

# 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

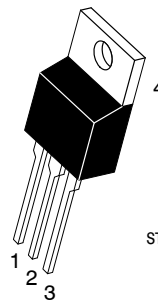
- High DC Current Gain –  
 $h_{FE} = 2500$  (Typ) @  $I_C$   
= 1.0 Adc
- Collector–Emitter Sustaining Voltage – @ 30 mAdc  
 $V_{CEO(sus)} = 60$  Vdc (Min) – TIP110, TIP115  
= 80 Vdc (Min) – TIP111, TIP116  
= 100 Vdc (Min) – TIP112, TIP117
- Low Collector–Emitter Saturation Voltage –  
 $V_{CE(sat)} = 2.5$  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.

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## 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 $25^\circ\text{C}$	$P_D$	50 0.4			W W/ $^\circ\text{C}$
Total Power Dissipation @ $T_A = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	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
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### 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)

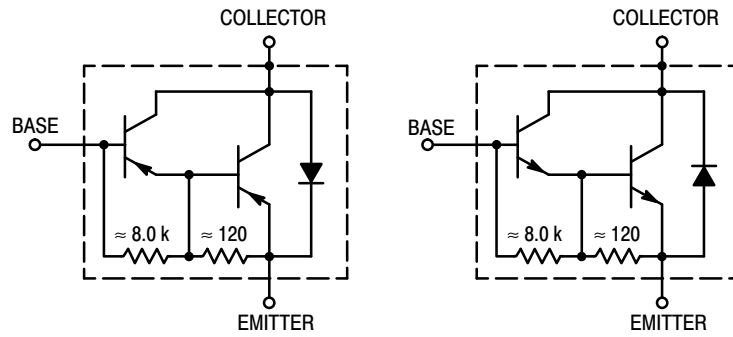


Figure 1. Darlington Circuit Schematic

## 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

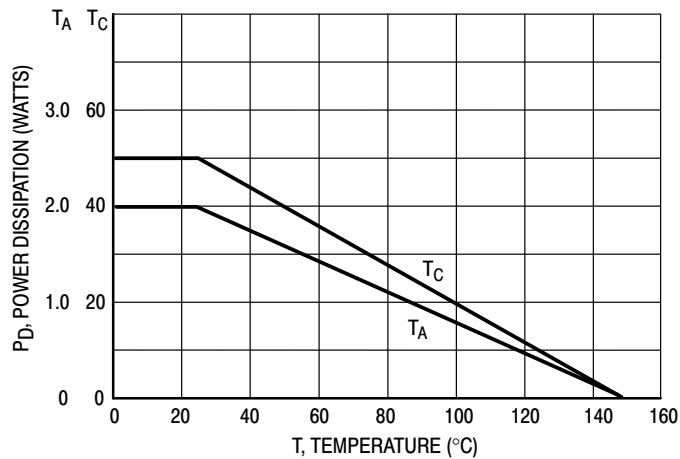


Figure 2. Power Derating

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

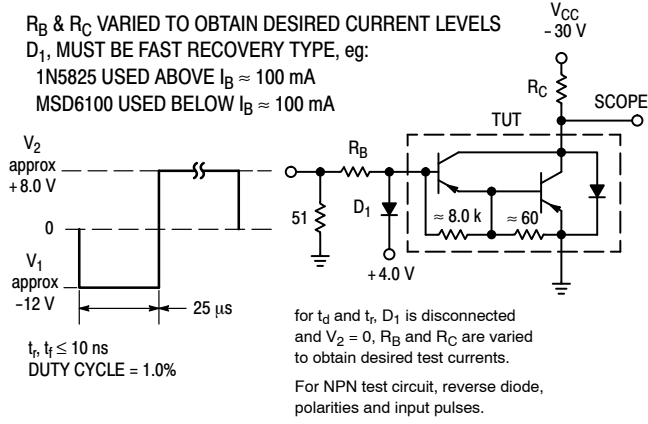


Figure 3. Switching Times Test Circuit

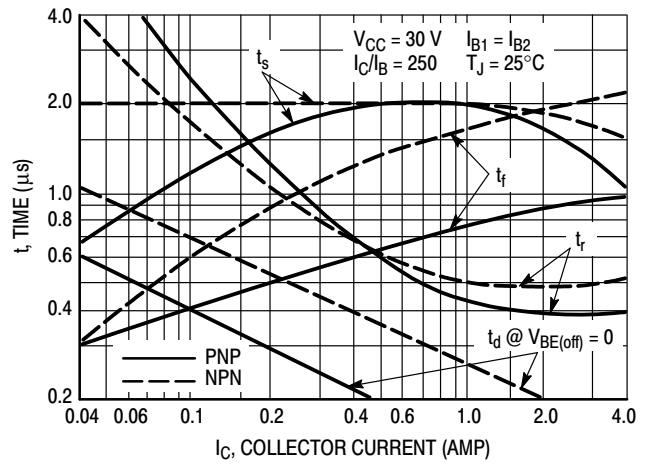


Figure 4. Switching Times

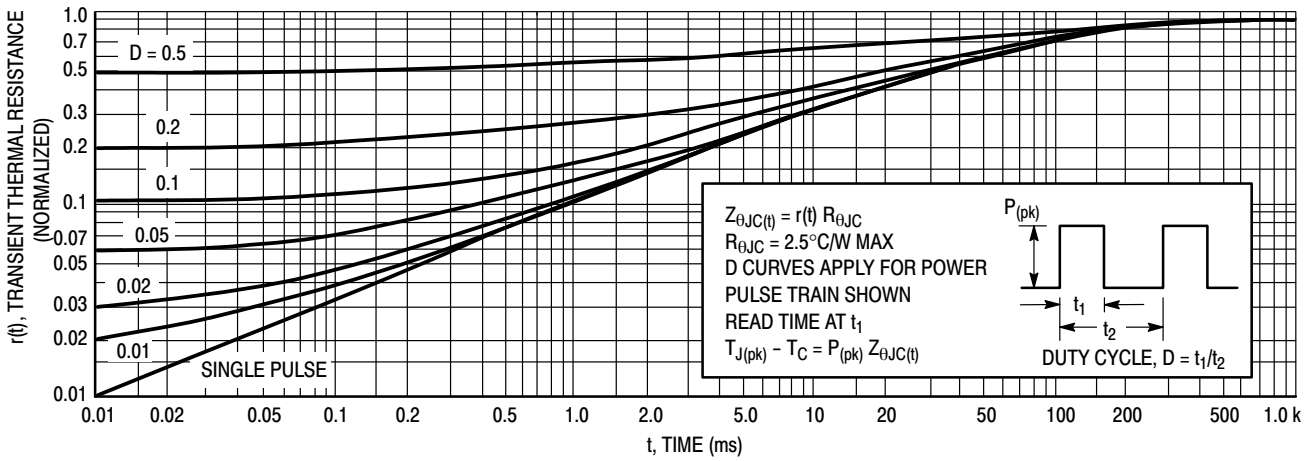


Figure 5. Thermal Response

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

## ACTIVE-REGION SAFE-OPERATING AREA

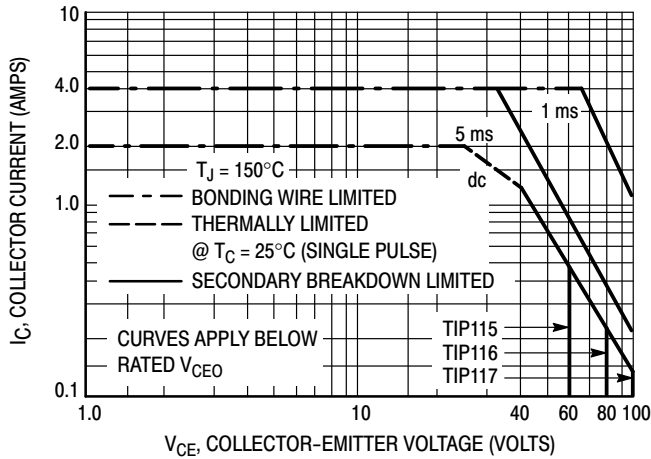


Figure 6. TIP115, 116, 117

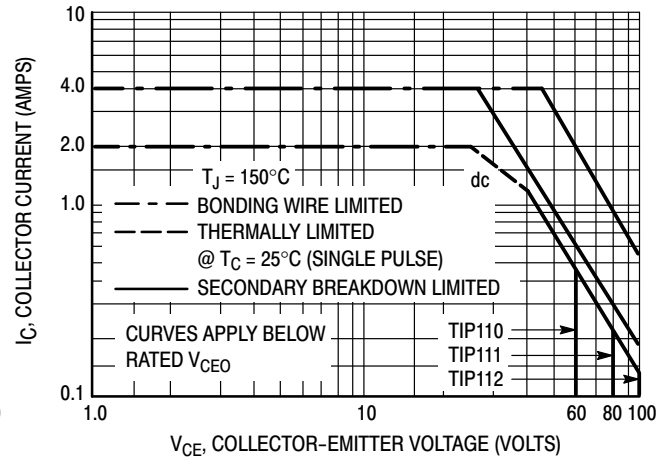


Figure 7. TIP110, 111, 112

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.

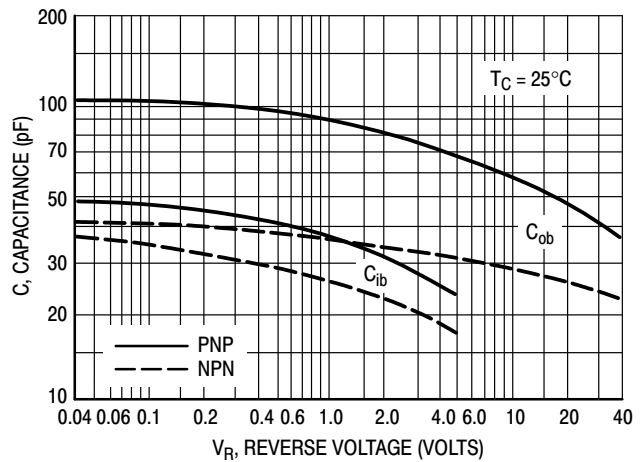


Figure 8. Capacitance

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

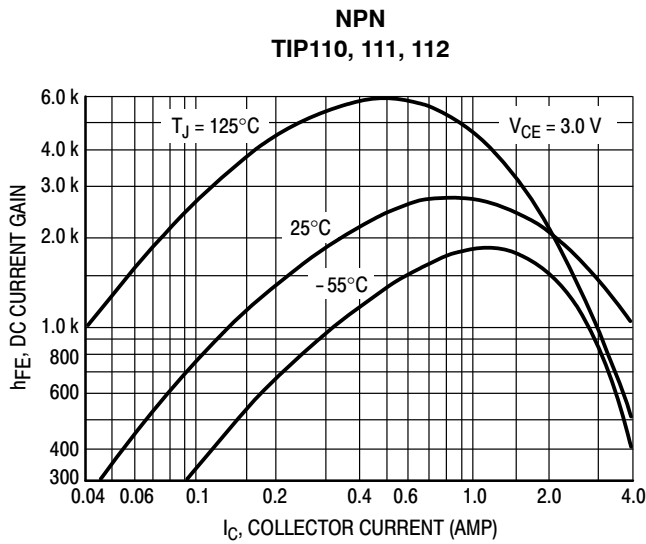


Figure 9. DC Current Gain

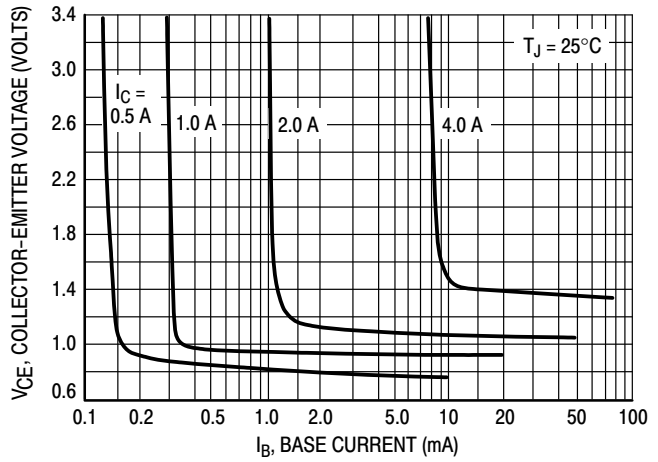
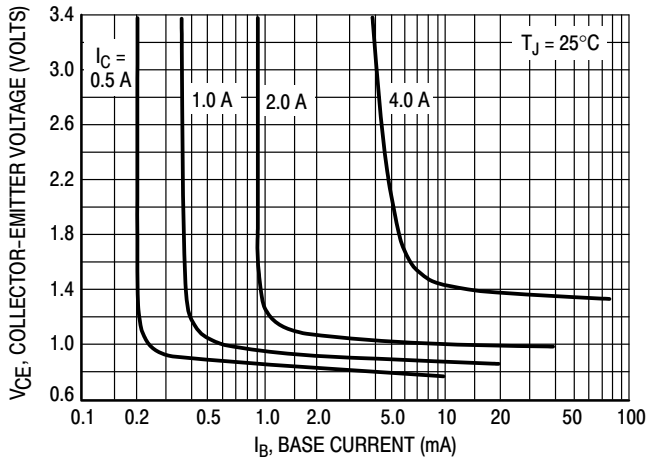


Figure 10. Collector Saturation Region

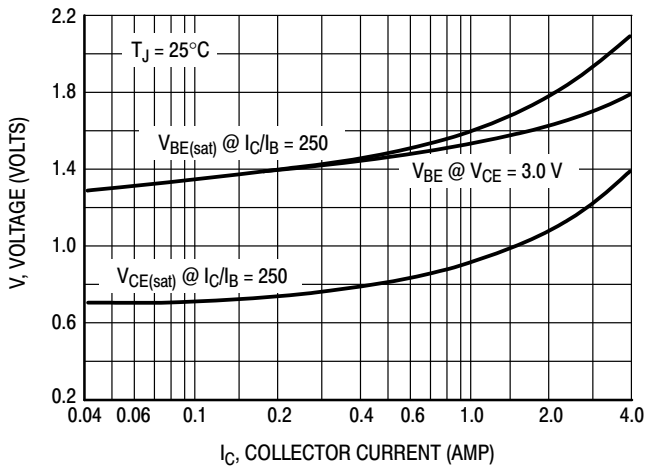
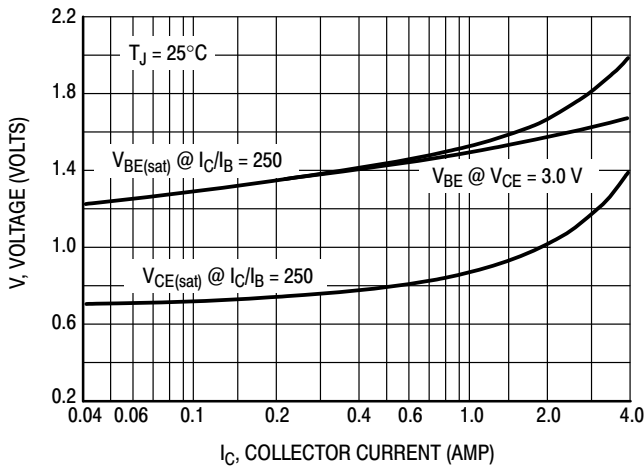


Figure 11. "On" Voltages

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

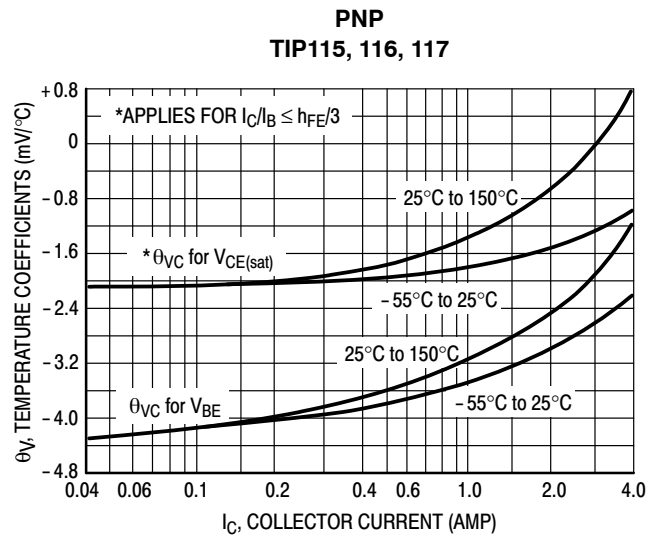
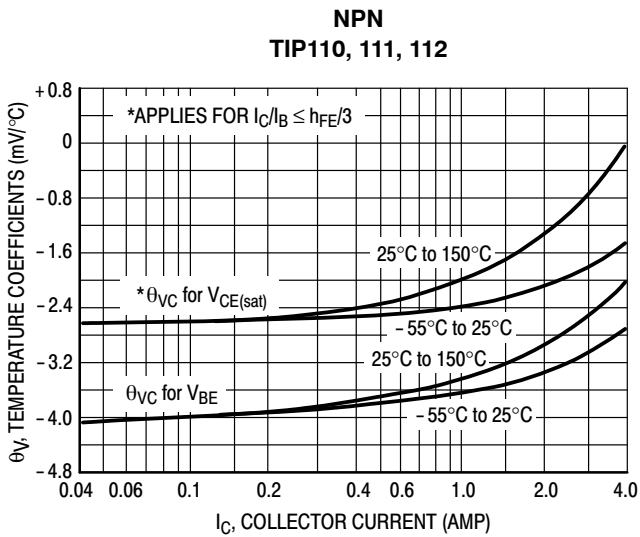


Figure 12. Temperature Coefficients

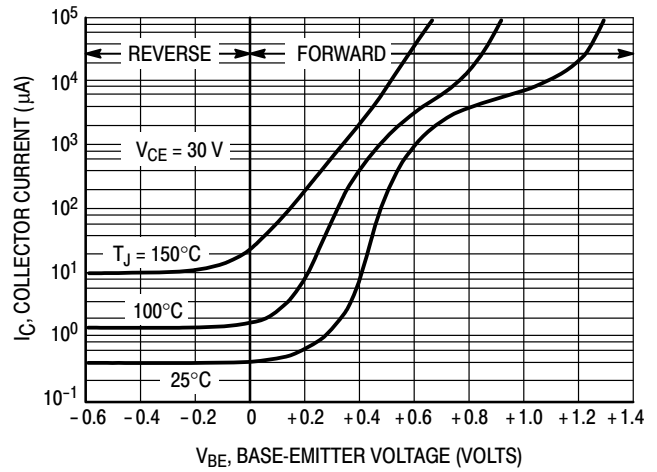
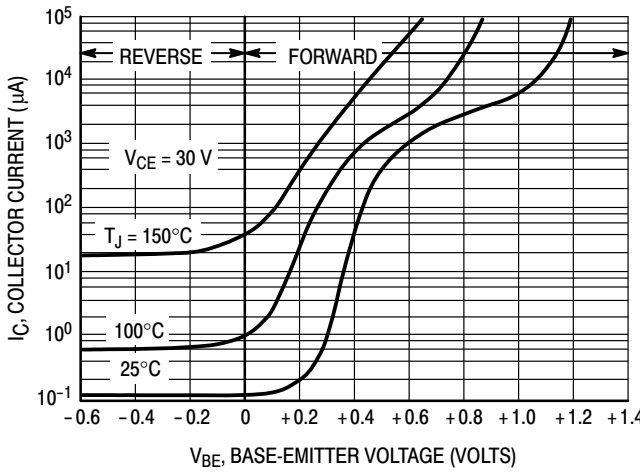
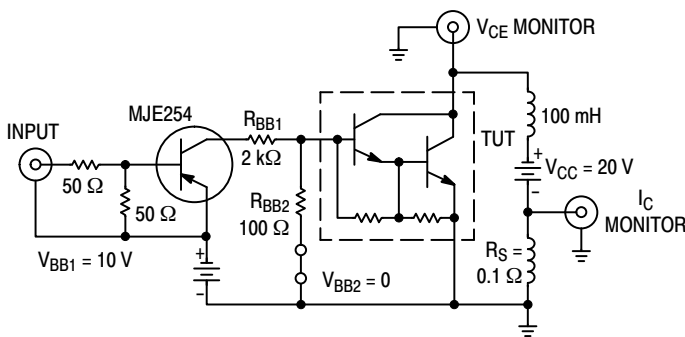


Figure 13. Collector Cut-Off Region

**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**

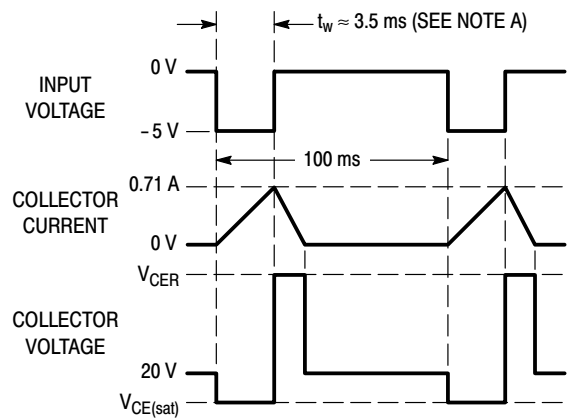


Figure 14. Inductive Load Switching

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