

# 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 in the package dimensions section 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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## 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 ( $V_{CB} = 10 \text{ Vdc}, I_E = 0, f = 0.1 \text{ MHz}$ )	$C_{ob}$	– –	200 100	pF
	TIP115, TIP116, TIP117 TIP110, TIP111, TIP112			

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

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

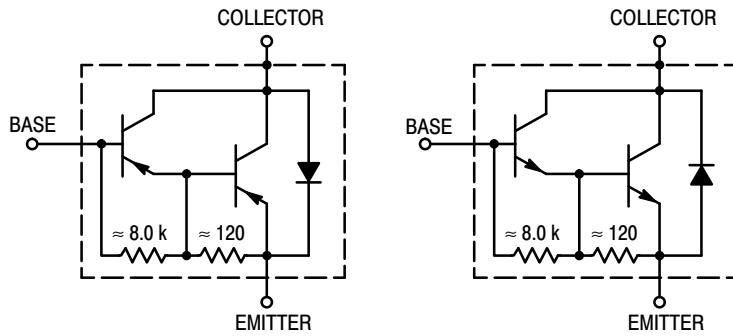


Figure 1. Darlington Circuit Schematic

## 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

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Figure 3. Switching Times Test Circuit

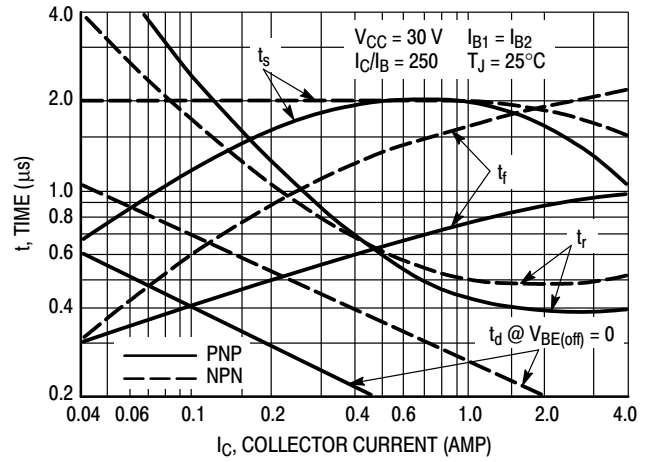


Figure 4. Switching Times



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)

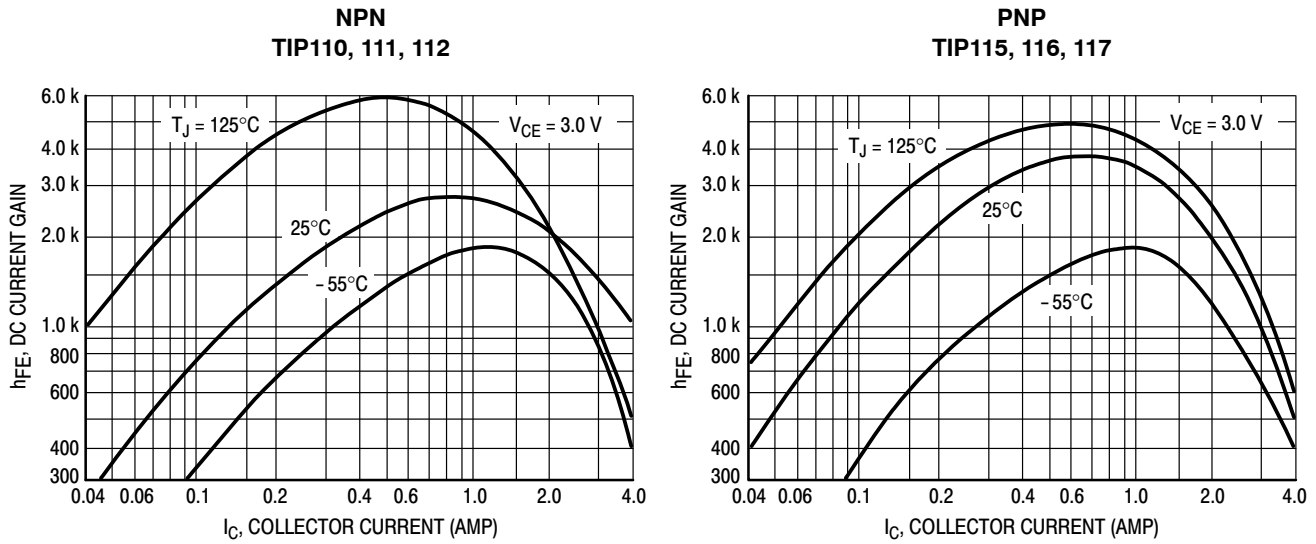


Figure 9. DC Current Gain

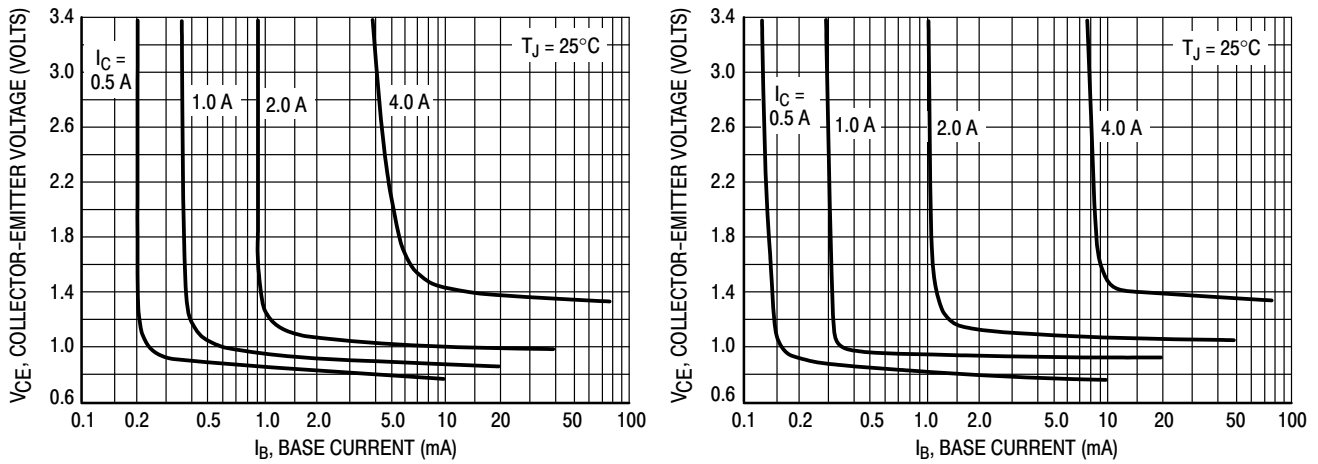


Figure 10. Collector Saturation Region

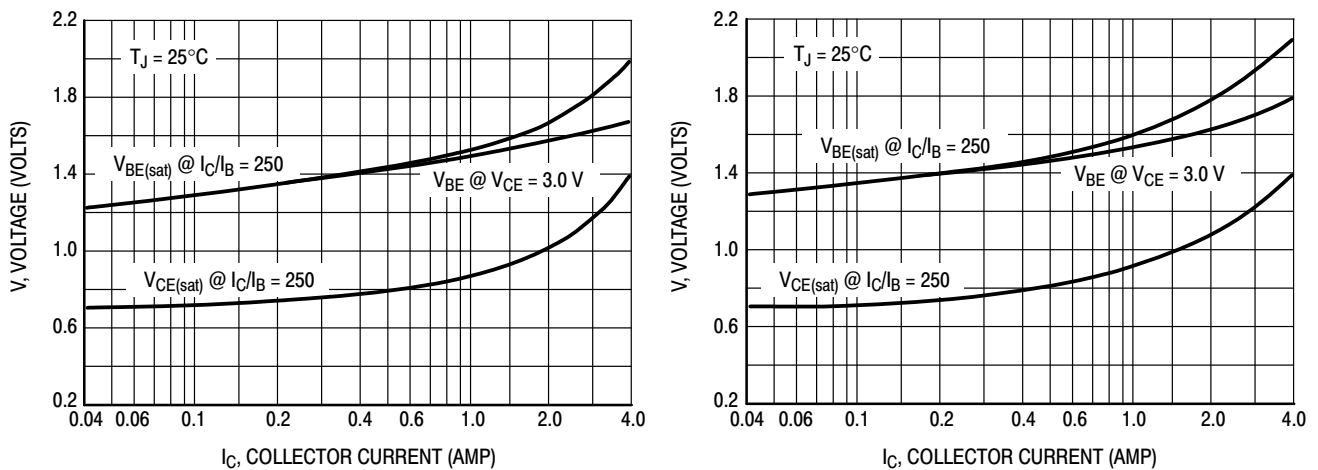


Figure 11. "On" Voltages

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

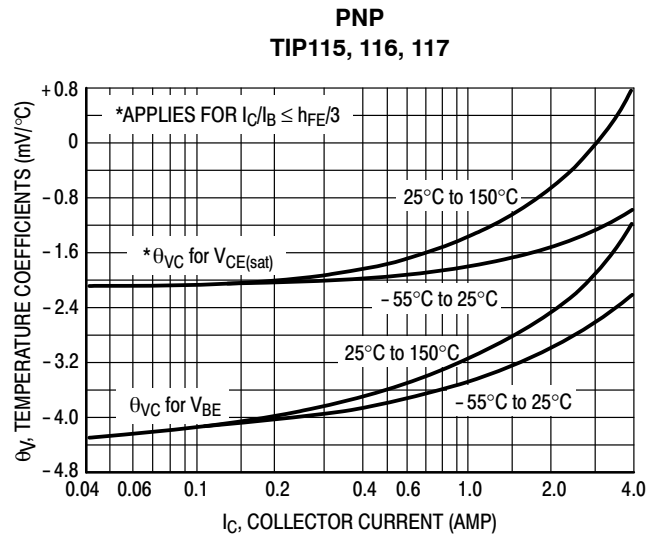
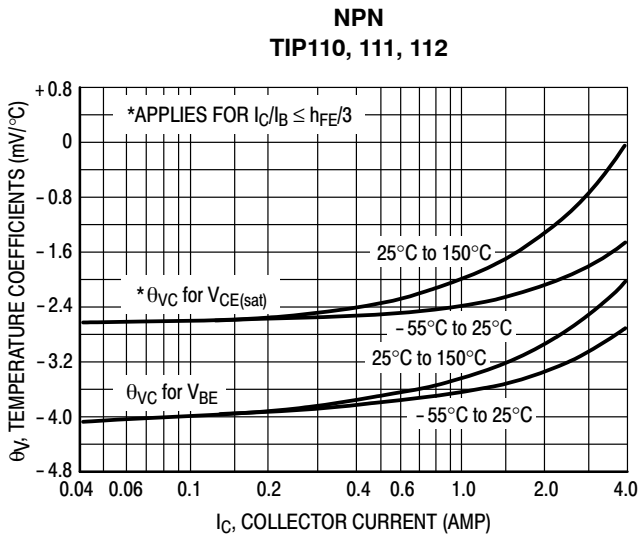


Figure 12. Temperature Coefficients

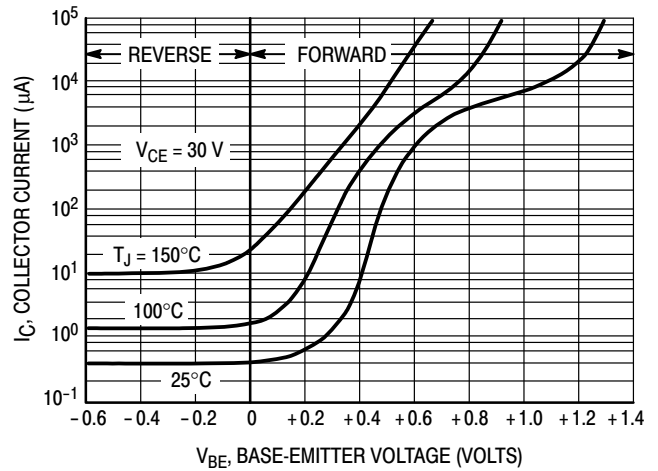
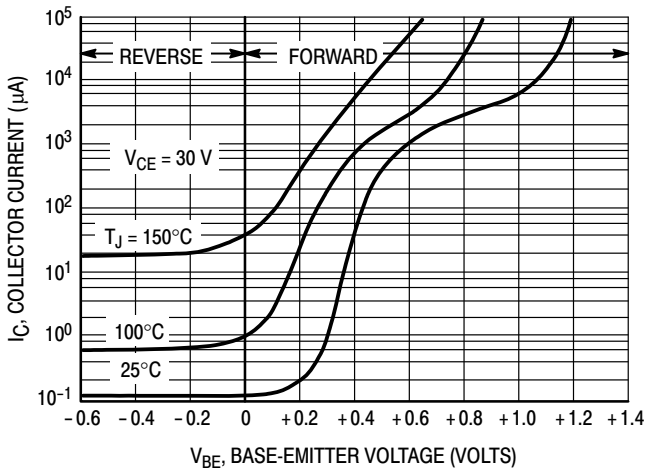
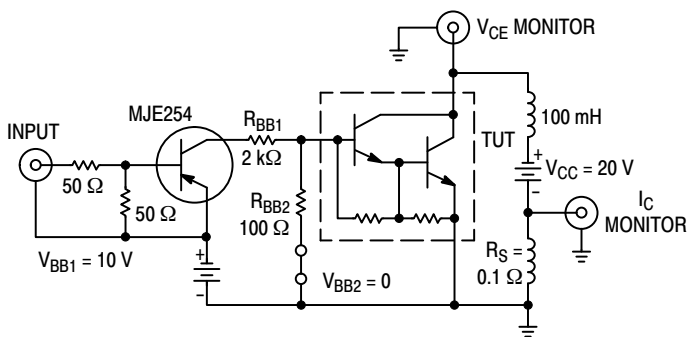
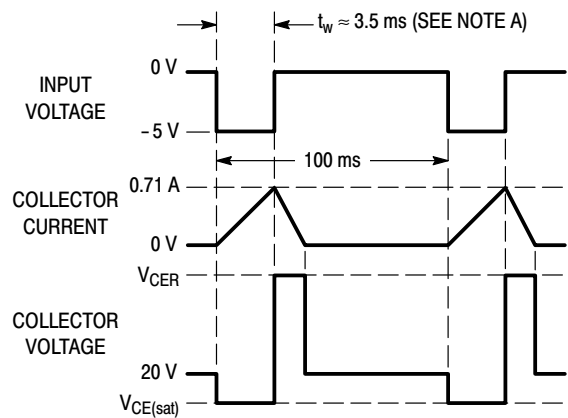


Figure 13. Collector Cut-Off Region

**TEST CIRCUIT**



**VOLTAGE AND CURRENT WAVEFORMS**



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.

Figure 14. Inductive Switching

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## PACKAGE DIMENSIONS

### TO-220 CASE 221A-09 ISSUE AG



#### 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	0.036	0.64	0.91
F	0.142	0.161	3.61	4.09
G	0.095	0.105	2.42	2.66
H	0.110	0.161	2.80	4.10
J	0.014	0.025	0.36	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

#### STYLE 1:

1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

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