

# 2N5190G, 2N5191G, 2N5192G

## Silicon NPN Power Transistors

Silicon NPN power transistors are for use in power amplifier and switching circuits – excellent safe area limits. Complement to PNP 2N5194, 2N5195.

### Features

- Epoxy Meets UL 94 V-0 @ 0.125 in.
- These Devices are Pb-Free and are RoHS Compliant\*

### MAXIMUM RATINGS

| Rating  | Symbol         | Value          | Unit                      |
|---|----------------|----------------|---------------------------|
| Collector–Emitter Voltage<br>2N5190G<br>2N5191G<br>2N5192G                                | $V_{CE0}$      | 40<br>60<br>80 | Vdc                       |
| Collector–Base Voltage<br>2N5190G<br>2N5191G<br>2N5192G                                   | $V_{CBO}$      | 40<br>60<br>80 | Vdc                       |
| Emitter–Base Voltage  | $V_{EBO}$      | 5.0            | Vdc                       |
| Collector Current   | $I_C$          | 4.0            | Adc                       |
| Base Current  | $I_B$          | 1.0            | Adc                       |
| Total Device Dissipation<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$          | 40<br>320      | W<br>mW/ $^\circ\text{C}$ |
| Operating and Storage Junction Temperature Range  | $T_J, T_{stg}$ | -65 to +150    | $^\circ\text{C}$          |
| ESD – Human Body Model  | HBM            | 3B             | V                         |
| ESD – Machine Model   | MM             | C              | V                         |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

### THERMAL CHARACTERISTICS

| Characteristic                       | Symbol          | Max  | Unit                      |
|--------------------------------------|-----------------|------|---------------------------|
| Thermal Resistance, Junction-to-Case | $R_{\theta JC}$ | 3.12 | $^\circ\text{C}/\text{W}$ |

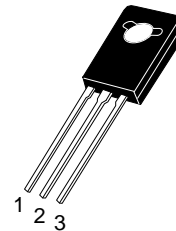
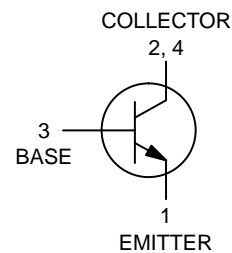
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



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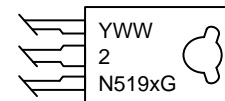
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**4.0 AMPERES  
NPN SILICON  
POWER TRANSISTORS  
40, 60, 80 VOLTS – 40 WATTS**



**TO-225  
CASE 77-09  
STYLE 1**

### MARKING DIAGRAM



Y = Year  
 WW = Work Week  
 2N519x = Device Code  
 x = 0, 1, or 2  
 G = Pb-Free Package

### ORDERING INFORMATION

| Device  | Package             | Shipping      |
|---------|---------------------|---------------|
| 2N5190G | TO-225<br>(Pb-Free) | 500 Units/Box |
| 2N5191G | TO-225<br>(Pb-Free) | 500 Units/Box |
| 2N5192G | TO-225<br>(Pb-Free) | 500 Units/Box |

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### ELECTRICAL CHARACTERISTICS\* ( $T_C = 25^\circ\text{C}$ unless otherwise noted)

| Characteristic   | Symbol        | Min                        | Max                                    | Unit |
|--|---------------|----------------------------|--|------|
| <b>OFF CHARACTERISTICS</b>   |               |                            |  |      |
| Collector–Emitter Sustaining Voltage (Note 1)<br>( $I_C = 0.1\text{ Adc}$ , $I_B = 0$ )<br>2N5190G<br>2N5191G<br>2N5192G   | $V_{CE(sus)}$ | 40<br>60<br>80             | –<br>–<br>–                            | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = 40\text{ Vdc}$ , $I_B = 0$ )<br>2N5190G<br>( $V_{CE} = 60\text{ Vdc}$ , $I_B = 0$ )<br>2N5191G<br>( $V_{CE} = 80\text{ Vdc}$ , $I_B = 0$ )<br>2N5192G  | $I_{CEO}$     | –<br>–<br>–                | 1.0<br>1.0<br>1.0                      | mAdc |
| Collector Cutoff Current<br>( $V_{CE} = 40\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ )<br>2N5190G<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ )<br>2N5191G<br>( $V_{CE} = 80\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ )<br>2N5192G<br>( $V_{CE} = 40\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )<br>2N5190G<br>( $V_{CE} = 60\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )<br>2N5191G<br>( $V_{CE} = 80\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )<br>2N5192G | $I_{CEX}$     | –<br>–<br>–<br>–<br>–<br>– | 0.1<br>0.1<br>0.1<br>2.0<br>2.0<br>2.0 | mAdc |
| Collector Cutoff Current<br>( $V_{CB} = 40\text{ Vdc}$ , $I_E = 0$ )<br>2N5190G<br>( $V_{CB} = 60\text{ Vdc}$ , $I_E = 0$ )<br>2N5191G<br>( $V_{CB} = 80\text{ Vdc}$ , $I_E = 0$ )<br>2N5192G  | $I_{CBO}$     | –<br>–<br>–                | 0.1<br>0.1<br>0.1                      | mAdc |
| Emitter Cutoff Current<br>( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )  | $I_{EBO}$     | –                          | 1.0                                    | mAdc |
| <b>ON CHARACTERISTICS</b> (Note 1)   |               |                            |  |      |
| DC Current Gain<br>( $I_C = 1.5\text{ Adc}$ , $V_{CE} = 2.0\text{ Vdc}$ )<br>2N5190G/2N5191G<br>2N5192G<br>( $I_C = 4.0\text{ Adc}$ , $V_{CE} = 2.0\text{ Vdc}$ )<br>2N5190G/2N5191G<br>2N5192G  | $h_{FE}$      | 25<br>20<br>10<br>7.0      | 100<br>80<br>–<br>–                    | –    |
| Collector–Emitter Saturation Voltage<br>( $I_C = 1.5\text{ Adc}$ , $I_B = 0.15\text{ Adc}$ )<br>( $I_C = 4.0\text{ Adc}$ , $I_B = 1.0\text{ Adc}$ )  | $V_{CE(sat)}$ | –<br>–                     | 0.6<br>1.4                             | Vdc  |
| Base–Emitter On Voltage<br>( $I_C = 1.5\text{ Adc}$ , $V_{CE} = 2.0\text{ Vdc}$ )  | $V_{BE(on)}$  | –                          | 1.2                                    | Vdc  |
| <b>DYNAMIC CHARACTERISTICS</b>   |               |                            |  |      |
| Current–Gain – Bandwidth Product<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1.0\text{ MHz}$ )   | $f_T$         | 2.0                        | –                                      | MHz  |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

\*JEDEC Registered Data.

1. Pulse Test: Pulse Width  $\leq 300\ \mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

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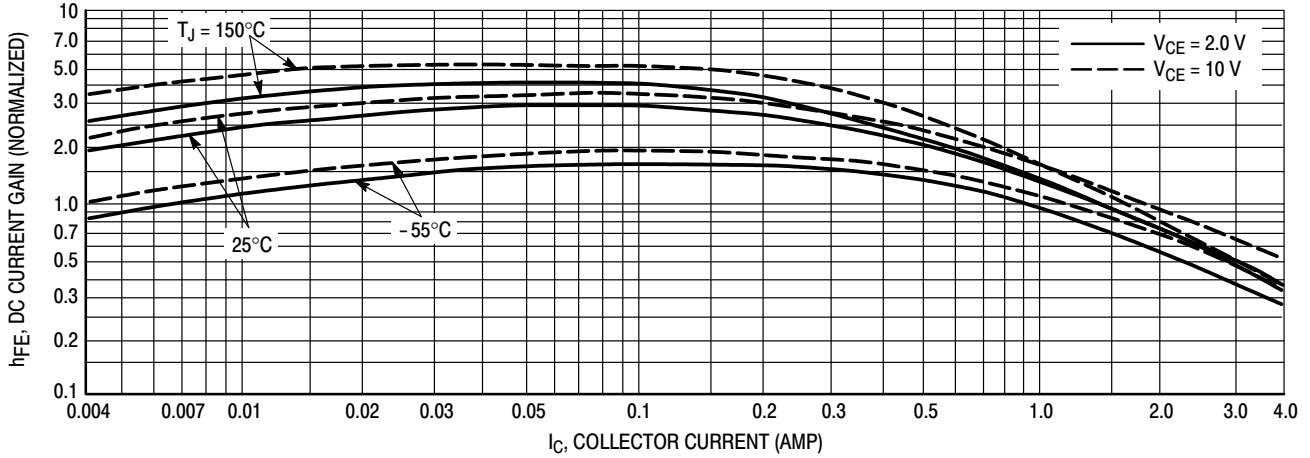


Figure 1. DC Current Gain

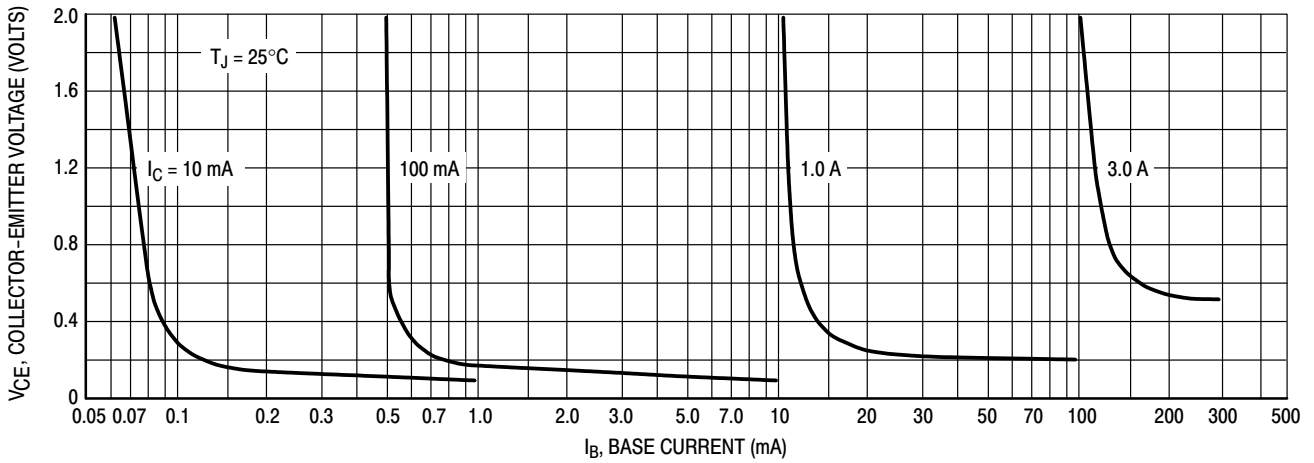


Figure 2. Collector Saturation Region

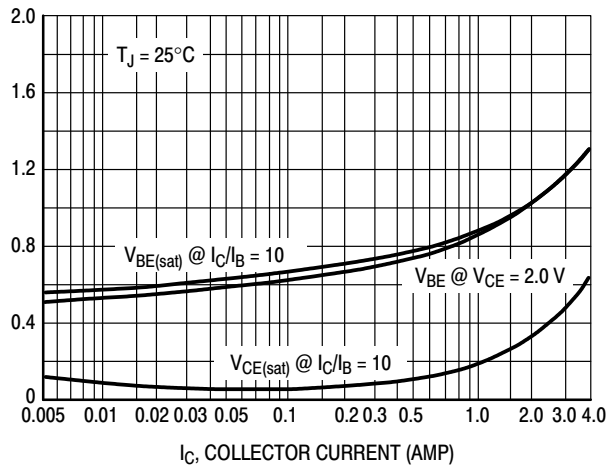


Figure 3. "On" Voltages

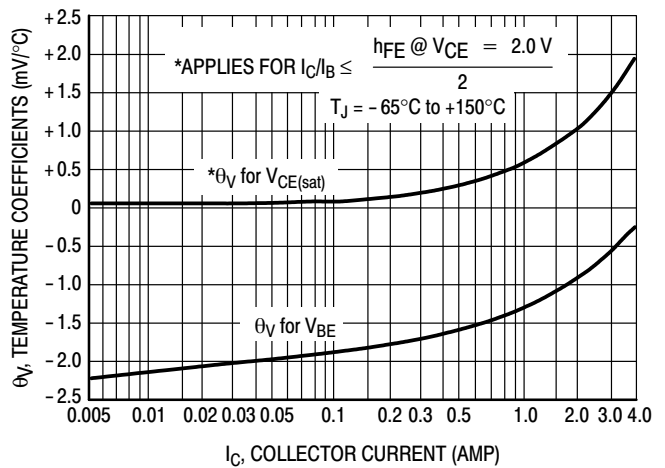


Figure 4. Temperature Coefficients

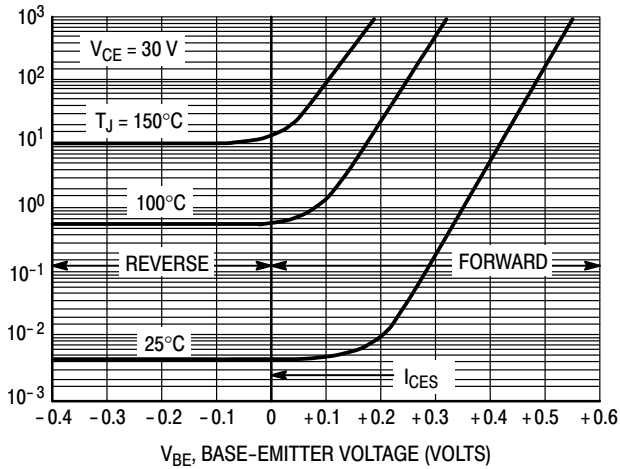


Figure 5. Collector Cut-Off Region

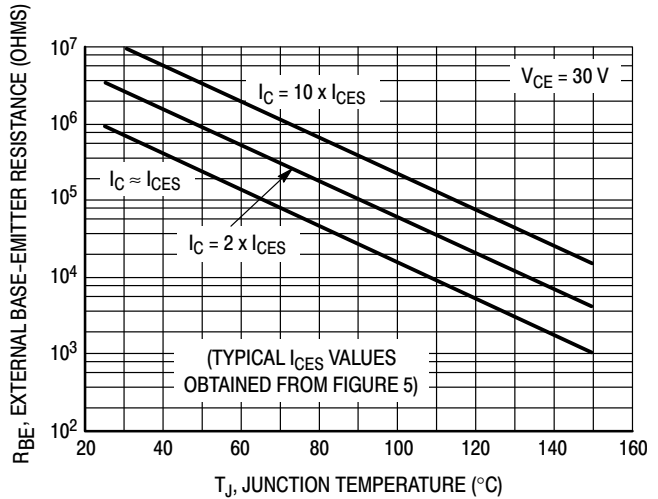


Figure 6. Effects of Base-Emitter Resistance

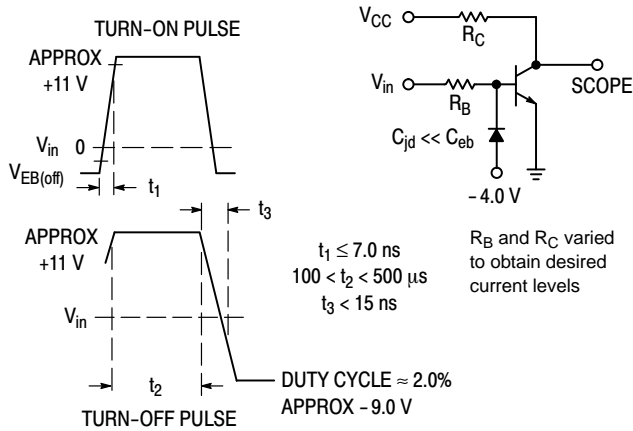


Figure 7. Switching Time Equivalent Test Circuit

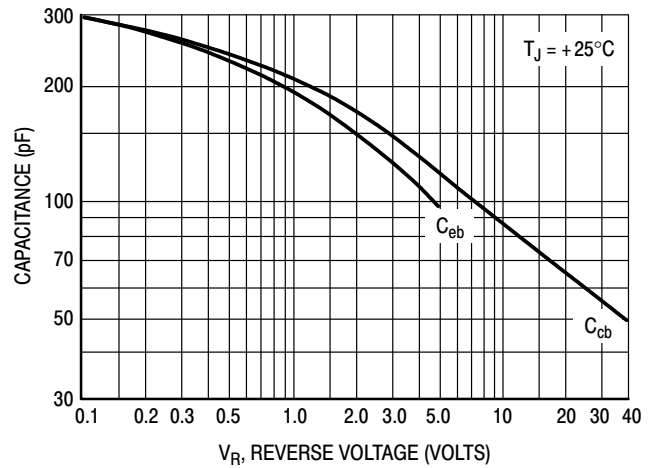


Figure 8. Capacitance

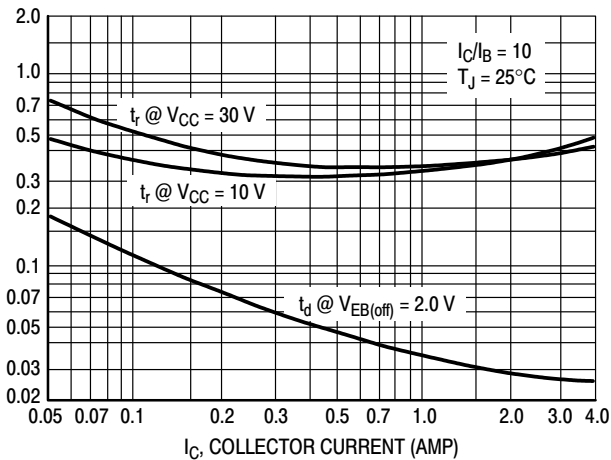


Figure 9. Turn-On Time

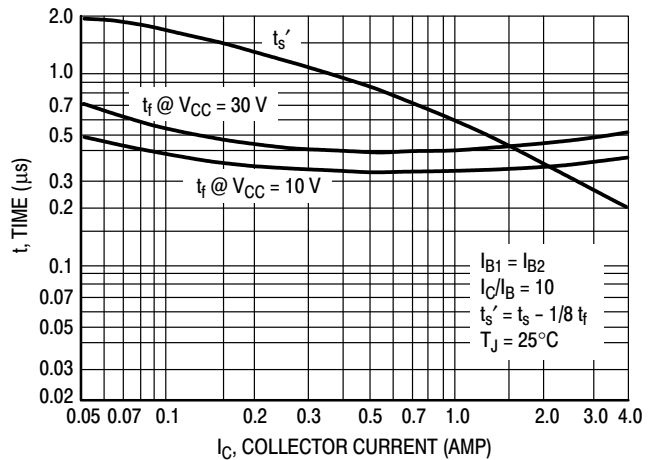
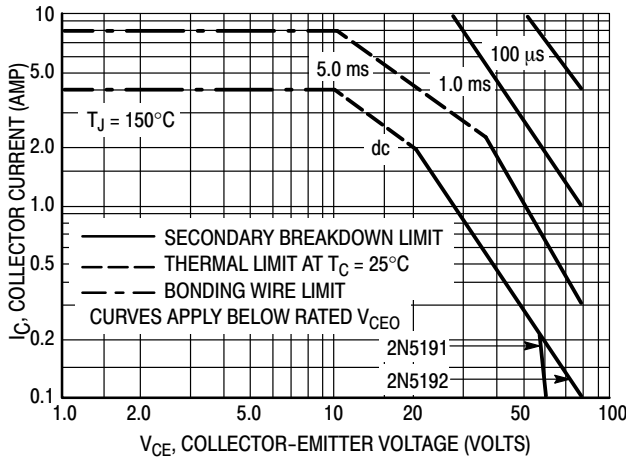


Figure 10. Turn-Off Time

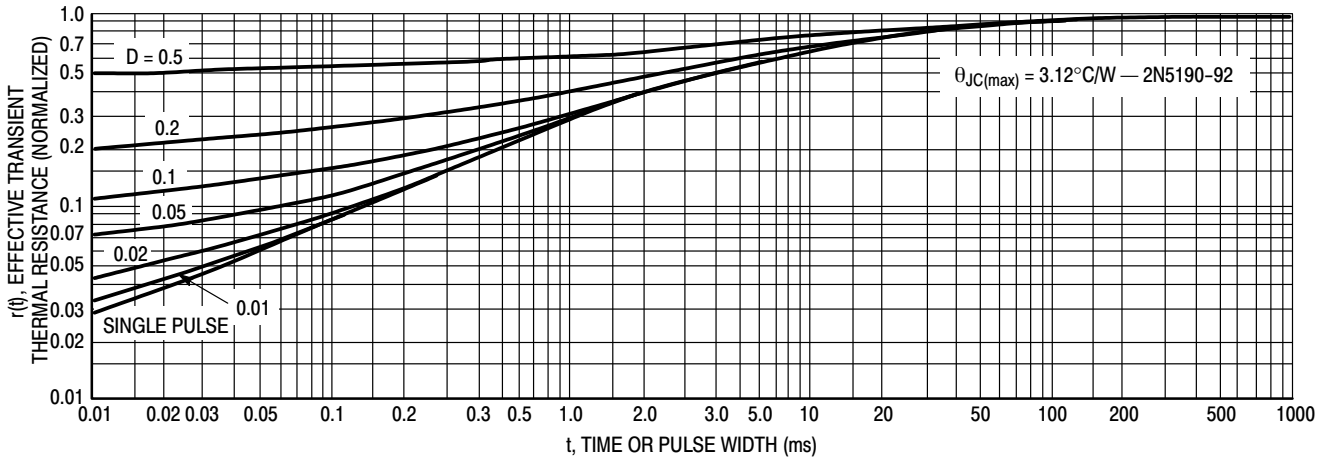
## 2N5190G, 2N5191G, 2N5192G



**Figure 11. Rating and Thermal Data Active-Region Safe Operating Area**

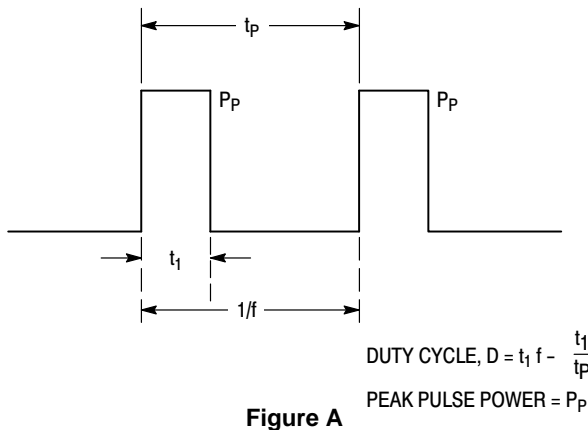
There are two limitations on the power handling ability of a transistor; average junction temperature and second breakdown. Safe operating area curves indicate  $I_C - V_{CE}$  limits of the transistor that must be observed for reliable operation; i.e., the transistor must not be subjected to greater dissipation than the curves indicate.

The data of Figure 11 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Second breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} \leq 150^\circ\text{C}$ . At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.



**Figure 12. Thermal Response**

### DESIGN NOTE: USE OF TRANSIENT THERMAL RESISTANCE DATA



**Figure A**

A train of periodical power pulses can be represented by the model shown in Figure A. Using the model and the device thermal response, the normalized effective transient thermal resistance of Figure 12 was calculated for various duty cycles.

To find  $\theta_{JC}(t)$ , multiply the value obtained from Figure 12 by the steady state value  $\theta_{JC}$ .

Example:

The 2N5190 is dissipating 50 watts under the following conditions:  $t_1 = 0.1$  ms,  $t_p = 0.5$  ms. ( $D = 0.2$ ).

Using Figure 12, at a pulse width of 0.1 ms and  $D = 0.2$ , the reading of  $r(t_1, D)$  is 0.27.

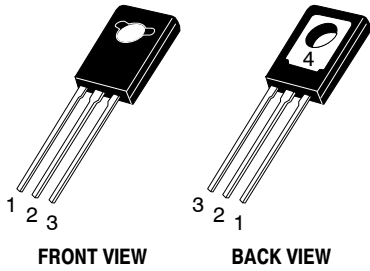
The peak rise in function temperature is therefore:

$$\Delta T = r(t) \times P_p \times \theta_{JC} = 0.27 \times 50 \times 3.12 = 42.2^\circ\text{C}$$

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

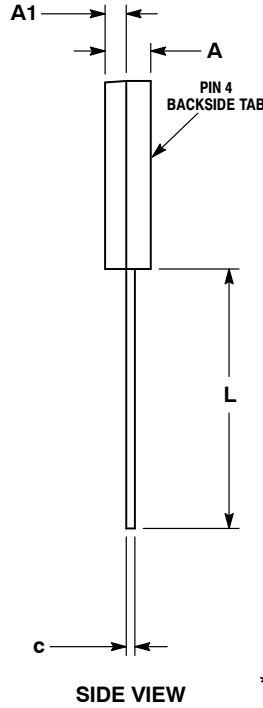
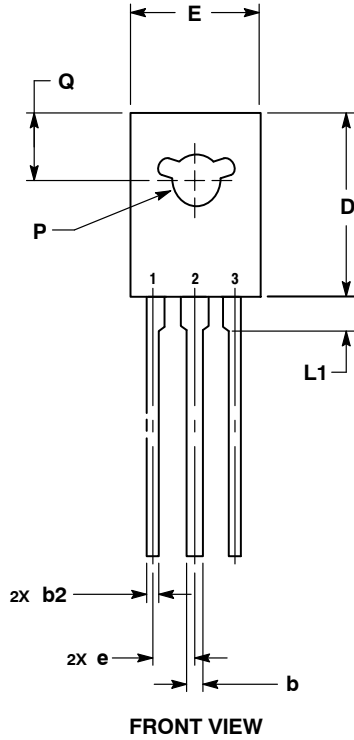
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**TO-225**  
CASE 77-09  
ISSUE AD

DATE 25 MAR 2015

SCALE 1:1

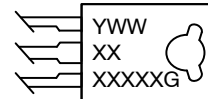


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. NUMBER AND SHAPE OF LUGS OPTIONAL.

| DIM | MILLIMETERS |       |
|-----|-------------|-------|
|     | MIN         | MAX   |
| A   | 2.40        | 3.00  |
| A1  | 1.00        | 1.50  |
| b   | 0.60        | 0.90  |
| b2  | 0.51        | 0.88  |
| c   | 0.39        | 0.63  |
| D   | 10.60       | 11.10 |
| E   | 7.40        | 7.80  |
| e   | 2.04        | 2.54  |
| L   | 14.50       | 16.63 |
| L1  | 1.27        | 2.54  |
| P   | 2.90        | 3.30  |
| Q   | 3.80        | 4.20  |

**GENERIC MARKING DIAGRAM\***



- Y = Year
- WW = Work Week
- XXXXX = Device Code
- G = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present.

- |   |   |   |   |   |
|---|---|---|---|---|
| <p>STYLE 1:<br/>PIN 1. EMITTER<br/>2., 4. COLLECTOR<br/>3. BASE</p> | <p>STYLE 2:<br/>PIN 1. CATHODE<br/>2., 4. ANODE<br/>3. GATE</p> | <p>STYLE 3:<br/>PIN 1. BASE<br/>2., 4. COLLECTOR<br/>3. EMITTER</p> | <p>STYLE 4:<br/>PIN 1. ANODE 1<br/>2., 4. ANODE 2<br/>3. GATE</p> | <p>STYLE 5:<br/>PIN 1. MT 1<br/>2., 4. MT 2<br/>3. GATE</p>     |
| <p>STYLE 6:<br/>PIN 1. CATHODE<br/>2., 4. GATE<br/>3. ANODE</p>     | <p>STYLE 7:<br/>PIN 1. MT 1<br/>2., 4. GATE<br/>3. MT 2</p>     | <p>STYLE 8:<br/>PIN 1. SOURCE<br/>2., 4. GATE<br/>3. DRAIN</p>      | <p>STYLE 9:<br/>PIN 1. GATE<br/>2., 4. DRAIN<br/>3. SOURCE</p>    | <p>STYLE 10:<br/>PIN 1. SOURCE<br/>2., 4. DRAIN<br/>3. GATE</p> |

|                         |                    |  |
|-------------------------|--------------------|--|
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| <b>DESCRIPTION:</b>     | <b>TO-225</b>      | <b>PAGE 1 OF 1</b>   |

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