

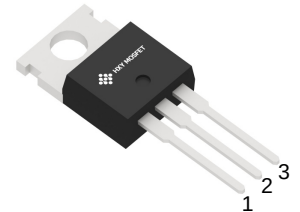


## Features

- High Current Gain Bandwidth Product
- These Devices are Pb-Free and are RoHS Compliant

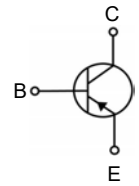
## Maximum Ratings (Ta=25°C unless otherwise noted)

| Symbol          | Parameter                                        | Value    | Unit |
|-----------------|--------------------------------------------------|----------|------|
| $V_{CBO}$       | Collector-Base Voltage                           | -100     | V    |
| $V_{CEO}$       | Collector-Emitter Voltage                        | -100     | V    |
| $V_{EBO}$       | Emitter-Base Voltage                             | -5       | V    |
| $I_C$           | Collector Current                                | -6       | A    |
| $P_D$           | Total Device Dissipation                         | 65       | W    |
| $R_{\theta JC}$ | Thermal Resistance, Junction to Case             | 1.92     | °C/W |
| $T_J, T_{stg}$  | Operation Junction and Storage Temperature Range | -65~+150 | °C   |



1.BASE  
2.COLLECTOR  
3.EMITTER

## TO-220C



## Electrical Characteristics (Ta=25°C unless otherwise specified)

| Characteristic                                                                                                   | Symbol         | Min      | Max | Unit |
|------------------------------------------------------------------------------------------------------------------|----------------|----------|-----|------|
| Collector-Emitter Sustaining Voltage (Note 1)<br>( $I_C = -30$ mAdc, $I_B = 0$ )                                 | $V_{CEO(sus)}$ | 100      |     | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = -60$ Vdc, $I_B = 0$ )                                                    | $I_{CEO}$      |          | 0.7 | mAdc |
| Collector Cutoff Current<br>( $V_{CE} = -100$ Vdc, $V_{EB} = 0$ )                                                | $I_{CES}$      |          | 400 | μAdc |
| Emitter Cutoff Current<br>( $V_{BE} = -5.0$ Vdc, $I_C = 0$ )                                                     | $I_{EBO}$      |          | 1.0 | mAdc |
| DC Current Gain (Note 1)<br>( $I_C = -0.3$ Adc, $V_{CE} = -4.0$ Vdc)<br>( $I_C = -3.0$ Adc, $V_{CE} = -4.0$ Vdc) | $h_{FE}$       | 30<br>15 |     |      |
| Collector-Emitter Saturation Voltage (Note 1)<br>( $I_C = -6.0$ Adc, $I_B = -1.0$ Adc)                           | $V_{CE(sat)}$  |          | 1.5 | Vdc  |
| Base-Emitter On Voltage (Note 1)<br>( $I_C = -6.0$ Adc, $V_{CE} = -4.0$ Vdc)                                     | $V_{BE(on)}$   |          | 2.0 | Vdc  |
| Current-Gain – Bandwidth Product (Note 2)<br>( $I_C = -500$ mAdc, $V_{CE} = -10$ Vdc, $f_{test} = 1.0$ MHz)      | $f_T$          | 3.0      |     | MHz  |
| Small-Signal Current Gain<br>( $I_C = -0.5$ Adc, $V_{CE} = -10$ Vdc, $f = 1.0$ kHz)                              | $h_{fe}$       | 20       |     |      |

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.

1. Pulse Test: Pulswidth  $\leq 300$  μs, Duty Cycle  $\leq 2.0\%$ .

2.  $f_T = h_{fe} \cdot f_{test}$



## Typical Characteristics

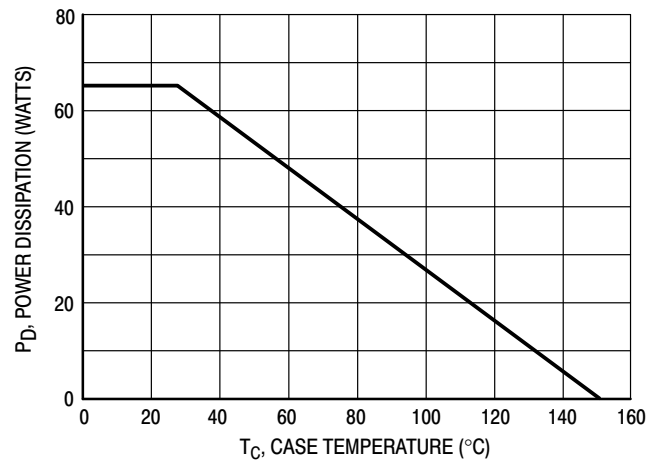


Figure 1. Power Derating

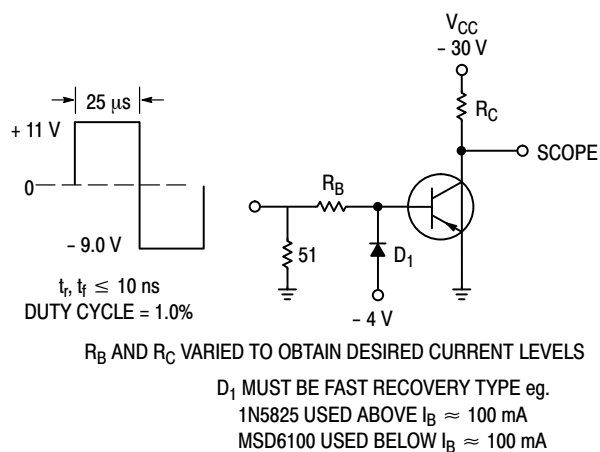


Figure 2. Switching Time Test Circuit

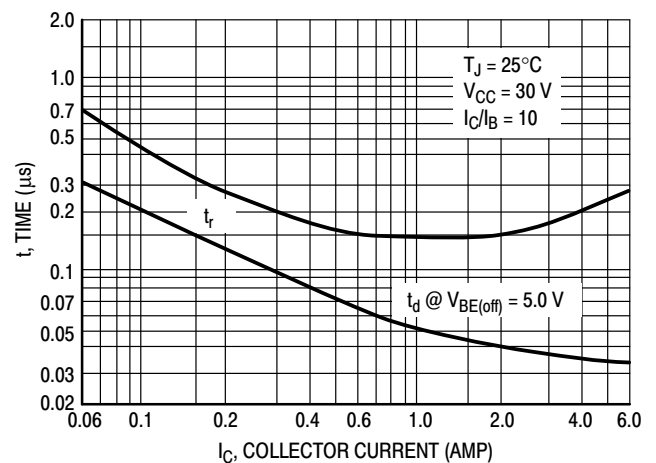


Figure 3. Turn-On Time

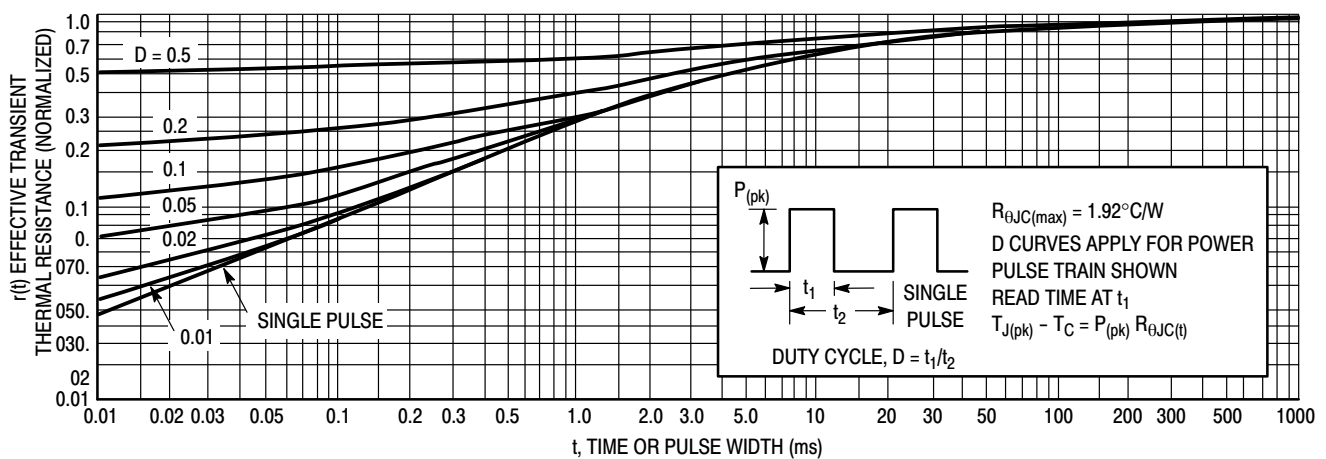


Figure 4. Thermal Response

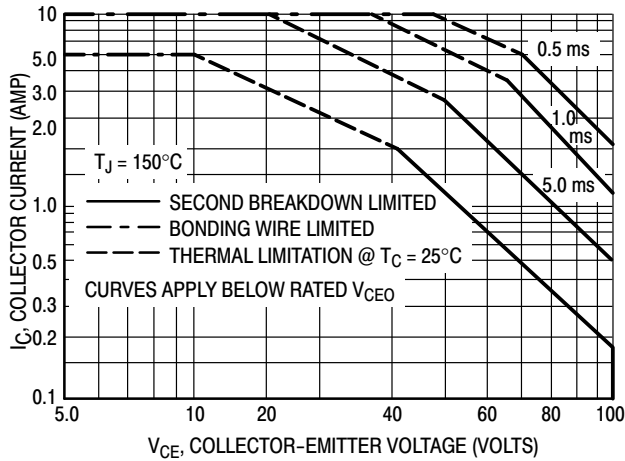


Figure 5. Active Region Safe Operating Area

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 5 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  $T_{J(pk)} \leq 150^\circ\text{C}$ ,  $T_{J(pk)}$  may be calculated from the data in Figure 4. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

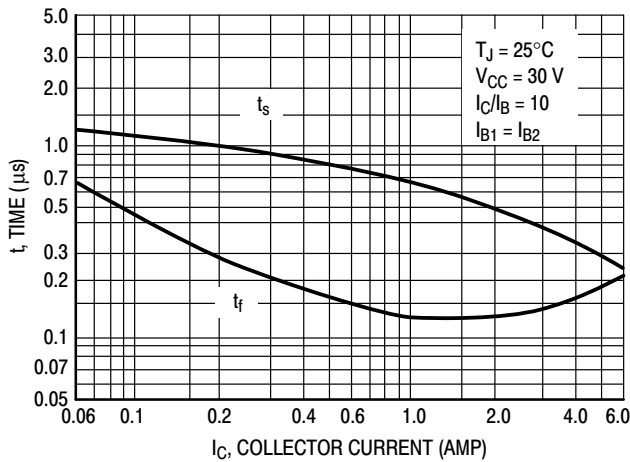


Figure 6. Turn-Off Time

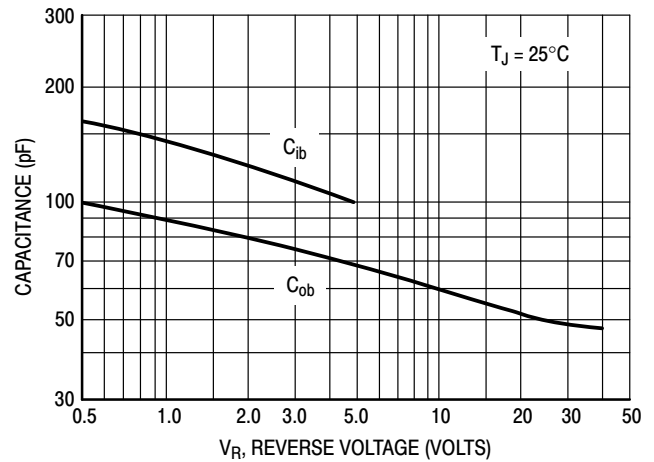


Figure 7. Capacitance

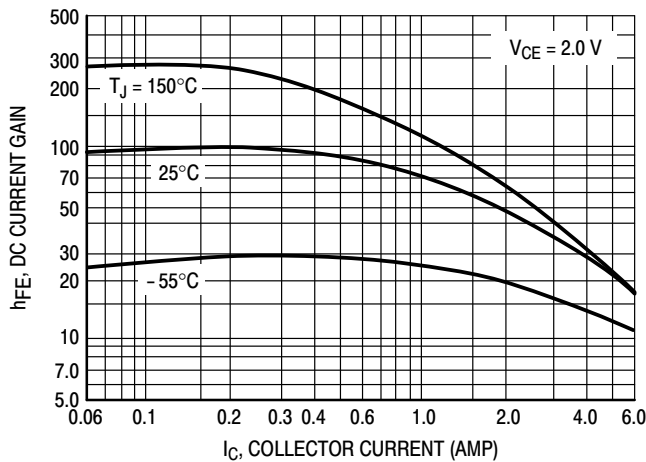


Figure 8. DC Current Gain

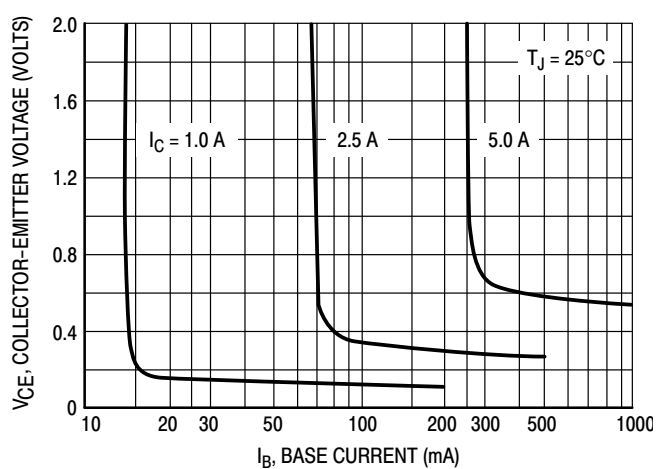


Figure 9. Collector Saturation Region

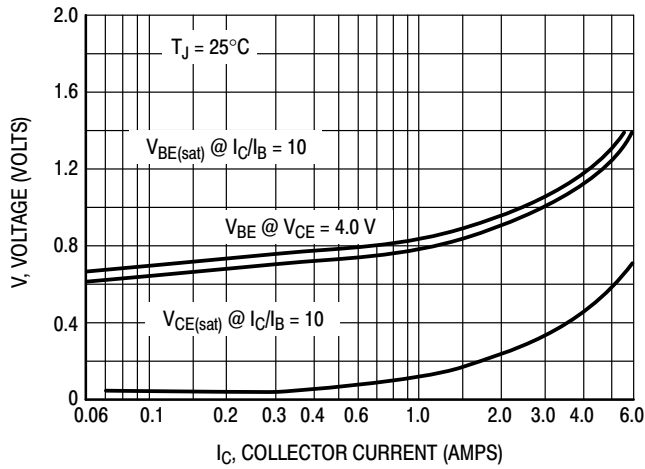


Figure 10. "On" Voltages

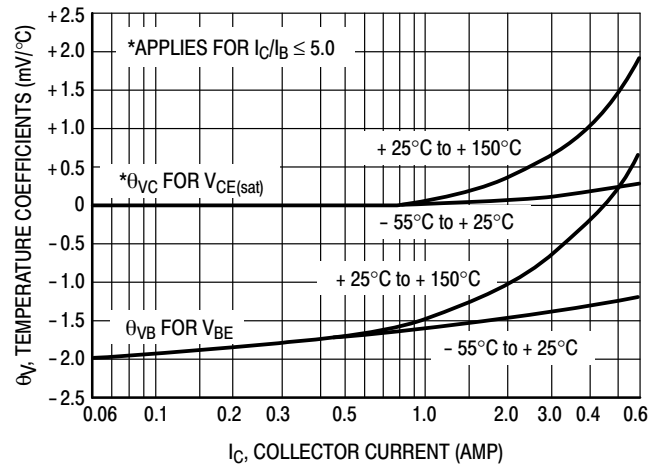


Figure 11. Temperature Coefficients

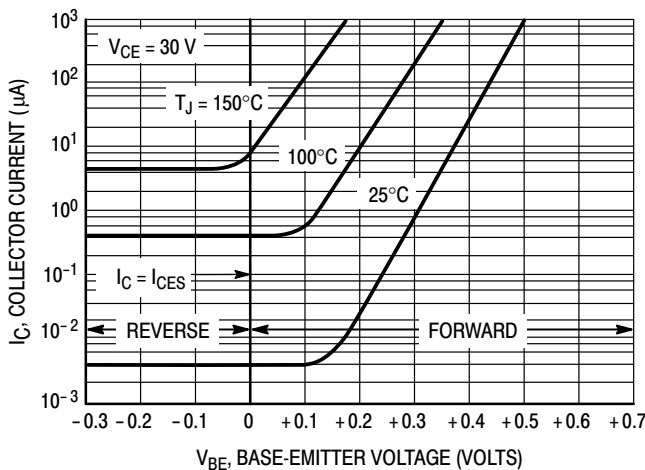


Figure 12. Collector Cut-Off Region

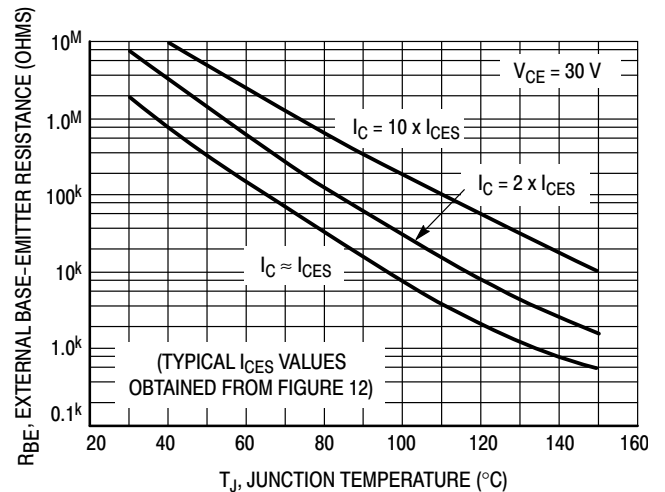
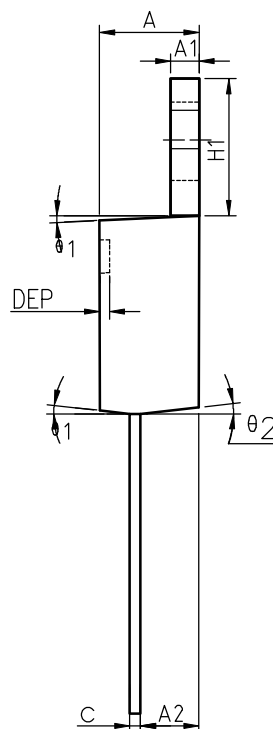
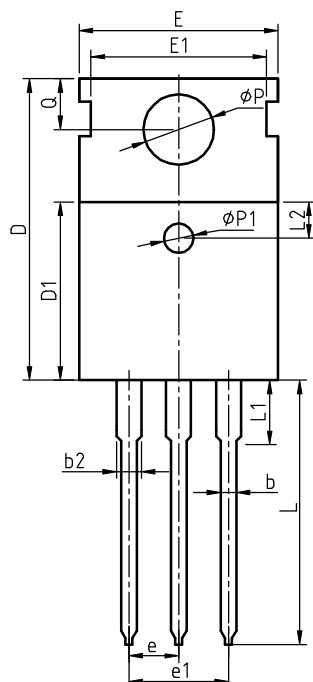


Figure 13. Effects of Base-Emitter Resistance

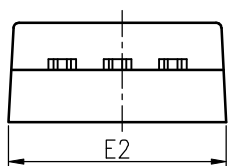


## Package Information TO-220C



COMMON DIMENSIONS

| SYMBOL | MIN   | NOM   | MAX   | MIN   | NOM   | MAX   |
|--------|-------|-------|-------|-------|-------|-------|
| A      | 4.40  | 4.57  | 4.70  | 0.173 | 0.180 | 0.185 |
| A1     | 1.27  | 1.30  | 1.33  | 0.050 | 0.051 | 0.052 |
| A2     | 2.35  | 2.40  | 2.50  | 0.093 | 0.094 | 0.098 |
| b      | 0.77  | 0.80  | 0.90  | 0.030 | 0.031 | 0.035 |
| b2     | 1.17  | 1.27  | 1.36  | 0.046 | 0.050 | 0.054 |
| c      | 0.48  | 0.50  | 0.56  | 0.019 | 0.020 | 0.022 |
| D      | 15.40 | 15.60 | 15.80 | 0.606 | 0.614 | 0.622 |
| D1     | 9.00  | 9.10  | 9.20  | 0.354 | 0.358 | 0.362 |
| DEP    | 0.05  | 0.10  | 0.20  | 0.002 | 0.004 | 0.008 |
| E      | 9.80  | 10.00 | 10.20 | 0.386 | 0.394 | 0.402 |
| E1     | -     | 8.70  | -     | -     | 0.343 | -     |
| E2     | 9.80  | 10.00 | 10.20 | 0.386 | 0.394 | 0.402 |
| e      |       | 2.54  | BSC   |       | 0.100 | BSC   |
| e1     |       | 5.08  | BSC   |       | 0.200 | BSC   |
| H1     | 6.40  | 6.50  | 6.60  | 0.252 | 0.256 | 0.260 |
| L      | 12.75 | 13.50 | 13.65 | 0.502 | 0.531 | 0.537 |
| L1     | -     | 3.10  | 3.30  | -     | 0.122 | 0.130 |
| L2     |       | 2.50  | REF   |       | 0.098 | REF   |
| P      | 3.50  | 3.60  | 3.63  | 0.138 | 0.142 | 0.143 |
| P1     | 3.50  | 3.60  | 3.63  | 0.138 | 0.142 | 0.143 |
| Q      | 2.73  | 2.80  | 2.87  | 0.107 | 0.110 | 0.113 |
| θ 1    | 5°    | 7°    | 9°    | 5°    | 7°    | 9°    |
| θ 2    | 1°    | 3°    | 5°    | 1°    | 3°    | 5°    |
| θ 3    | 1°    | 3°    | 5°    | 1°    | 3°    | 5°    |





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