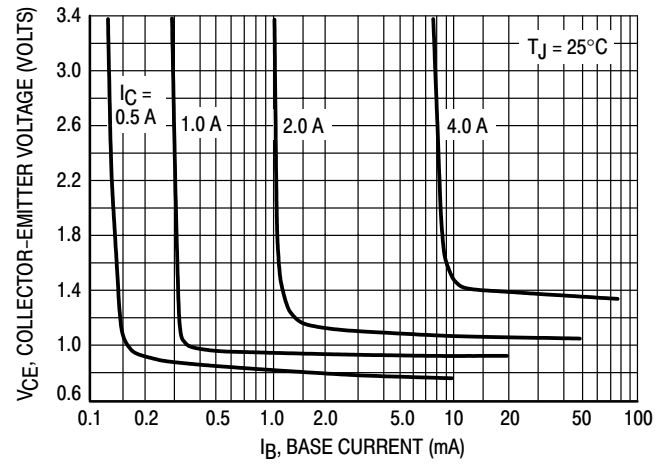
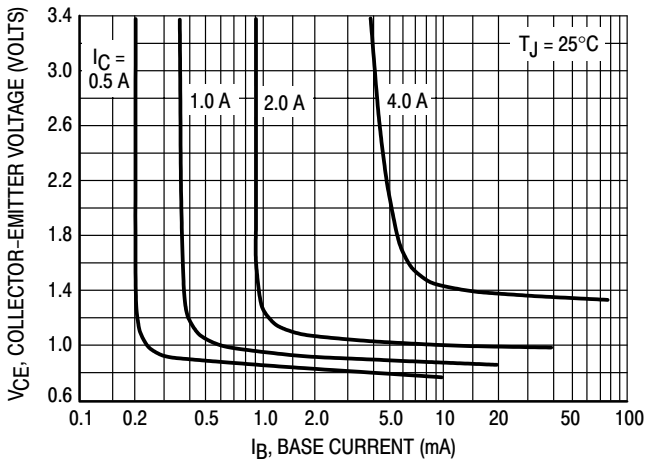


Figure 9. Collector Saturation Region

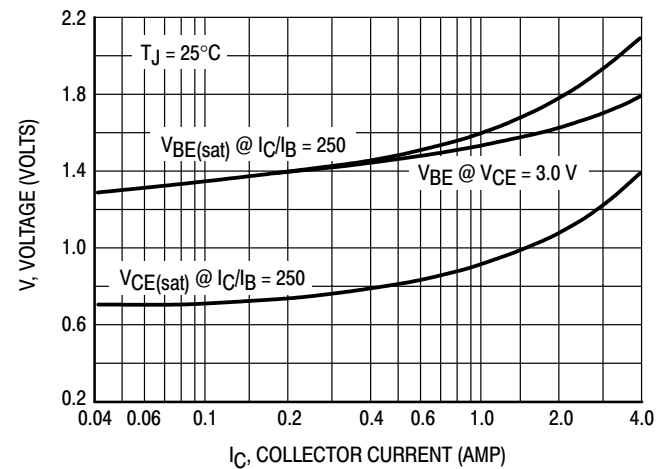
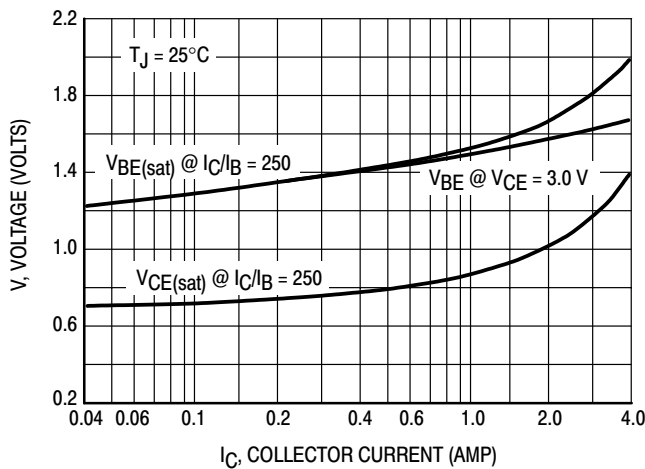


Figure 10. "On" Voltages

TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

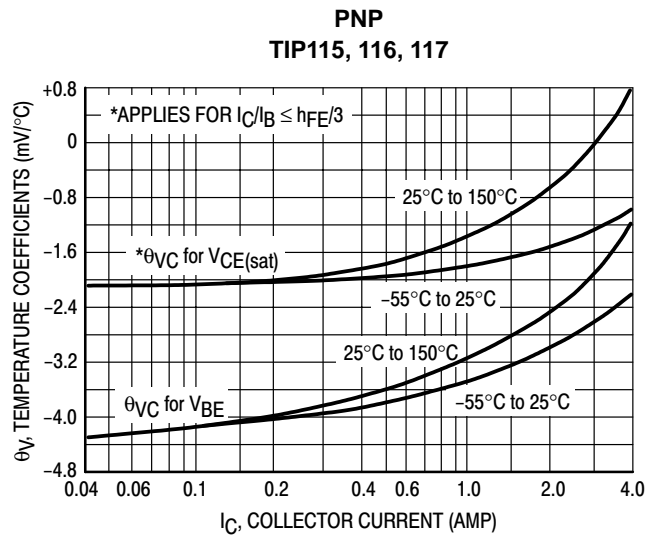
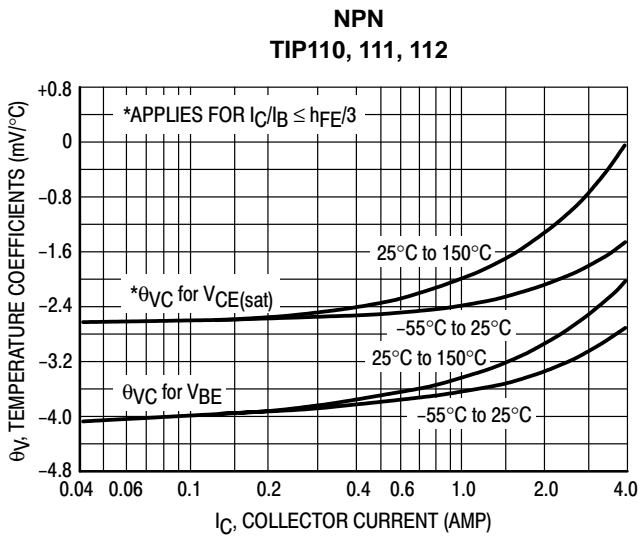


Figure 11. Temperature Coefficients

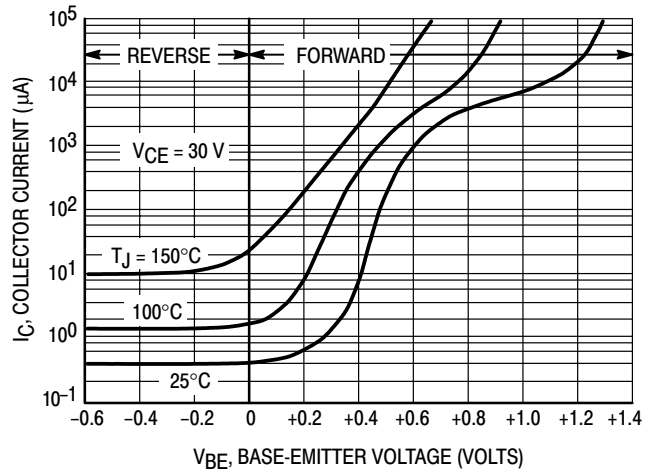
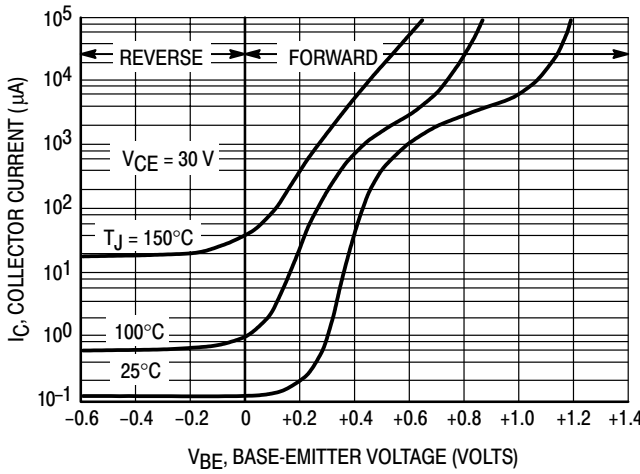
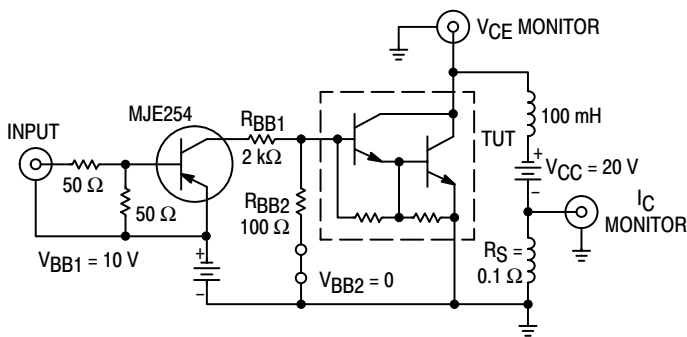


Figure 12. Collector Cut-Off Region

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

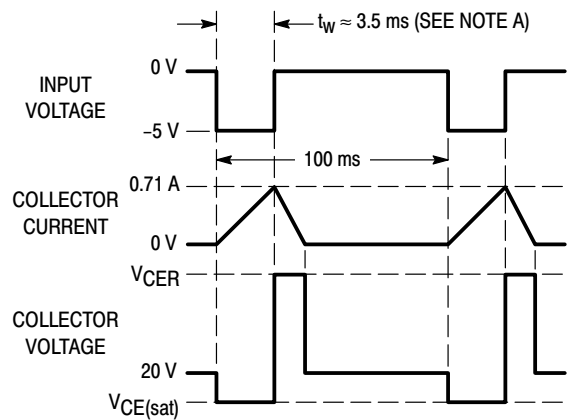
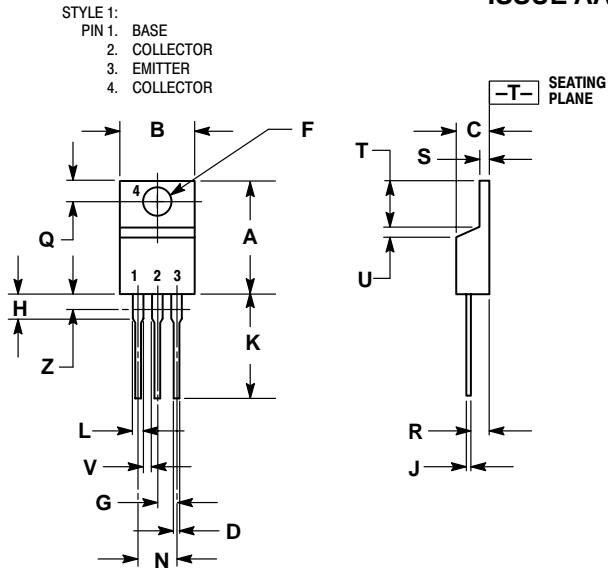


Figure 13. Inductive Load Switching

TIP110 TIP111 TIP112 TIP115 TIP116 TIP117

PACKAGE DIMENSIONS

TO-220AB  
CASE 221A-09  
ISSUE AA



- 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  |

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