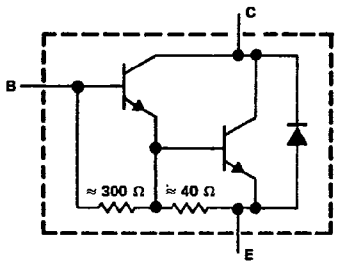
TIP160, TIP161, TIP162
N-P-N DARLINGTON-CONNECTED SILICON POWER TRANSISTORS

REVISED OCTOBER 1984

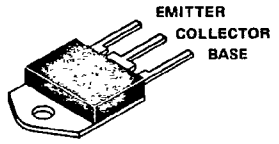
T-33-29

- 50 W at 100°C Case Temperature
- 10 A Rated Continuous Collector Current
- MAX $V_{CE(sat)}$ of 2.8 V at 6.5 A
- High-Voltage, High-Forward and Reverse Energy
- Designed for Automotive Ignition Applications

device schematic



TO 218AA PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE MOUNTING TAB

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

	TIP160	TIP161	TIP162
Collector-base voltage	320 V	350 V	380 V
Collector-emitter voltage (I_B = 0)	320 V	350 V	380 V
Emitter-base voltage	5 V		
Continuous collector current	10 A		
Peak collector current (see Note 1)	15 A		
Commutating diode current (see Note 2)	10 A		
Continuous base current	1 A		
Continuous device dissipation at (or below) 100°C case temperature (see Note 3)	50 W		
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 4)	3 W		
Safe operating areas at (or below) 100°C case temperature	See Figure 9		
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 $t_w \leq 10$ ms, duty cycle ≤ 10 %.
2. This applies to the total collector-terminal current when the collector is at negative potential with respect to the emitter.
3. Derate linearly to 150°C case at the rate of 1 W/°C or refer to Dissipation Derating Curve, Figure 10.
4. Derate linearly to 150°C free-air temperature at the rate of 24 mW/°C or refer to Dissipation Derating Curve, Figure 11.

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electrical characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS		TIP160			TIP161			TIP162			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
I_{CEO}	V_{CE} = 320 V,	I_B = 0			1							mA
	V_{CE} = 350 V,	I_B = 0						1				
	V_{CE} = 380 V,	I_B = 0									1	
I_{EBO}	V_{BE} = 5 V,	I_C = 0			100			100			100	mA
h_{FE}	V_{CE} = 2.2 V, See Notes 5 and 6	I_C = 4 A,	200			200			200			
V_{BE}	I_B = 0.1 A, See Notes 5 and 6	I_C = 6.5 A			2.2			2.2			2.2	V
$V_{CE(sat)}$	I_B = 0.1 A, See Notes 5 and 6	I_C = 6.5 A,			2.8			2.8			2.8	V
	I_B = 1 A See Notes 5 and 6	I_C = 10 A,			2.9			2.9			2.9	
V_F	I_F = 10 A, See Notes 5 and 6				3			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 3,2 mm (0.125 inch) from the device body.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JC}$				1	°C/W
$R_{\theta JA}$				41.7	°C/W
$R_{\theta CHS}$	See Note 7		0.6		°C/W
$C_{\theta C}$			1.4		J/°C

NOTE 7: This parameter is measured using a 0.003 inch mica insulator Dow Corning 11 compound on both sides of the insulator, 6-32 mounting screw with bushing, and a mounting torque of 8 inch-pounds.

resistive-load switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_d	I_C = 6.5 A,	I_{B1} = 100 mA,	I_{B2} = −100 mA,		0.04		μs
t_r	$V_{BE(off)}$ = −5 V,	R_L = 5 Ω,	See Figure 1		1.5		μs
t_s					2.2		μs
t_f					2.6		μs

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

functional tests at 25°C free-air temperature

TEST	CONDITIONS			LEVEL
Power (V_{CE} • I_C)	V_{CE} = 40 V,	I_C = 2 A,	t_{test} = 0.15 s	80 W
Reverse Pulse Energy $\frac{I_C^2 L}{2}$	I_{CM} = 6 A, t_{test} = 0.5 s,	L = 100 μH, See Note 8	f = 10 Hz,	1.8 mJ
Forward Pulse Energy $\frac{I_C^2 L}{2}$	I_{CM} = 7 A, f = 60 Hz,	L = 5 mH, t_{test} = 0.5 s,	V_{clamp} = V_{CEO} max rating, See Figure 3	122.5 mJ

NOTE 8: The test circuit is the unclamped inductive load circuit shown in Figure 2, L = 100 μH, R_{BB1} = 20 Ω, R_{BB2} = 100 Ω, V_{BB1} = 20 V, V_{BB2} = 0 V, R_L = 0.1 Ω, V_{CC} = 20 V, 1 cm = 6 A.

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PARAMETER MEASUREMENT INFORMATION

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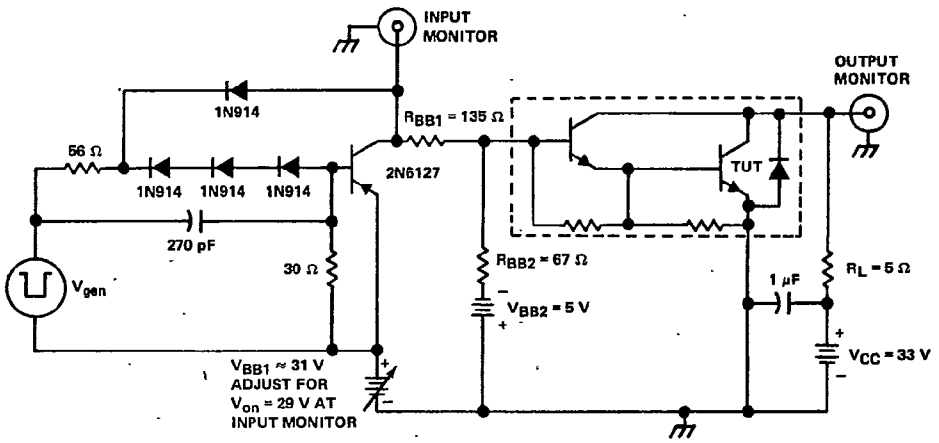
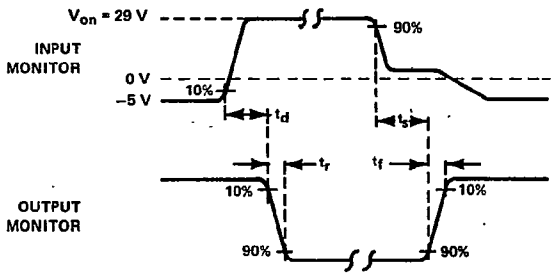


TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. V_{gen} is a −30-V pulse into a 50 Ω termination.
B. The V_{gen} waveform has 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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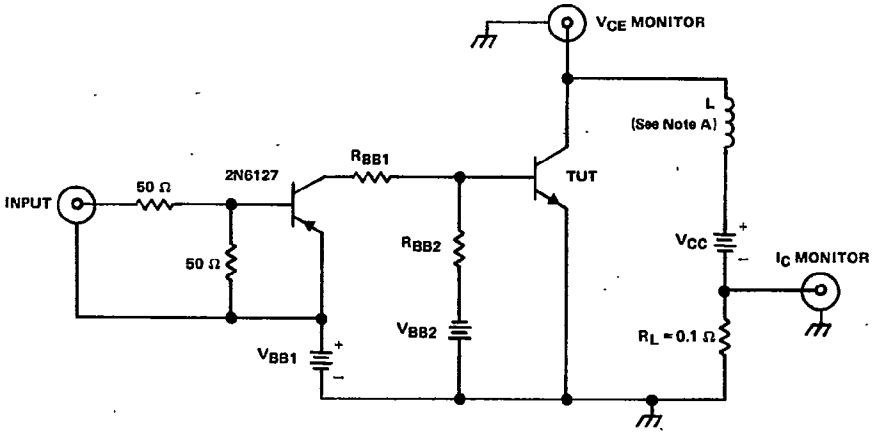
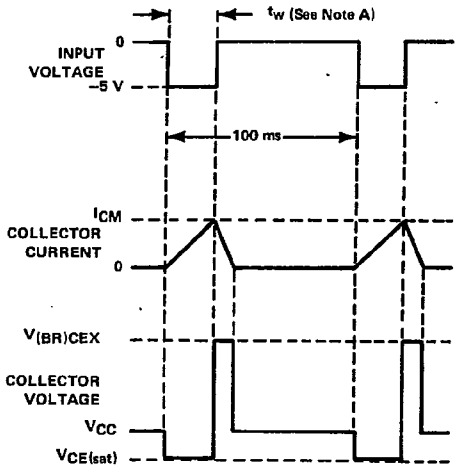
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTE A: Input pulse duration is increased until the peak collector current reaches the specified value of I_{CM}.

FIGURE 2. REVERSE PULSE ENERGY TEST

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FUNCTIONAL TEST INFORMATION

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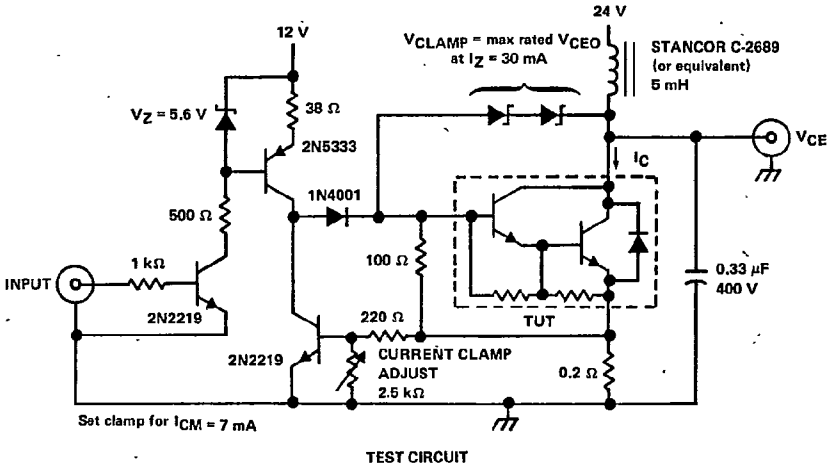
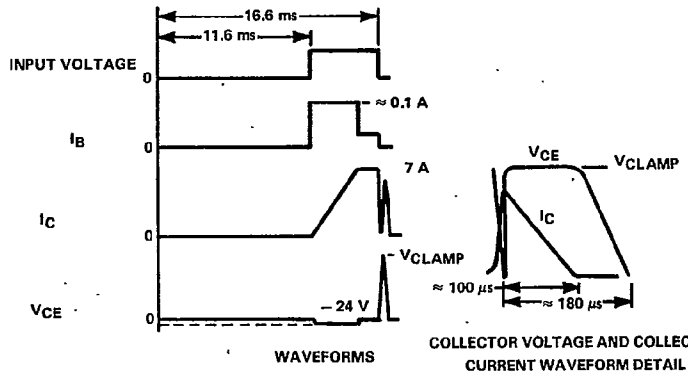


TEST CIRCUIT



WAVEFORMS

COLLECTOR VOLTAGE AND COLLECTOR CURRENT WAVEFORM DETAIL

NOTES: A. Base and collector currents are measured using current probes such as Tektronix types P6019, P6020, P6021, P6042 or the equivalent.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 20$ ns, $R_{in} \geq 10$ MΩ, $C_{in} \leq 11.5$ pF.

FIGURE 3. FORWARD PULSE ENERGY TEST

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TYPICAL CHARACTERISTICS

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

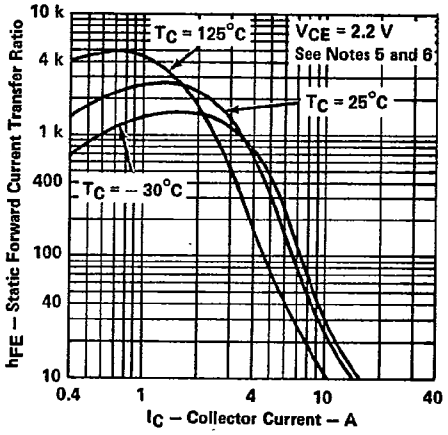

FIGURE 4

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

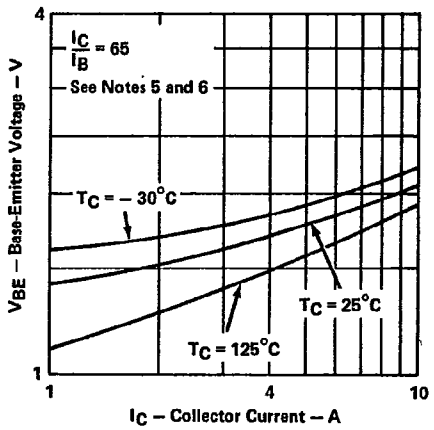

FIGURE 5

BASE-EMITTER VOLTAGE
vs
COLLECTOR CURRENT

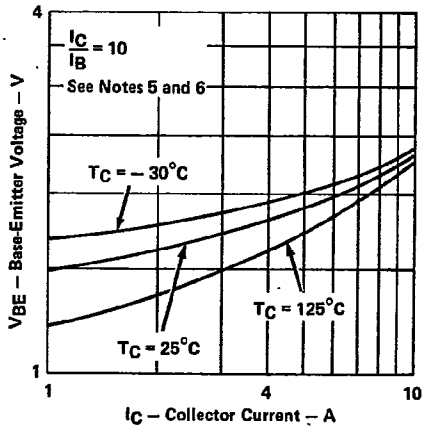

FIGURE 6

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

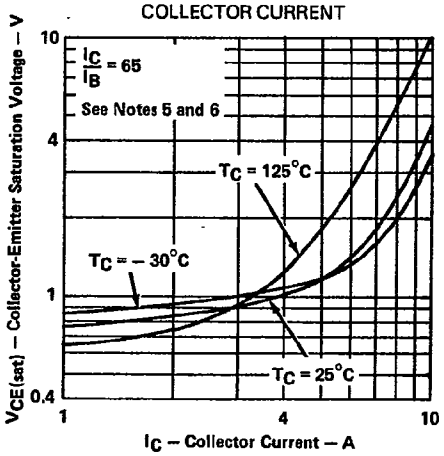

FIGURE 7

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 located within 3,2 mm (0.125 inch) from the device body.

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TYPICAL CHARACTERISTICS

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
COLLECTOR CURRENT

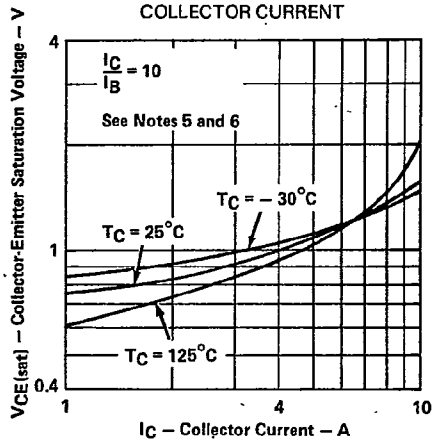

FIGURE 8

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

MAXIMUM SAFE OPERATING AREA

FORWARD-BIAS SAFE OPERATING AREA

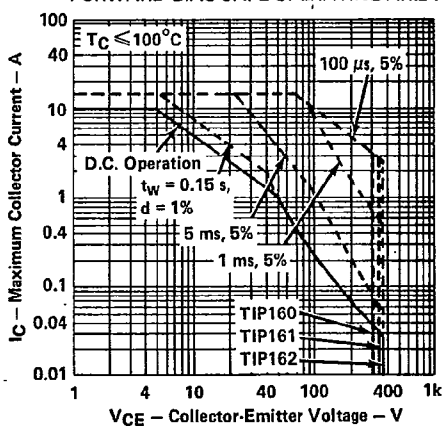

FIGURE 9

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THERMAL INFORMATION

CASE TEMPERATURE
DISSIPATION DERATING CURVE

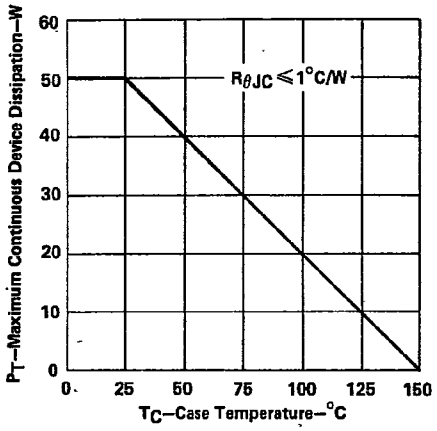

FIGURE 10

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE

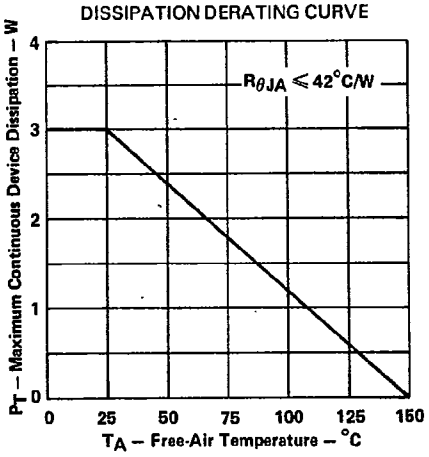

FIGURE 11

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