

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

Plastic Medium-Power Complementary Silicon Transistors

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

Features

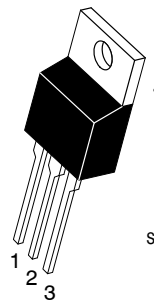
- High DC Current Gain –
 $h_{FE} = 2500$ (Typ) @ I_C
= 1.0 Adc
- Collector–Emitter Sustaining Voltage – @ 30 mAdc
 $V_{CEO(sus)} = 60$ Vdc (Min) – TIP110, TIP115
= 80 Vdc (Min) – TIP111, TIP116
= 100 Vdc (Min) – TIP112, TIP117
- Low Collector–Emitter Saturation Voltage –
 $V_{CE(sat)} = 2.5$ Vdc (Max)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



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



TO-220AB
CASE 221A
STYLE 1

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

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 3 of this data sheet.

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

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

MAXIMUM RATINGS

| Rating | Symbol | TIP110, TIP115 | TIP111, TIP116 | TIP112, 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 – Peak | I_C | 2.0 4.0 | | | Adc |
| Base Current | I_B | 50 | | | mAdc |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$ Derate above 25°C | P_D | 50 0.4 | | | W W/ $^\circ\text{C}$ |
| Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above 25°C | P_D | 2.0 0.016 | | | W W/ $^\circ\text{C}$ |
| Unclamped Inductive Load Energy – 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 | $^\circ\text{C}/\text{W}$ |

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.

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

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

OFF CHARACTERISTICS

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

ON CHARACTERISTICS (Note 1)

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

DYNAMIC CHARACTERISTICS

| | | | | | |
|--|--|----------|--------|------------|----|
| Small–Signal Current Gain ($I_C = 0.75 \text{ Adc}, V_{CE} = 10 \text{ Vdc}, f = 1.0 \text{ MHz}$) | | h_{fe} | 25 | – | – |
| Output Capacitance ($V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 0.1 \text{ MHz}$) | TIP115, TIP116, TIP117 TIP110, TIP111, TIP112 | C_{ob} | – – | 200 100 | 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 $\leq 300 \mu\text{s}$, Duty Cycle $\leq 2\%$.

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

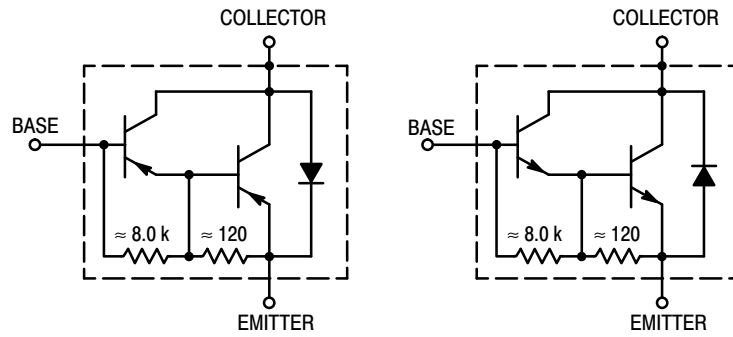


Figure 1. Darlington Circuit Schematic

ORDERING INFORMATION

| Device | Package | Shipping |
|---------|---------------------|-----------------|
| TIP110 | TO-220 | 50 Units / Rail |
| TIP110G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP111 | TO-220 | 50 Units / Rail |
| TIP111G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP112 | TO-220 | 50 Units / Rail |
| TIP112G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP115 | TO-220 | 50 Units / Rail |
| TIP115G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP116 | TO-220 | 50 Units / Rail |
| TIP116G | TO-220 (Pb-Free) | 50 Units / Rail |
| TIP117 | TO-220 | 50 Units / Rail |
| TIP117G | TO-220 (Pb-Free) | 50 Units / Rail |

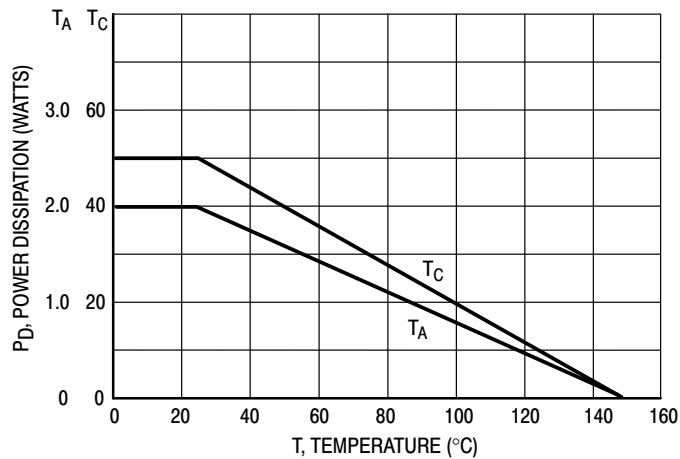


Figure 2. Power Derating

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

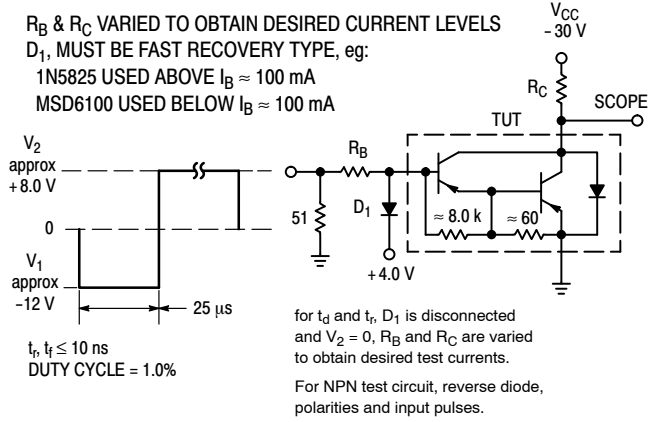


Figure 3. Switching Times Test Circuit

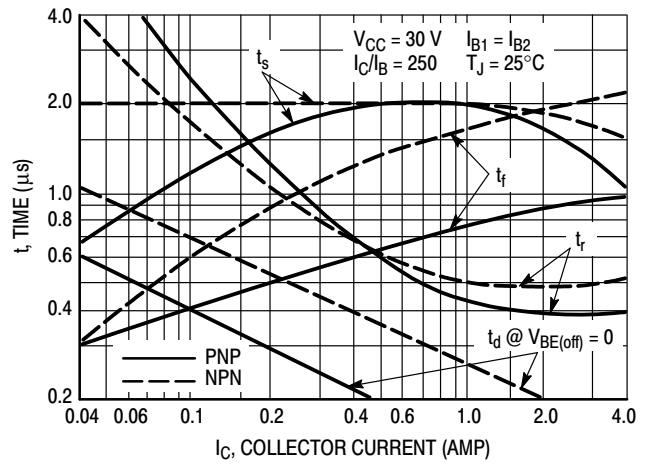


Figure 4. Switching Times

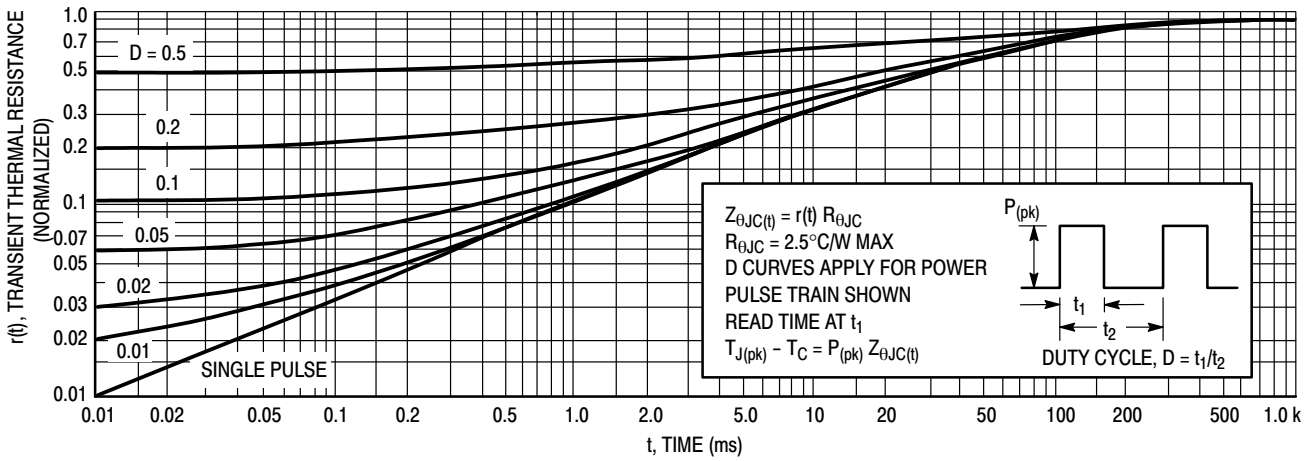


Figure 5. Thermal Response

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

ACTIVE-REGION SAFE-OPERATING AREA

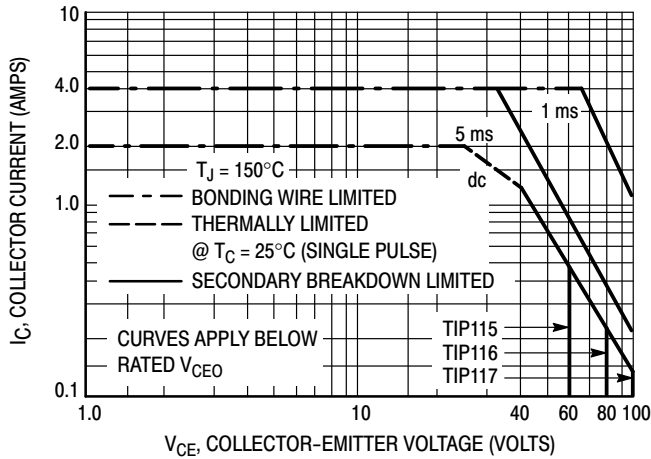


Figure 6. TIP115, 116, 117

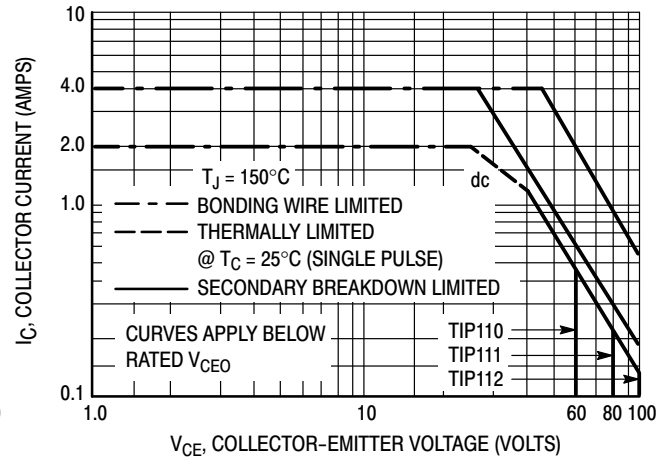


Figure 7. TIP110, 111, 112

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.

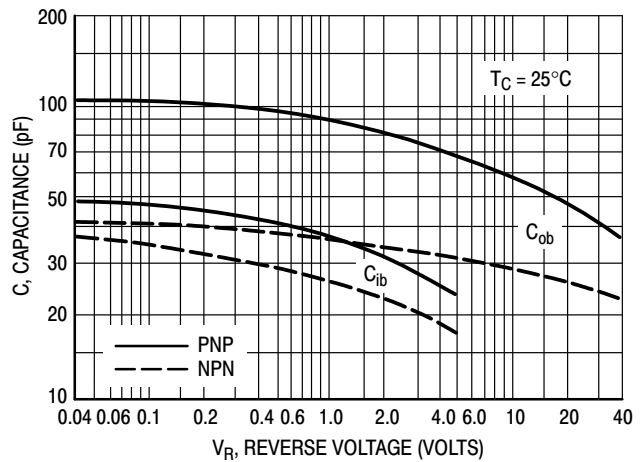


Figure 8. Capacitance

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

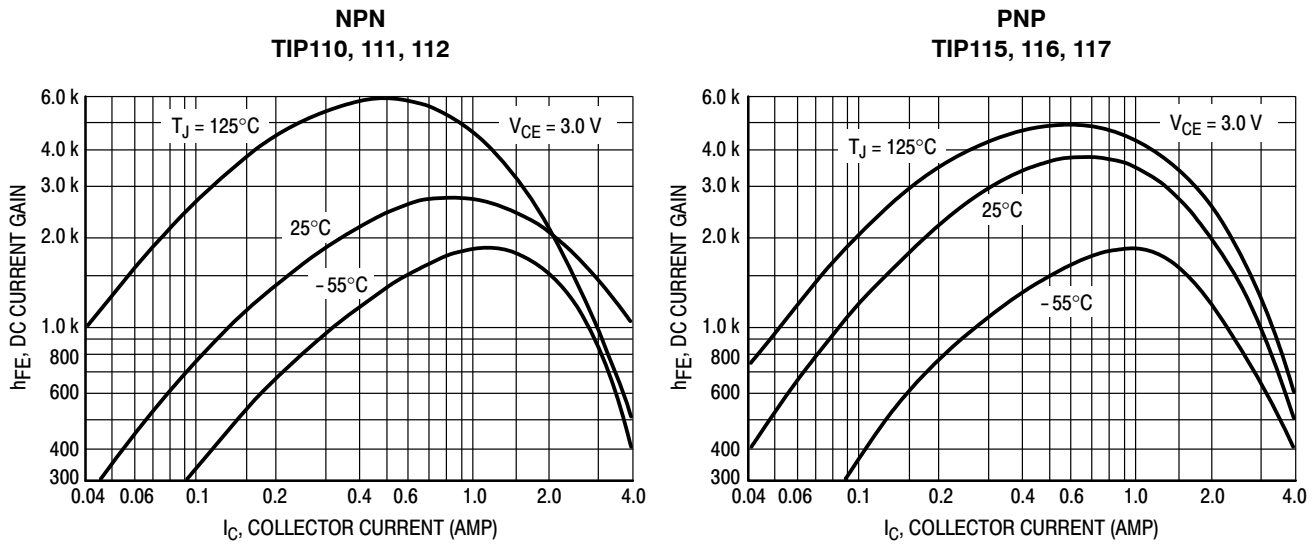


Figure 9. DC Current Gain

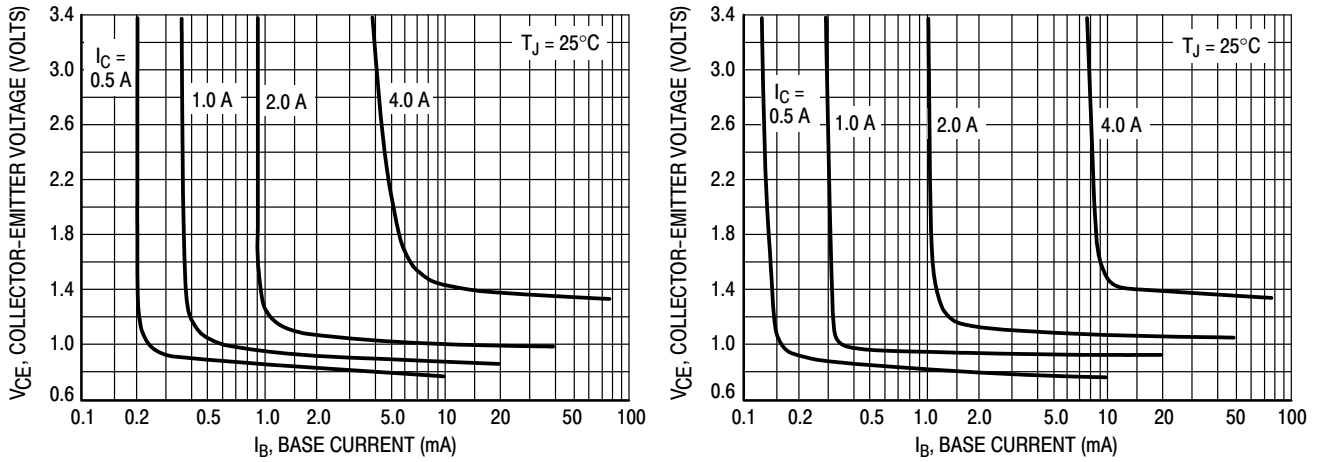


Figure 10. Collector Saturation Region

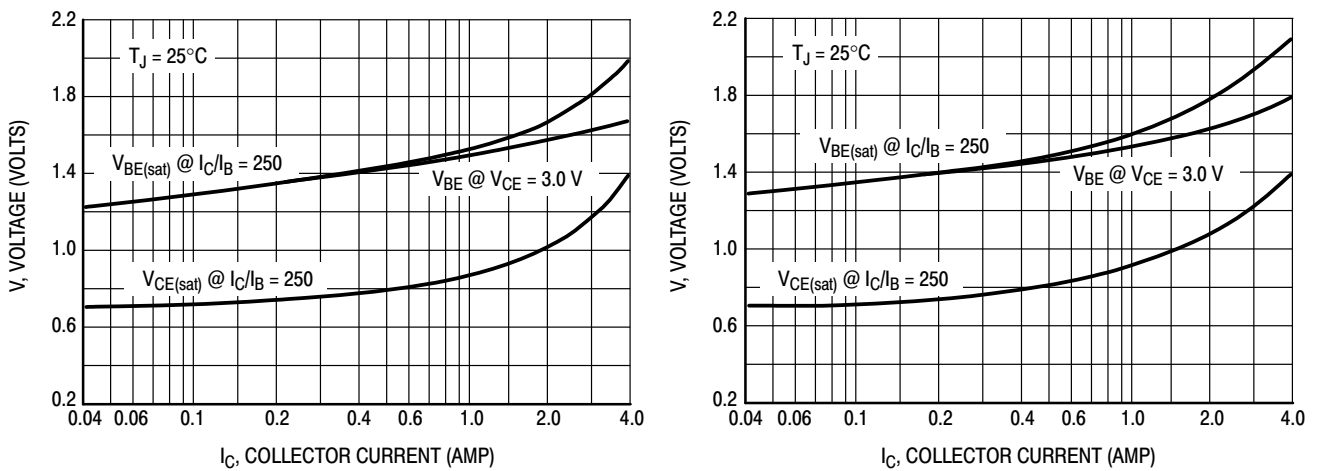


Figure 11. "On" Voltages

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

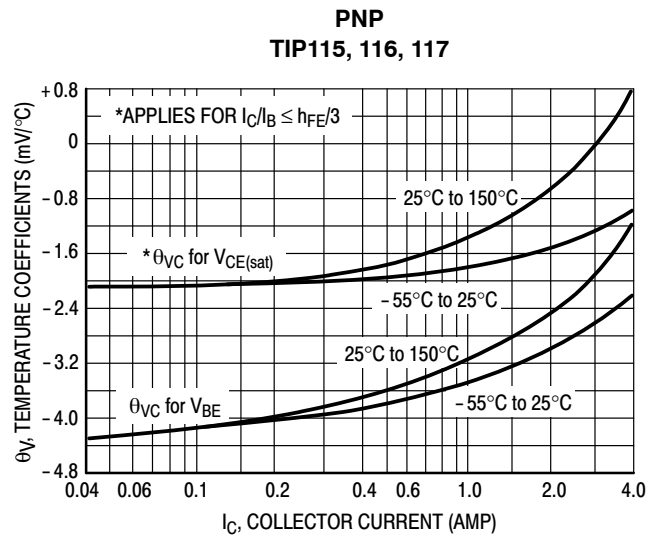
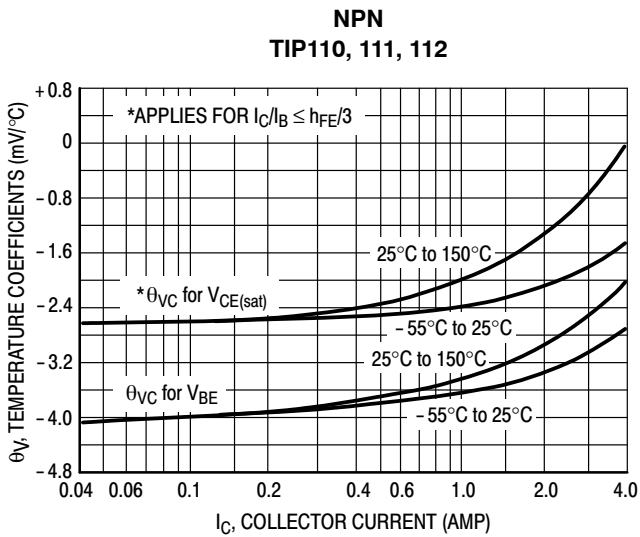


Figure 12. Temperature Coefficients

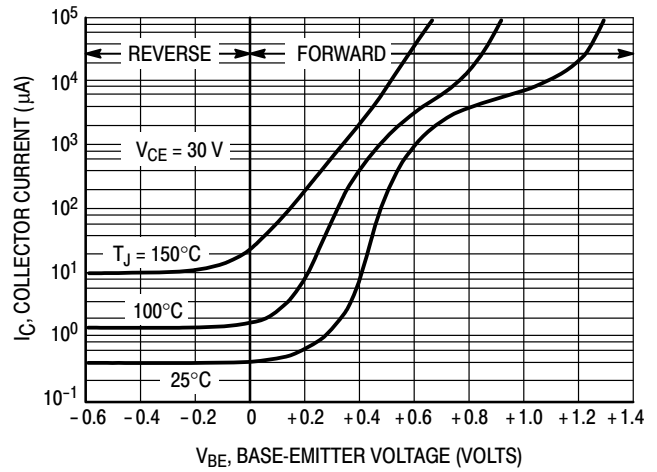
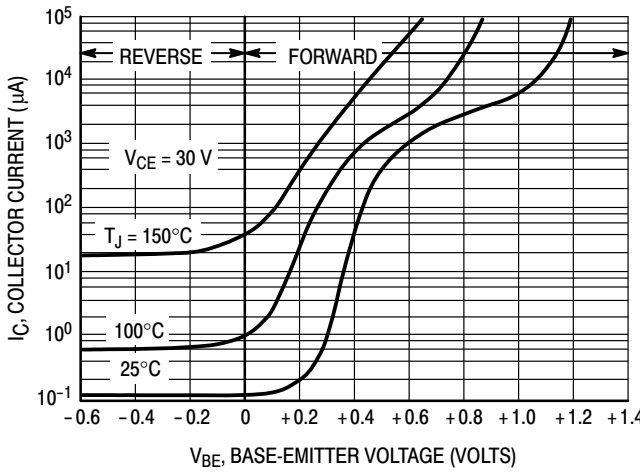
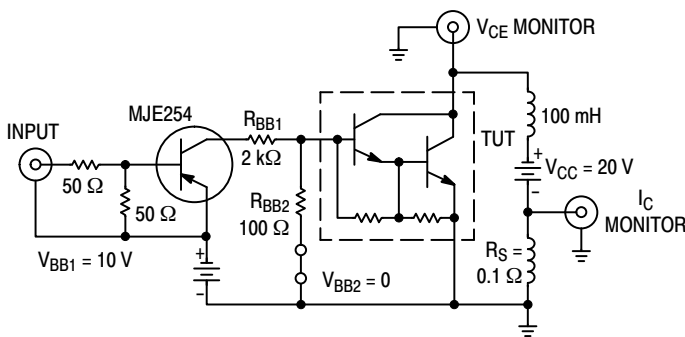


Figure 13. Collector Cut-Off Region

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

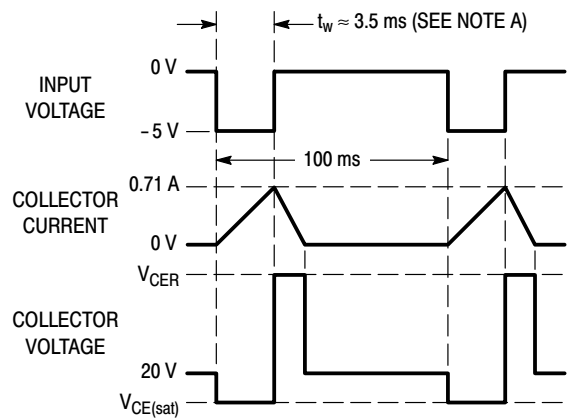
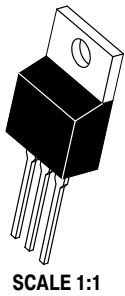


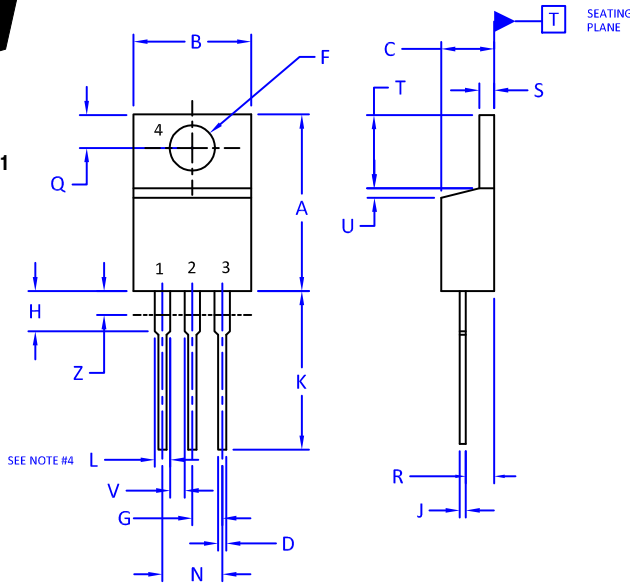
Figure 14. Inductive Load Switching

MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



TO-220 CASE 221A ISSUE AK

DATE 13 JAN 2022



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 2009.
 2. CONTROLLING DIMENSION: INCHES
 3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.
 4. MAX WIDTH FOR F102 DEVICE = 1.35MM

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|-------|-------------|-------|
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.570 | 0.620 | 14.48 | 15.75 |
| B | 0.380 | 0.415 | 9.66 | 10.53 |
| C | 0.160 | 0.190 | 4.07 | 4.83 |
| D | 0.025 | 0.038 | 0.64 | 0.96 |
| F | 0.142 | 0.161 | 3.60 | 4.09 |
| G | 0.095 | 0.105 | 2.42 | 2.66 |
| H | 0.110 | 0.161 | 2.80 | 4.10 |
| J | 0.014 | 0.024 | 0.36 | 0.61 |
| 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 | 1.41 |
| 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

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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