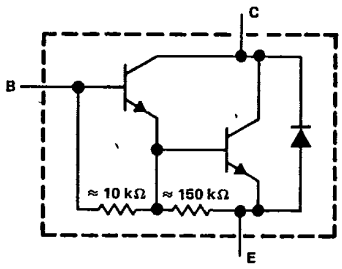
TIP110, TIP111, TIP112
N-P-N DARLINGTON-CONNECTED SILICON POWER TRANSISTORS

REVISED OCTOBER 1984

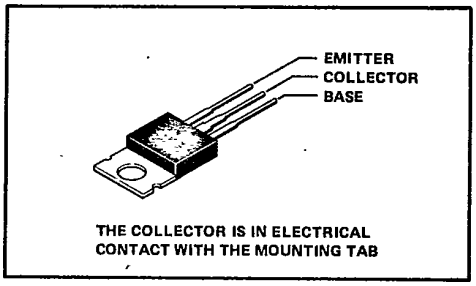
T-33-29

- Designed for Complementary Use With TIP115, TIP116, TIP117
- High SOA Capability, 40 V and 1.25 A
- 50 W at 25°C Case Temperature
- 4 A Rated Collector Current
- Min h_{FE} of 500 at 4 V, 2 A
- 25 mJ Reverse Energy Rating

device schematic



TO-220 PACKAGE



absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	TIP110	TIP111	TIP112
Collector-base voltage	60 V	80 V	100 V
Collector-emitter voltage (I_B = 0)	60 V	80 V	100 V
Emitter-base voltage	5 V		
Continuous collector current	4 A		
Peak collector current (see Note 1)	6 A		
Continuous base current	50 mA		
Safe operating area at (or below) 25°C case temperature	See Figures 7 and 8		
Continuous device dissipation at (or below) 25°C case temperature (see Note 2)	50 W		
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	2 W		
Unclamped inductive load energy (see Note 4)	25 mJ		
Operating collector junction and storage temperature range	−65°C to 150°C		
Lead temperature 3,2 mm (0.125 inch) from case for 10 seconds	260°C		

NOTES: 1. This value applies for $t_w \leq 0.3$ ms, duty cycle ≤ 10%.
2. Derate linearly to 150°C case temperature at the rate of 0.4 W/°C or refer to Dissipation Derating Curve, Figure 9.
3. Derate linearly to 150°C free-air temperature at the rate of 16 mW/°C or refer to Dissipation Derating Curve, Figure 10.
4. This rating is based on the capability of the transistors to operate safely in the circuit of Figure 2. L = 20mH, R_{BB2} = 100 Ω, V_{BB2} = 0 V, R_S = 0.1 Ω, V_{CC} = 20 V, Energy ≈ $I_C^2 L/2$.

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electrical characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS		TIP110			TIP111			TIP112			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
$V_{(BR)CEO}$	I_C = 30 mA, See Note 5	I_B = 0,	60			80			100			V
I_{CEO}	V_{CE} = 30 V,	I_B = 0			2							mA
	V_{CE} = 40 V,	I_B = 0						2				
	V_{CE} = 50 V,	I_B = 0									2	
I_{CBO}	V_{CB} = 60 V,	I_E = 0			1							mA
	V_{CB} = 80 V,	I_E = 0						1				
	V_{CB} = 100 V,	I_E = 0									1	
I_{EBO}	V_{EB} = 5 V,	I_C = 0			2			2			2	mA
h_{FE}	V_{CE} = 4 V, See Notes 5 and 6	I_C = 1 A,	1000			1000			1000			
	V_{CE} = 4 V, See Notes 5 and 6	I_C = 2 A,	500			500			500			
V_{BE}	V_{CE} = 4 V, See Notes 5 and 6	I_C = 2 A,			2.8			2.8			2.8	V
$V_{CE(sat)}$	I_B = 8 mA, See Notes 5 and 6	I_C = 2 A,			2.5			2.5			2.5	V
V_F	$I_F = I_C$ = 4 A, See Notes 5 and 6				3.5			3.5			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 3,2mm (0.125 inch) from the device body.

resistive-load switching characteristics at 25° C case temperature

PARAMETER	TEST CONDITIONS †			MIN	TYP	MAX	UNIT
t_{on}	I_C = 2 A,	I_{B1} = 8 mA,	I_{B2} = −8 mA,		2.6		μs
t_{off}	$V_{BE(off)}$ = −5 V,	R_L = 15 Ω,	See Figure 1		4.5		

† Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

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PARAMETER MEASUREMENT INFORMATION

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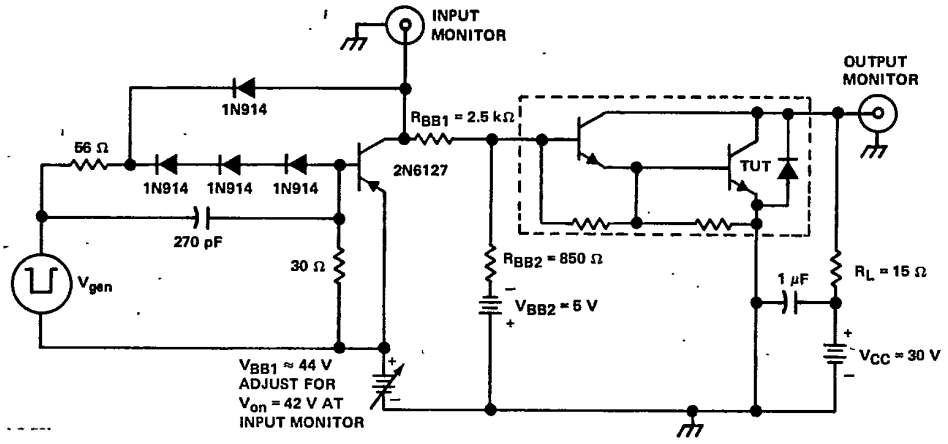
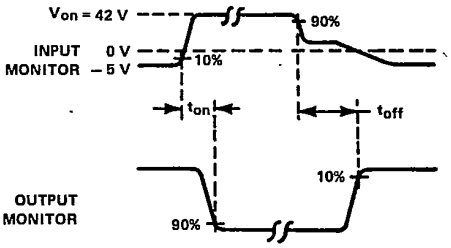


TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. V_{gen} is a −30-V pulse into a 50 Ω termination.
B. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\ \Omega$, $t_w = 20\ \mu s$, duty cycle ≤ 2%.
C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10\ M\Omega$, $C_{in} \leq 11.5$ pF.
D. Resistors must be noninductive types.
E. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

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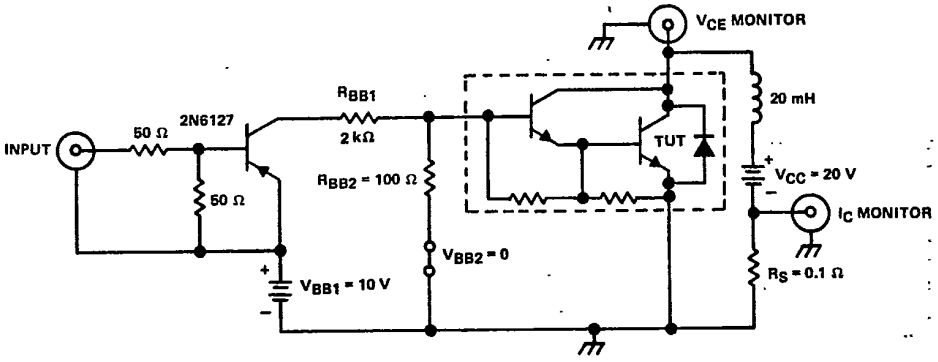
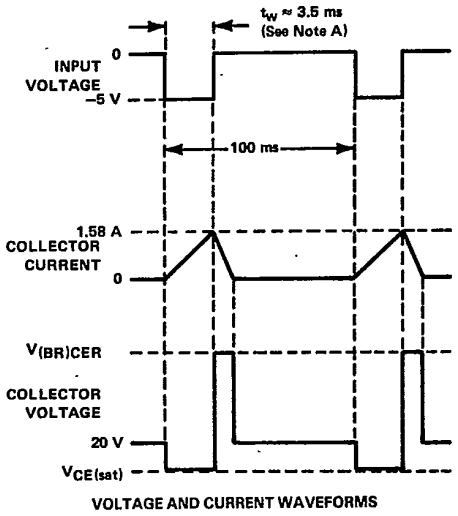
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTE A: Input pulse duration is increased until I_{CM} = 1.58 A.

FIGURE 2. INDUCTIVE-LOAD SWITCHING

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TYPICAL CHARACTERISTICS

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STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

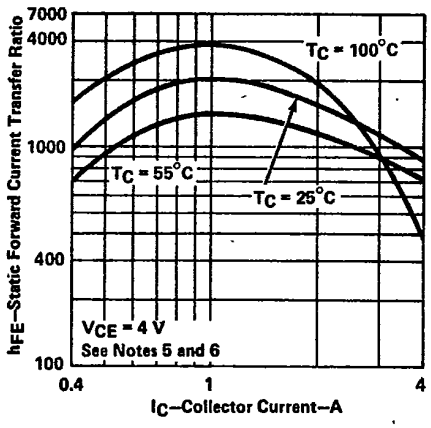

FIGURE 3

BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE

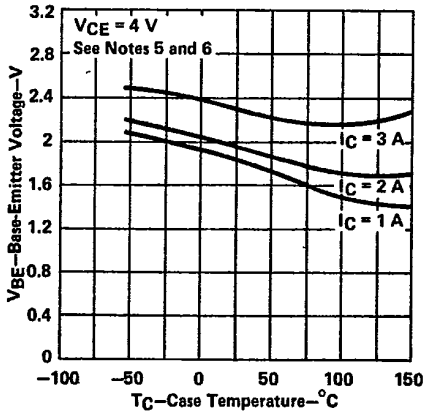

FIGURE 4

COLLECTOR-EMITTER
SATURATION VOLTAGE
vs
CASE TEMPERATURE

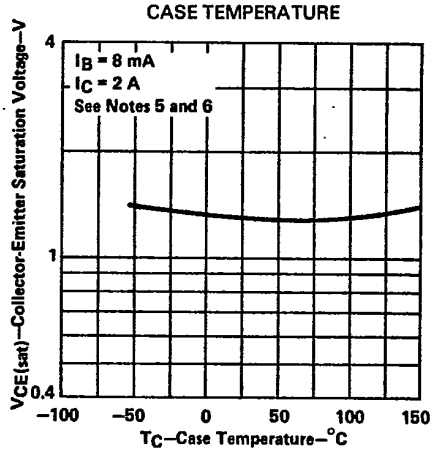

FIGURE 5

SMALL-SIGNAL COMMON-EMITTER
FORWARD CURRENT TRANSFER RATIO
vs
FREQUENCY

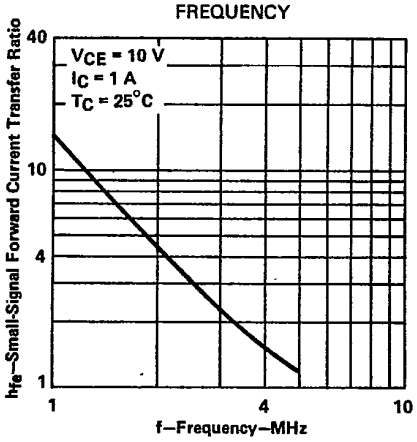

FIGURE 6

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 3,2mm (0.125 inch) from the device body.

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MAXIMUM SAFE OPERATING AREA

MAXIMUM COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

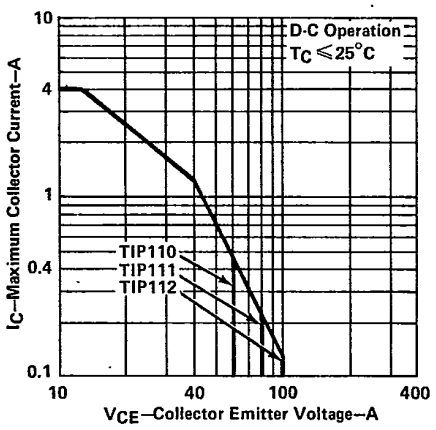

FIGURE 7

MAXIMUM COLLECTOR CURRENT
vs
UNCLAMPED INDUCTIVE LOAD

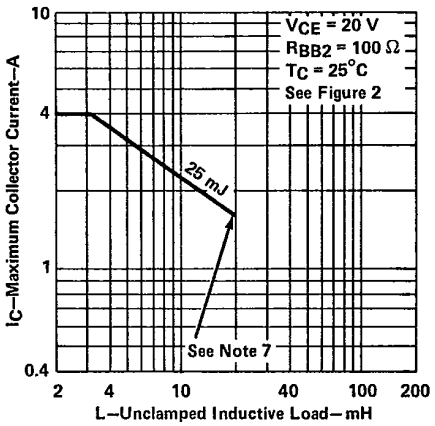

FIGURE 8

NOTE 7: Above this point the safe operating area has not been defined.

THERMAL INFORMATION

CASE TEMPERATURE
DISSIPATION DERATING CURVE

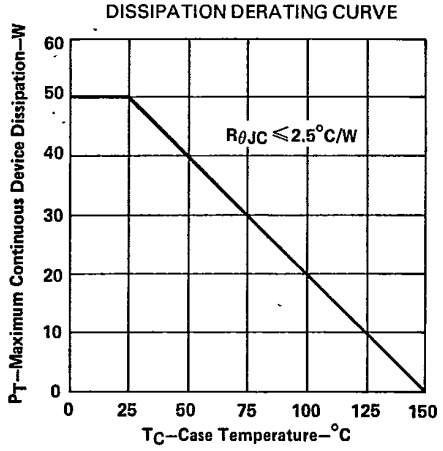

FIGURE 9

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE

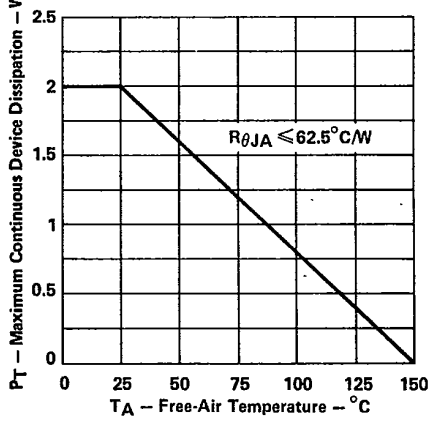

FIGURE 10

TIP Devices

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