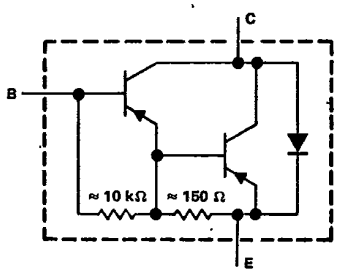
TIP645, TIP646, TIP647
P-N-P DARLINGTON-CONNECTED SILICON POWER TRANSISTORS

REVISED OCTOBER 1984

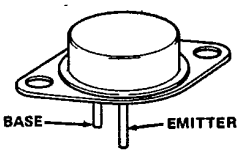
T-33-31

- Designed For Complementary Use With TIP640, TIP641, TIP642
- 175 W at 25°C Case Temperature
- 10 A Rated Collector Current
- Min h_{FE} of 1000 at 4 V, 5 A
- 100 mJ Reverse Energy Rating

device schematic



TO-3 PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

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

	TIP645	TIP646	TIP647
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	−10 A		
Peak collector current (see Note 1)	−15 A		
Continuous base current	−0.5 A		
Safe operating areas 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)	175 W		
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	5 W		
Unclamped inductive load energy (see Note 4)	100 mJ		
Operating collector junction and storage temperature range	−65°C to 200°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 200°C case temperature at the rate of 1 W/°C or refer to Dissipation Derating Curve, Figure 9.
3. Derate linearly to 200°C free-air temperature at the rate of 28.6 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 = 20 mH, 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		TIP645			TIP646			TIP647			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				
	$V_{CE} = -60$ 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	$I_C = -5$ A,	1000			1000			1000			
	$V_{CE} = -4$ V, See Notes 5 and 6	$I_C = -10$ A,	500			500			500			
V_{BE}	$V_{CE} = -4$ V, See Notes 5 and 6	$I_C = -10$ A,			−3			−3			−3	V
$V_{CE(sat)}$	$I_B = -10$ mA, See Notes 5 and 6	$I_C = -5$ A,			−2			−2			−2	V
	$I_B = -40$ mA, See Notes 5 and 6	$I_C = -10$ A,			−3			−3			−3	
V_F	$I_F = 10$ A, See Notes 5 and 6				3.5			3.5			3.5	V

NOTES: 5. These parameters must be measured using pulse techniques, $t_w = 300\ \mu s$, 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.

resistive-load switching characteristic at 25°C case temperature

PARAMETER	TEST CONDITIONS†			MIN	TYP	MAX	UNIT
t_{on}	$I_C = -10$ A,	$I_{B1} = -40$ mA,	$I_{B2} = 40$ mA,		0.9		μs
t_{off}	$V_{BE(off)} = 4.2$ V,	$R_L = 3\ \Omega$,	See Figure 1		11		

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

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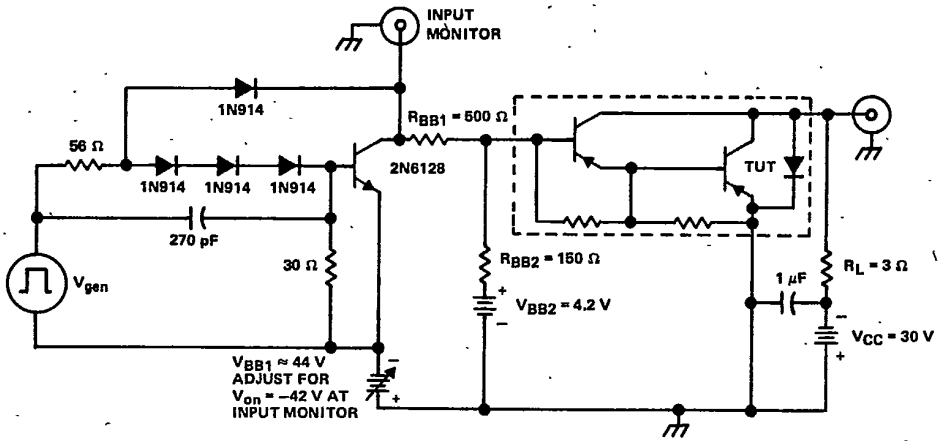
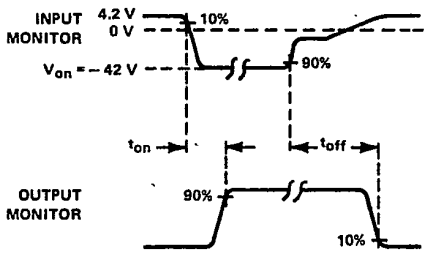
PARAMETER MEASUREMENT INFORMATION

T-33-31



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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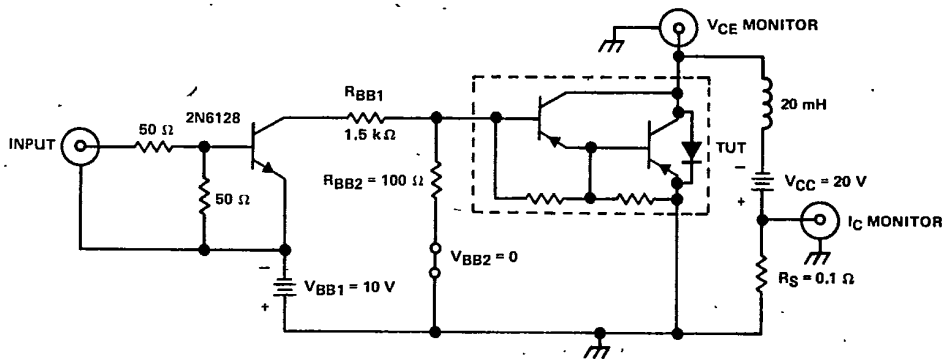
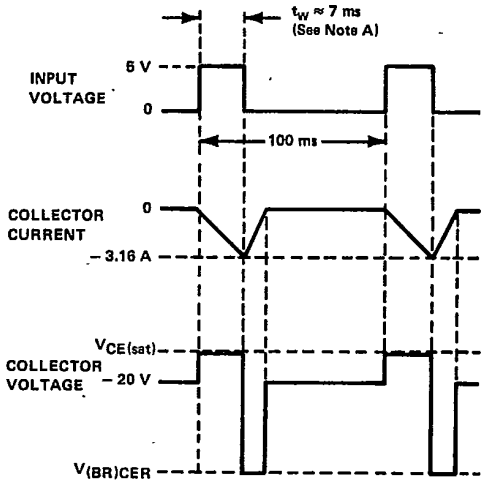
PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTE A: Input pulse duration is increased until $I_{CM} = -3.16$ A.

FIGURE 2. INDUCTIVE-LOAD SWITCHING

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TYPICAL CHARACTERISTICS

T-33-31

STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

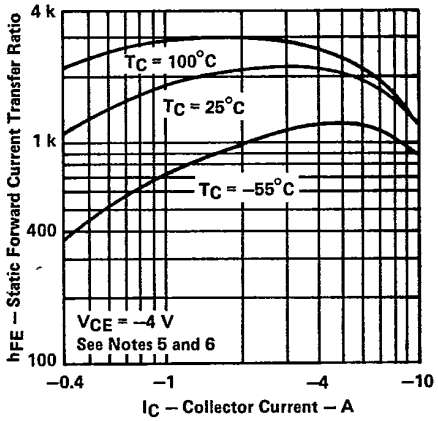

FIGURE 3

BASE EMITTER VOLTAGE
vs
CASE TEMPERATURE

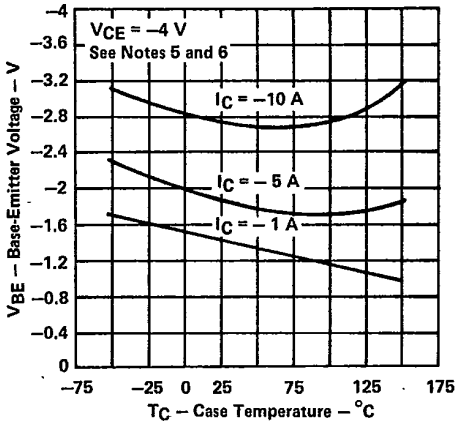

FIGURE 4

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE

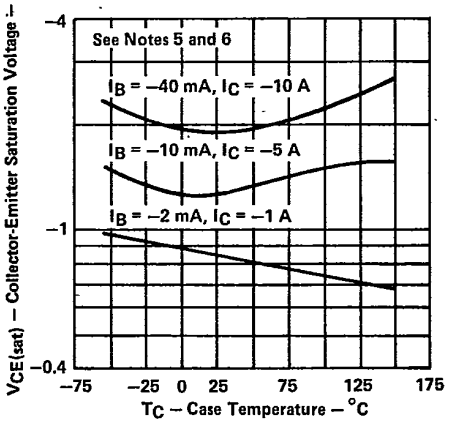

FIGURE 5

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

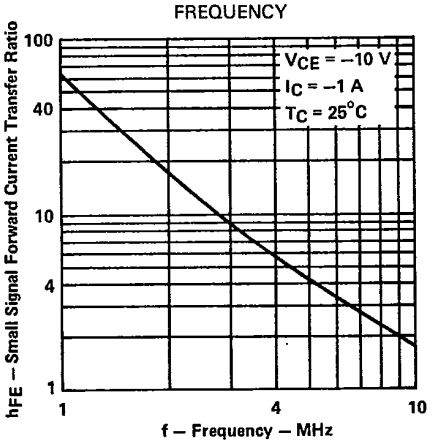

FIGURE 6

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

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MAXIMUM SAFE OPERATING AREA

MAXIMUM COLLECTOR CURRENT
vs
COLLECTOR-EMITTER VOLTAGE

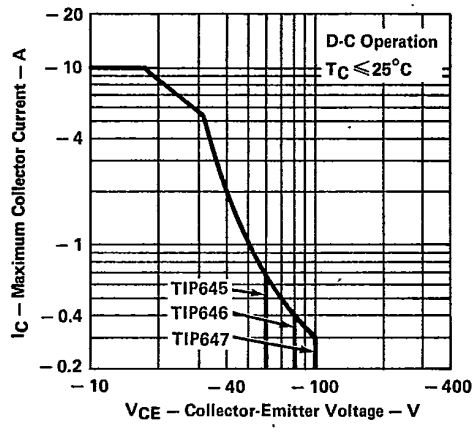

FIGURE 7

MAXIMUM COLLECTOR CURRENT
vs
UNCLAMPED INDUCTIVE LOAD

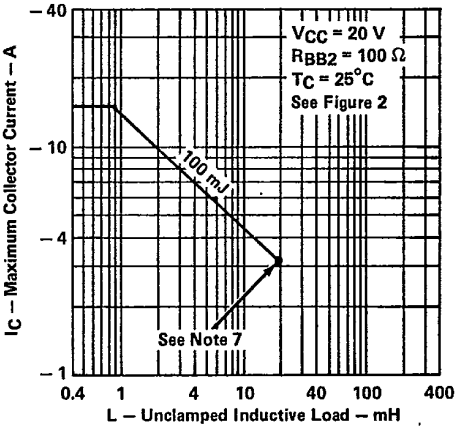

FIGURE 8

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

THERMAL INFORMATION

CASE TEMPERATURE
DISSIPATION DERATING CURVE

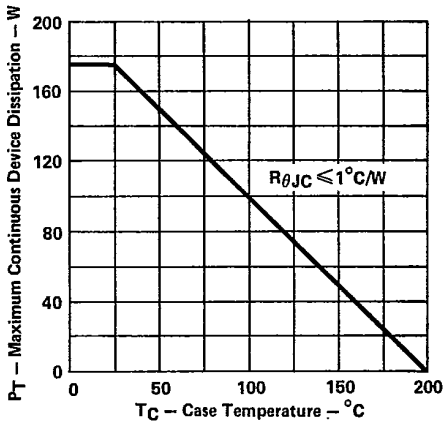

FIGURE 9

FREE-AIR TEMPERATURE
DISSIPATION DERATING CURVE

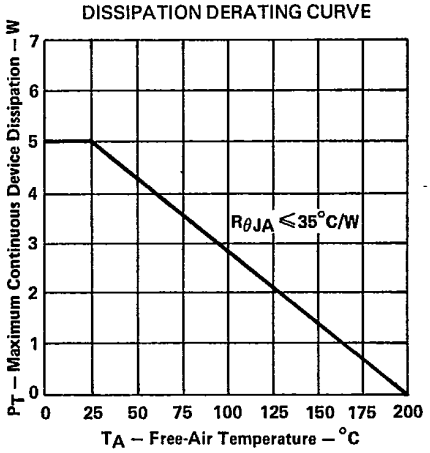

FIGURE 10

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