

8961726 TEXAS INSTR (OPTO)

62C 36760

D

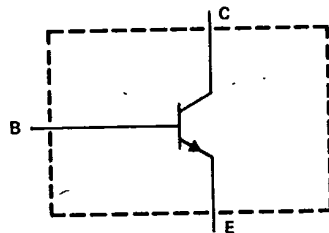
TIP31, TIP31A, TIP31B, TIP31C,  
TIP31D, TIP31E, TIP31F  
N-P-N SILICON POWER TRANSISTORS

DECEMBER 1970 - REVISED OCTOBER 1984

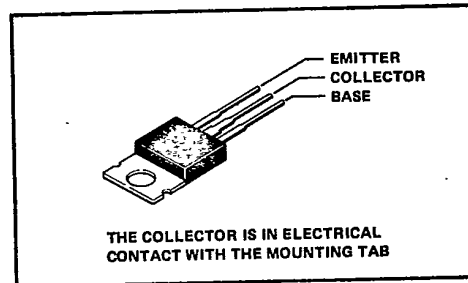
T-33-11

- 40 W at 25°C Case Temperature
- 3 A Continuous Collector Current
- 5 A Peak Collector Current
- Minimum  $f_T$  of 3 MHz at 10 V, 0.5 mA
- Customer-Specified Selections Available

## device schematic



## TO-220AB PACKAGE



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

|                                                                                    | TIP31           | TIP31A | TIP31B | TIP31C |
|------------------------------------------------------------------------------------|-----------------|--------|--------|--------|
| 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                                                       | 3 A             |        |        |        |
| Peak collector current (see Note 1)                                                | 5 A             |        |        |        |
| Continuous base current                                                            | 1 A             |        |        |        |
| Safe operating area at 25°C case temperature                                       | See Figure 4    |        |        |        |
| Continuous device dissipation at (or below) 25°C case temperature (see Note 2)     | 40 W            |        |        |        |
| Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3) | 2 W             |        |        |        |
| Unclamped inductive load energy (see Note 4)                                       | 32 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  $t_W \leq 0.3$  ms, duty cycle  $\leq 10\%$ .  
 2. Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.  
 3. Derate linearly to 150°C free-air temperature at the rate of 16 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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TIP Devices

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TIP31, TIP31A, TIP31B, TIP31C,  
TIP31D, TIP31E, TIP31F  
N-P-N SILICON POWER TRANSISTORS

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

|                                                                                    | TIP31D         | TIP31E | TIP31F |
|------------------------------------------------------------------------------------|----------------|--------|--------|
| 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                                                       | 3 A            |        |        |
| Peak collector current (see Note 1)                                                | 5 A            |        |        |
| Continuous base current                                                            | 1 A            |        |        |
| Safe operating area at 25°C case temperature                                       | See Figure 4   |        |        |
| Continuous device dissipation at (or below) 25°C case temperature (see Note 2)     | 40 W           |        |        |
| Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3) | 2 W            |        |        |
| Unclamped inductive load energy (see Note 4)                                       | 32 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  $t_W \leq 0.3$  ms, duty cycle  $\leq 10\%$ .  
 2. Derate linearly to 150°C case temperature at the rate of 0.32 W/°C.  
 3. Derate linearly to 150°C free-air temperature at the rate of 16 mW/°C.  
 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 (unless otherwise noted)

| PARAMETER     | TEST CONDITIONS                                                          | TIP31     |     |     | TIP31A |     |     | TIP31B |     |     | TIP31C |     |     | UNIT |    |
|---------------|--------------------------------------------------------------------------|-----------|-----|-----|--------|-----|-----|--------|-----|-----|--------|-----|-----|------|----|
|               |                                                                          | MIN       | TYP | MAX | MIN    | TYP | MAX | MIN    | TYP | MAX | MIN    | TYP | MAX |      |    |
| $V_{(BR)CEO}$ | $I_C = 30\text{ mA}$ ,<br>See Note 5                                     | $I_B = 0$ | 40  |     | 60     |     |     | 80     |     |     | 100    |     |     | V    |    |
| $I_{CEO}$     | $V_{CE} = 30\text{ V}$ ,<br>$I_B = 0$                                    |           | 0.3 |     |        | 0.3 |     |        |     |     |        |     |     |      | mA |
|               | $V_{CE} = 60\text{ V}$ ,<br>$I_B = 0$                                    |           |     |     |        |     |     |        | 0.3 |     |        | 0.3 |     |      |    |
| $I_{CES}$     | $V_{CE} = 80\text{ V}$ ,<br>$V_{BE} = 0$                                 |           | 0.2 |     |        |     |     |        |     |     |        |     |     |      | mA |
|               | $V_{CE} = 100\text{ V}$ ,<br>$V_{BE} = 0$                                |           |     |     |        | 0.2 |     |        |     |     |        |     |     |      |    |
|               | $V_{CE} = 120\text{ V}$ ,<br>$V_{BE} = 0$                                |           |     |     |        |     |     |        | 0.2 |     |        |     |     |      |    |
|               | $V_{CE} = 140\text{ V}$ ,<br>$V_{BE} = 0$                                |           |     |     |        |     |     |        |     |     |        | 0.2 |     |      |    |
| $I_{EBO}$     | $V_{EB} = 5\text{ V}$ ,<br>$I_C = 0$                                     |           | 1   |     |        | 1   |     |        | 1   |     |        | 1   |     |      | mA |
| $h_{FE}$      | $V_{CE} = 4\text{ V}$ ,<br>$I_C = 1\text{ A}$ ,<br>See Notes 5 and 6     |           | 25  |     | 25     |     |     | 25     |     |     | 25     |     |     |      |    |
|               | $V_{CE} = 4\text{ V}$ ,<br>$I_C = 3\text{ A}$ ,<br>See Notes 5 and 6     |           | 10  | 50  | 10     | 50  | 10  | 50     | 10  | 50  | 10     | 50  |     |      |    |
| $V_{BE}$      | $V_{CE} = 4\text{ V}$ ,<br>$I_C = 3\text{ A}$ ,<br>See Notes 5 and 6     |           | 1.8 |     |        | 1.8 |     |        | 1.8 |     |        | 1.8 |     |      | V  |
| $V_{CE(sat)}$ | $I_B = 375\text{ mA}$ ,<br>$I_C = 3\text{ A}$ ,<br>See Notes 5 and 6     |           | 1.2 |     |        | 1.2 |     |        | 1.2 |     |        | 1.2 |     |      | V  |
| $h_{fe}$      | $V_{CE} = 10\text{ V}$ ,<br>$I_C = 0.5\text{ A}$ ,<br>$f = 1\text{ kHz}$ |           | 20  |     | 20     |     |     | 20     |     |     | 20     |     |     |      |    |
| $h_{fe}$      | $V_{CE} = 10\text{ V}$ ,<br>$I_C = 0.5\text{ A}$ ,<br>$f = 1\text{ MHz}$ |           | 3   |     | 3      |     |     | 3      |     |     | 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 contacts separate from the current-carrying contacts.

TIP Devices

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TIP31, TIP31A, TIP31B, TIP31C,  
TIP31D, TIP31E, TIP31F  
N-P-N SILICON POWER TRANSISTORS

electrical characteristics at 25°C case temperature (unless otherwise noted)

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| PARAMETER     | TEST CONDITIONS                                                          | TIP31D |     |     | TIP31E |     |     | TIP31F |     |     | UNIT |
|---------------|--------------------------------------------------------------------------|--------|-----|-----|--------|-----|-----|--------|-----|-----|------|
|               |                                                                          | MIN    | TYP | MAX | MIN    | TYP | MAX | MIN    | TYP | MAX |      |
| $V_{(BR)CEO}$ | $I_C = 30 \text{ mA}$ , $I_B = 0$ ,<br>See Note 5                        | 120    |     |     | 140    |     |     | 160    |     |     | V    |
| $I_{CEO}$     | $V_{CE} = 90 \text{ V}$ , $I_B = 0$                                      |        | 0.3 |     |        | 0.3 |     |        | 0.3 |     | mA   |
| $I_{CES}$     | $V_{CE} = 160 \text{ V}$ , $V_{BE} = 0$                                  |        | 0.2 |     |        |     |     |        |     |     | mA   |
|               | $V_{CE} = 180 \text{ V}$ , $V_{BE} = 0$                                  |        |     |     |        | 0.2 |     |        |     |     |      |
|               | $V_{CE} = 200 \text{ V}$ , $V_{BE} = 0$                                  |        |     |     |        |     |     |        | 0.2 |     |      |
| $I_{EBO}$     | $V_{EB} = 5 \text{ V}$ , $I_C = 0$                                       |        | 1   |     |        | 1   |     |        | 1   |     | mA   |
| $h_{FE}$      | $V_{CE} = 4 \text{ V}$ , $I_C = 1 \text{ A}$ ,<br>See Notes 5 and 6      | 25     |     |     | 25     |     |     | 25     |     |     |      |
|               | $V_{CE} = 4 \text{ V}$ , $I_C = 3 \text{ A}$ ,<br>See Notes 5 and 6      | 5      |     |     | 5      |     |     | 5      |     |     |      |
|               | $V_{CE} = 4 \text{ V}$ , $I_C = 3 \text{ A}$ ,<br>See Notes 5 and 6      |        |     |     |        |     |     |        |     |     |      |
| $V_{BE}$      | $V_{CE} = 4 \text{ V}$ , $I_C = 3 \text{ A}$ ,<br>See Notes 5 and 6      |        | 1.8 |     |        | 1.8 |     |        | 1.8 |     | V    |
| $V_{CE(sat)}$ | $I_B = 750 \text{ mA}$ , $I_C = 3 \text{ A}$ ,<br>See Notes 5 and 6      |        | 2.5 |     |        | 2.5 |     |        | 2.5 |     | V    |
| $h_{fe}$      | $V_{CE} = 10 \text{ V}$ , $I_C = 0.5 \text{ A}$ ,<br>$f = 1 \text{ kHz}$ | 20     |     |     | 20     |     |     | 20     |     |     |      |
| $h_{fe}$      | $V_{CE} = 10 \text{ V}$ , $I_C = 0.5 \text{ A}$ ,<br>$f = 1 \text{ MHz}$ | 3      |     |     | 3      |     |     | 3      |     |     |      |

NOTES: 5. These parameters must be measured using pulse techniques,  $t_W = 300 \mu\text{s}$ , duty cycle  $\leq 2\%$ .

6. These parameters are measured using voltage-sensing contacts separate from the current-carrying contacts.

## thermal characteristics

| PARAMETER       | MIN | TYP   | MAX | UNIT |
|-----------------|-----|-------|-----|------|
| $R_{\theta JC}$ |     | 3.125 |     | °C/W |
| $R_{\theta JA}$ |     | 62.5  |     |      |

## resistive-load switching characteristic at 25°C case temperature (unless otherwise noted)

| PARAMETER | TEST CONDITIONS†                                                                                                                                  |  |  | MIN | TYP | MAX | UNIT          |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------|--|--|-----|-----|-----|---------------|
| $t_{on}$  | $I_C = 1 \text{ A}$ , $I_{B1} = 0.1 \text{ A}$ , $I_{B2} = -0.1 \text{ A}$ ,<br>$V_{BE(off)} = -4.3 \text{ V}$ , $R_L = 30 \Omega$ , See Figure 1 |  |  |     | 0.5 |     | $\mu\text{s}$ |
| $t_{off}$ |                                                                                                                                                   |  |  |     | 2   |     |               |

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



TIP Devices

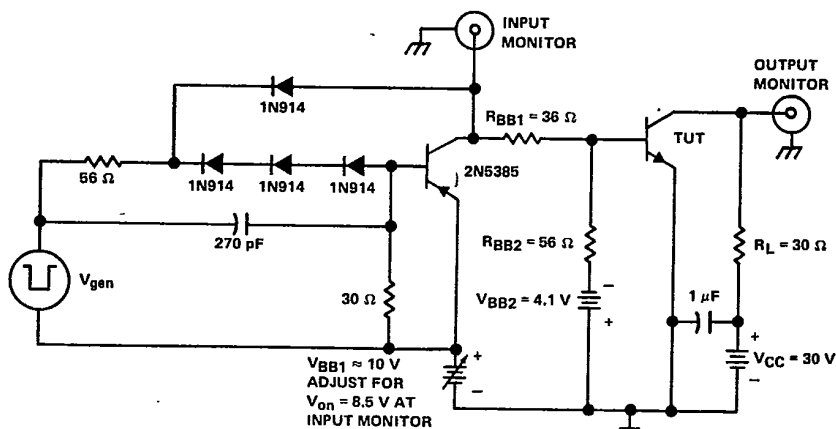
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TIP31, TIP31A, TIP31B, TIP31C,  
TIP31D, TIP31E, TIP31F  
N-P-N SILICON POWER TRANSISTORS

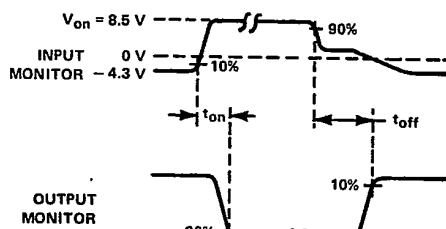
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## PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

- NOTES: A.  $V_{gen}$  is a -30-V pulse into a 50  $\Omega$  termination.  
B. The  $V_{gen}$  waveform is supplied by 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 $\Omega$ ,  $C_{in} \leq 11.5$  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



TIP Devices

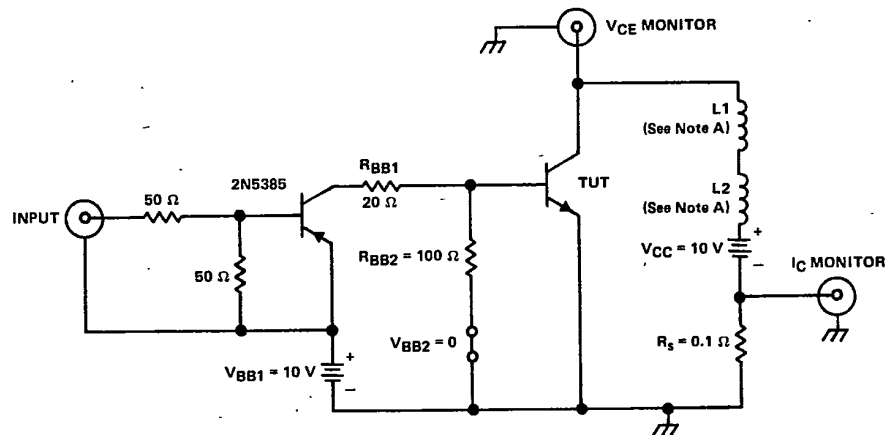
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62C 35764 D

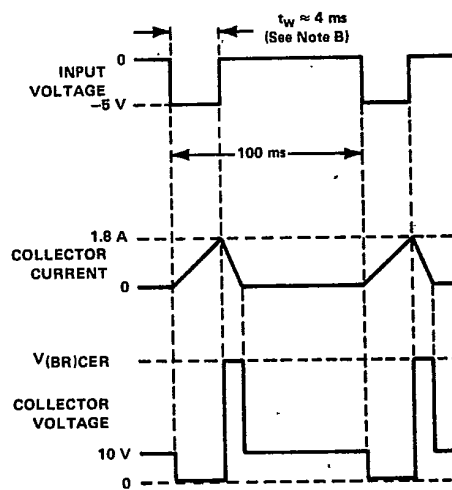
TIP31, TIP31A, TIP31B, TIP31C,  
TIP31D, TIP31E, TIP31F  
N-P-N SILICON POWER TRANSISTORS

## PARAMETER MEASUREMENT INFORMATION

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TEST CIRCUIT



VOLTAGE AND CURRENT WAVEFORMS

NOTES: A. L1 and L2 are 10 mH, 0.11  $\Omega$ , Chicago Standard Transformer Corporation C-2688, or equivalent.  
B. Input pulse duration is increased until  $I_{CM} = 1.8$  A.

FIGURE 2. INDUCTIVE-LOAD SWITCHING

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## TYPICAL CHARACTERISTICS

STATIC FORWARD CURRENT TRANSFER RATIO  
VS  
COLLECTOR CURRENT

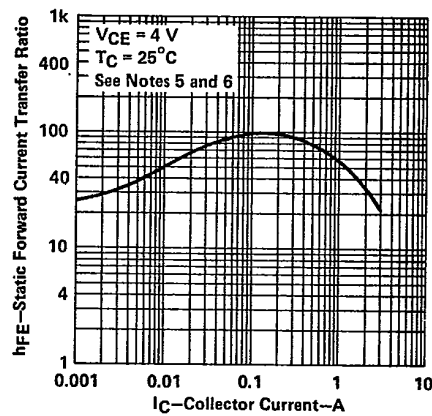


FIGURE 3

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 contacts separate from the current-carrying contacts.

## MAXIMUM SAFE OPERATING AREA

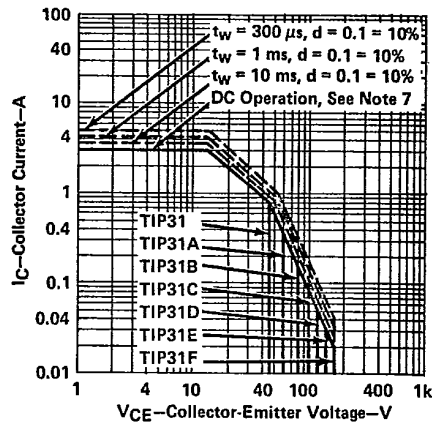


FIGURE 4

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

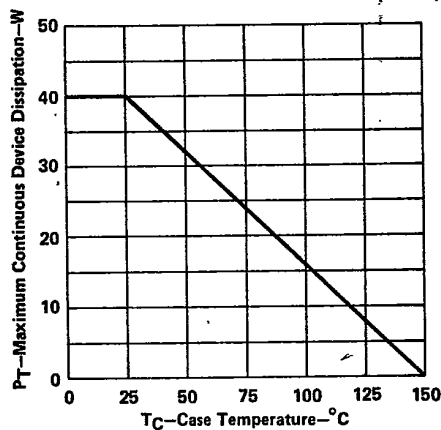


FIGURE 5



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