

8961726 TEXAS INSTR (OPTO)

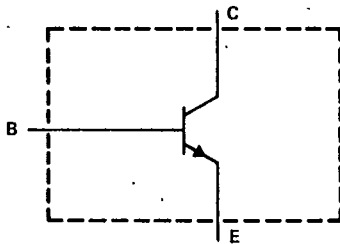
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T-33-13

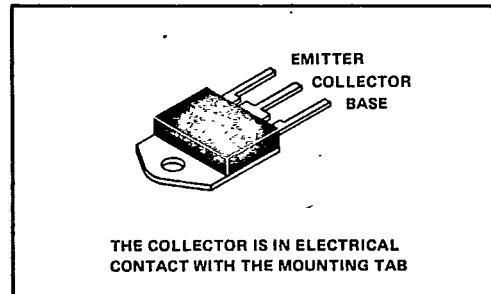
TIP33, TIP33A, TIP33B, TIP33C,
TIP33D, TIP33E, TIP33F
N-P-N SILICON POWER TRANSISTORS
JULY 1968 - REVISED OCTOBER 1984

- Designed for Complementary Use With TIP34 Series
- 80 W at 25°C Case Temperature
- 10 A Continuous Collector Current
- 15 A Peak Collector Current
- Minimum f_T of 3 MHz at 10 V, 0.5 A
- Customer-Specified Selections Available
- Designed for Power Amplifier and High-Speed Switching Applications

device schematic



TO-218AA PACKAGE



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

	TIP33	TIP33A	TIP33B	TIP33C
Collector-base voltage	80 V	100 V	120 V	140 V
Collector-emitter voltage ($I_B = 0$)	40 V	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	3 A			
Safe operating area at 25°C case temperature	See Figure 4			
Continuous device dissipation at 25°C case temperature (see Note 2)	80 W			
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	3.5 W			
Unclamped inductive load energy (see Note 4)	62.5 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	250°C			

- NOTES: 1. This value applies for $t_W = 0.3$ ms, duty cycle $\leq 10\%$.
 2. Derate linearly to 150°C case temperature at the rate of 0.64 W/°C.
 3. Derate linearly to 150°C free-air temperature at the rate of 28 mW/°C.
 4. This rating is based on the capability of the transistor to operate safely in the circuit in Figure 2.



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TIP33, TIP33A, TIP33B, TIP33C,
TIP33D, TIP33E, TIP33F
N-P-N SILICON POWER TRANSISTORS

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

	TIP33D	TIP33E	TIP33F
Collector-base voltage	160 V	180 V	200 V
Collector-emitter voltage ($I_B = 0$)	120 V	140 V	160 V
Emitter-base voltage	5 V		
Continuous collector current	10 A		
Peak collector current (see Note 1)	15 A		
Continuous base current	3 A		
Safe operating area at 25°C case temperature	See Figure 4		
Continuous device dissipation at 25°C case temperature (see Note 2)	80 W		
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	3.5 W		
Unclamped inductive load energy (see Note 4)	62.5 mJ		
Operating collector junction and storage temperature range	-65°C to 150°C		
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 4. This rating is based on the capability of the transistor to operate safely in the circuit in Figure 2.

electrical characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS	TIP33	TIP33A	TIP33B	TIP33C	UNIT
		MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	MIN TYP MAX	
$V_{(BR)CEO}$	$I_C = 30$ mA, $I_B = 0$, See Note 5	40	60	80	100	V
I_{CEO}	$V_{CE} = 30$ V, $I_B = 0$	0.7	0.7			mA
	$V_{CE} = 60$ V, $I_B = 0$			0.7	0.7	
I_{CES}	$V_{CE} = 80$ V, $V_{BE} = 0$	0.4				mA
	$V_{CE} = 100$ V, $V_{BE} = 0$		0.4			
	$V_{CE} = 120$ V, $V_{BE} = 0$			0.4		
	$V_{CE} = 140$ V, $V_{BE} = 0$				0.4	
I_{EBO}	$V_{EB} = 5$ V, $I_C = 0$	1	1	1	1	mA
h_{FE}	$V_{CE} = 4$ V, $I_C = 1$ A, See Notes 5 and 6	40	40	40	40	
	$V_{CE} = 4$ V, $I_C = 3$ A, See Notes 5 and 6	20 100	20 100	20 100	20 100	
V_{BE}	$V_{CE} = 4$ V, $I_C = 3$ A, See Notes 5 and 6	1.6	1.6	1.6	1.6	V
	$V_{CE} = 4$ V, $I_C = 10$ A, See Notes 5 and 6	3	3	3	3	
$V_{CE(sat)}$	$I_B = 0.3$ A, $I_C = 3$ A, See Notes 5 and 6	1	1	1	1	V
	$I_B = 2.5$ A, $I_C = 10$ A, See Notes 5 and 6	4	4	4	4	
h_{fe}	$V_{CE} = 10$ V, $I_C = 0.5$ A, $f = 1$ kHz	20	20	20	20	
$ h_{fe} $	$V_{CE} = 10$ V, $I_C = 0.5$ A, $f = 1$ MHz	3	3	3	3	

- NOTES: 5. These parameters must be measured using pulse techniques, $t_w = 300$ μ s, duty cycle $\leq 2\%$.
 6. These parameters are measured with voltage-sensing separate from the current-carrying contacts.

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N-P-N SILICON POWER TRANSISTORS

electrical characteristics at 25°C case temperature

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PARAMETER	TEST CONDITIONS	TIP33D			TIP33E			TIP33F			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V _{(BR)CEO}	I _C = 30 mA, See Note 5 I _B = 0	120			140			160			V
I _{CEO}	V _{CE} = 90 V, I _B = 0		0.7			0.7			0.7		mA
I _{CES}	V _{CE} = 160 V, V _{BE} = 0		0.4								mA
	V _{CE} = 180 V, V _{BE} = 0					0.4					
	V _{CE} = 200 V, V _{BE} = 0								0.4		
I _{EBO}	V _{EB} = 5 V, I _C = 0		1			1			1		mA
h _{FE}	V _{CE} = 4 V, See Notes 5 and 6 I _C = 1 A	40			40			40			
	V _{CE} = 4 V, See Notes 5 and 6 I _C = 3 A	20			20			20			
V _{BE}	V _{CE} = 4 V, See Notes 5 and 6 I _C = 1 A		1.6			1.6			1.6		V
	V _{CE} = 4 V, See Notes 5 and 6 I _C = 10 A		3			3			3		
V _{CE(sat)}	I _B = 0.3 A, See Notes 5 and 6 I _C = 3 A		1			1			1		V
	I _B = 3.3 A, See Notes 5 and 6 I _C = 10 A		4			4			4		
h _{fe}	V _{CE} = 10 V, f = 1 kHz I _C = 0.5 A	20			20			20			
h _{fe}	V _{CE} = 10 V, f = 1 MHz I _C = 0.5 A	3			3			3			

- 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 separate from the current-carrying contacts.

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
R _{θJC}			1.56	°C/W
R _{θJA}			35.7	

resistive-load switching characteristics at 25°C case temperature

PARAMETER	TEST CONDITIONS †	MIN	TYP	MAX	UNIT
t _{on}	I _C = 6 A, I _{B1} = 0.6 A, I _{B2} = -0.6 A, V _{BE(off)} = -4 V, R _L = 5 Ω, See Figure 1		0.6		μs
t _{off}			1		

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



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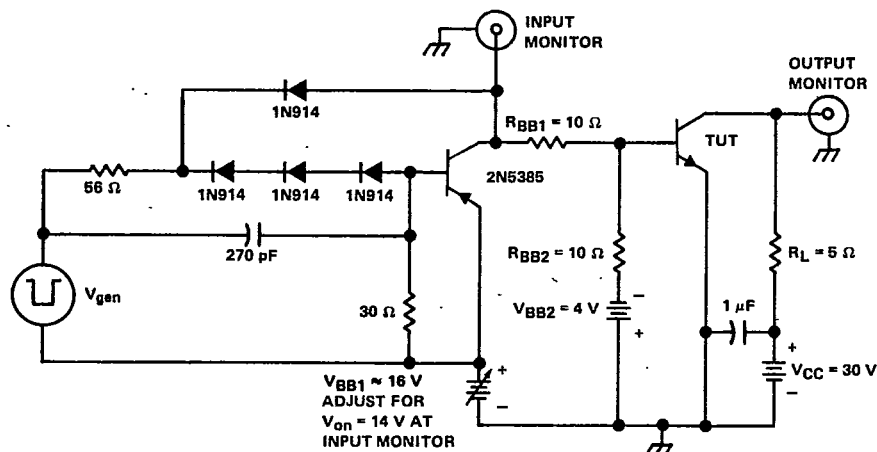
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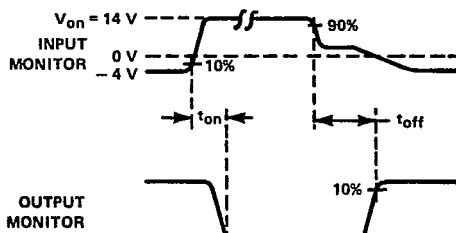
TIP33, TIP33A, TIP33B, TIP33C,
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N-P-N SILICON POWER TRANSISTORS

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PARAMETER MEASUREMENT INFORMATION



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 $\leq 2\%$.
 - C. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10$ M Ω , $C_{in} \leq 11.5$ 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



TIP Devices

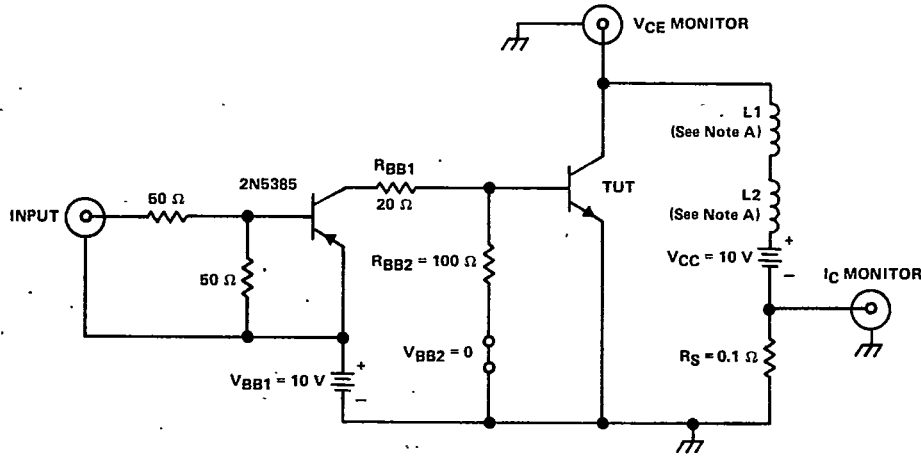
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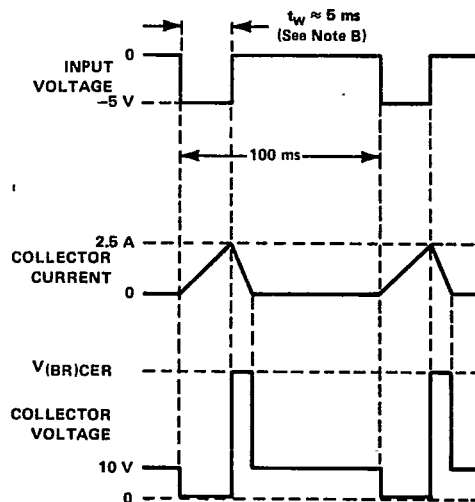
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N-P-N SILICON POWER TRANSISTORS

PARAMETER MEASUREMENT INFORMATION

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TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTES: A. L1 and L2 are 10 mH, 0.11 Ω , Chicago Standard Transformer Corporation C-2688, or equivalent.
B. Input pulse duration is increased until $I_{CM} = 2.5$ A.

FIGURE 2. INDUCTIVE-LOAD SWITCHING

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TIP33, TIP33A, TIP33B, TIP33C,
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TYPICAL CHARACTERISTICS
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

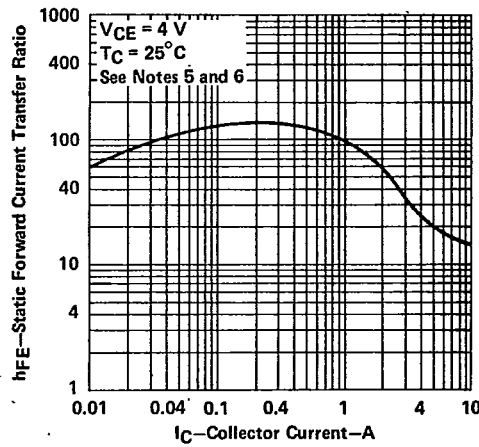


FIGURE 3

- 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 separate from the current-carrying contacts.

MAXIMUM SAFE OPERATING AREA
FORWARD-BIAS SAFE OPERATING AREA

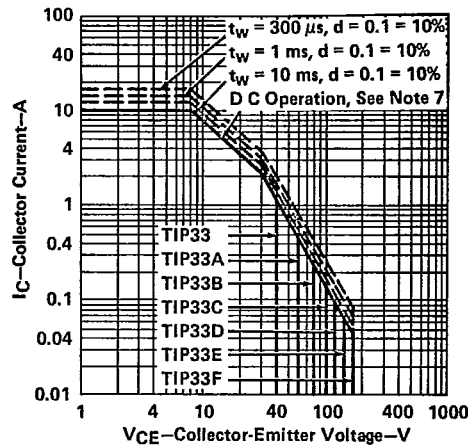


FIGURE 4

NOTE 7: This combination of maximum voltage and current may be achieved only when switching from saturation to cutoff with a clamped inductive load.



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THERMAL INFORMATION

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DISSIPATION DERATING CURVE

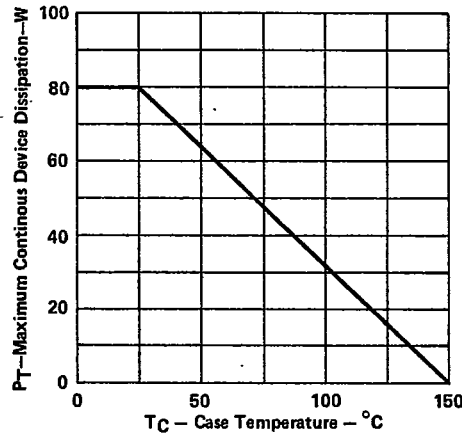


FIGURE 5



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