

# BUL642D2

## High Speed, High Gain Bipolar NPN Transistor with Integrated Collector-Emitter and Built-in Efficient Antisaturation Network

The BUL642D2 is a state-of-the-art High Speed High Gain Bipolar Transistor (H2BIP). Tight dynamic characteristics and lot to lot minimum spread (150 ns on storage time) make it ideally suitable for Light Ballast Application. A new development process brings avalanche energy capability, making the device extremely rugged.

### Features

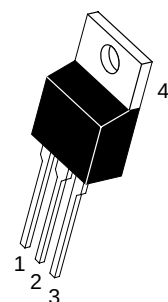
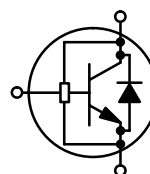
- Low Base Drive Requirement
- High Peak DC Current Gain (55 Typical) @  $I_C = 300 \text{ mA}/5 \text{ V}$
- Extremely Low Storage Time Min/Max Guarantees Due to the H2BIP Structure which Minimizes the Spread
- Integrated Collector-Emitter Free Wheeling Diode
- Fully Characterized Dynamic  $V_{CEsat}$
- "Six Sigma" Process Providing Tight and Reproducible Parameter Spreads
- Avalanche Energy 20 mJ Typical Capability
- Pb-Free Package is Available\*



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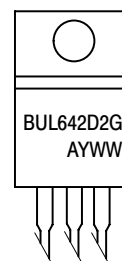
<http://onsemi.com>

**3 AMPERES  
825 VOLTS  
75 WATTS  
POWER TRANSISTOR**



TO-220AB  
CASE 221A  
STYLE 1

### MARKING DIAGRAM



BUL642D2 = Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

| Device    | Package             | Shipping      |
|-----------|---------------------|---------------|
| BUL642D2  | TO-220              | 50 Units/Rail |
| BUL642D2G | TO-220<br>(Pb-Free) | 50 Units/Rail |

\*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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## MAXIMUM RATINGS

| Rating                                                                                   | Symbol            | Value       | Unit                     |
|------------------------------------------------------------------------------------------|-------------------|-------------|--------------------------|
| Collector-Emitter Sustaining Voltage                                                     | $V_{CEO}$         | 440         | Vdc                      |
| Collector-Base Breakdown Voltage                                                         | $V_{CES}$         | 825         | Vdc                      |
| Emitter-Base Voltage                                                                     | $V_{EBO}$         | 11          | Vdc                      |
| Collector Current<br>– Continuous<br>– Peak (Note 1)                                     | $I_C$<br>$I_{CM}$ | 3.0<br>8.0  | Adc                      |
| Base Current<br>– Continuous<br>– Peak (Note 1)                                          | $I_B$<br>$I_{BM}$ | 2.0<br>4.0  | Adc                      |
| *Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>*Derate above $25^\circ\text{C}$ | $P_D$             | 75<br>0.6   | W<br>W/ $^\circ\text{C}$ |
| Operating and Storage Temperature                                                        | $T_J, T_{stg}$    | –65 to +150 | $^\circ\text{C}$         |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

## TYPICAL GAIN

| Rating                                                    | Symbol   | Value | Unit |
|-----------------------------------------------------------|----------|-------|------|
| Typical Gain @ $I_C = 1\text{ A}$ , $V_{CE} = 2\text{ V}$ | $h_{FE}$ | 45    | –    |
| Typical A, $V_{CE} = 1\text{ V}$                          | $h_{FE}$ | 50    | –    |

## THERMAL CHARACTERISTICS

| Characteristic                                                                   | Symbol          | Value | Unit               |
|----------------------------------------------------------------------------------|-----------------|-------|--------------------|
| Thermal Resistance, Junction-to-Case                                             | $R_{\theta JC}$ | 1.6   | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient                                          | $R_{\theta JA}$ | 62.5  | $^\circ\text{C/W}$ |
| Maximum Lead Temperature for Soldering Purposes: 1/8 in. from Case for 5 seconds | $T_L$           | 260   | $^\circ\text{C}$   |

1. Pulse Test: Pulse Width = 5.0 ms, Duty Cycle = 10%

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

| Characteristic | Symbol | Min | Typ | Max | Unit |
|----------------|--------|-----|-----|-----|------|
|----------------|--------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                                                                                              |                                                     |                       |        |        |             |      |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------|--------|--------|-------------|------|
| Collector–Emitter Sustaining Voltage<br>(I <sub>C</sub> = 200 mA, L = 25 mH)                 |                                                     | V <sub>CEO(sus)</sub> | 440    | –      | –           | Vdc  |
| Collector–Base Breakdown Voltage<br>(I <sub>CBO</sub> = 1 mA)                                |                                                     | V <sub>CBO</sub>      | 825    | –      | –           | Vdc  |
| Emitter–Base Breakdown Voltage<br>(I <sub>EBO</sub> = 1 mA)                                  |                                                     | V <sub>EBO</sub>      | 11     | –      | –           | Vdc  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = Rated V <sub>CEO</sub> , I <sub>B</sub> = 0)  | @ T <sub>C</sub> = 25°C<br>@ T <sub>C</sub> = 125°C | I <sub>CEO</sub>      | –<br>– | –<br>– | 200<br>1000 | μAdc |
| Collector Cutoff Current<br>(V <sub>CE</sub> = Rated V <sub>CES</sub> , V <sub>EB</sub> = 0) | @ T <sub>C</sub> = 25°C<br>@ T <sub>C</sub> = 125°C | I <sub>CES</sub>      | –<br>– | –<br>– | 100<br>1000 | μAdc |
| Emitter–Cutoff Current<br>(V <sub>EB</sub> = 10 Vdc, I <sub>C</sub> = 0)                     |                                                     | I <sub>EBO</sub>      | –      | –      | 100         | μAdc |

### ON CHARACTERISTICS

|                                                                                                                                                |               |          |        |            |     |
|------------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------|--------|------------|-----|
| Base-Emitter Saturation Voltage<br>( $I_C = 0.5\text{ Adc}$ , $I_B = 100\text{ mAdc}$<br>( $I_C = 1\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ )     | $V_{BE(sat)}$ | –<br>–   | –<br>– | 1.1<br>1.5 | Vdc |
| Collector-Emitter Saturation Voltage<br>( $I_C = 0.5\text{ Adc}$ , $I_B = 50\text{ mAdc}$<br>( $I_C = 2\text{ Adc}$ , $I_B = 0.2\text{ Adc}$ ) | $V_{CE(sat)}$ | –<br>–   | –<br>– | 0.5<br>1.5 | Vdc |
| DC Current Gain<br>( $I_C = 0.5\text{ Adc}$ , $V_{CE} = 1\text{ Vdc}$<br>( $I_C = 0.5\text{ Adc}$ , $V_{CE} = 3\text{ Vdc}$ )                  | $h_{FE}$      | 16<br>18 | –<br>– | –<br>–     | –   |

### DYNAMIC SATURATION VOLTAGE

|                             |                                                                                  |                          |                                                           |                |        |            |        |   |
|-----------------------------|----------------------------------------------------------------------------------|--------------------------|-----------------------------------------------------------|----------------|--------|------------|--------|---|
| Dynamic Saturation Voltage: | $I_C = 0.5\text{ Adc}$<br>$I_{B1} = 50\text{ mAdc}$<br>$V_{CC} = 125\text{ Vdc}$ | @ $1\text{ }\mu\text{s}$ | @ $T_C = 25^\circ\text{C}$<br>@ $T_C = 125^\circ\text{C}$ | $V_{CE(dsat)}$ | –<br>– | 2.0<br>5.0 | –<br>– | V |
|                             |                                                                                  | @ $3\text{ }\mu\text{s}$ | @ $T_C = 25^\circ\text{C}$                                |                | –<br>– | 0.2<br>1.3 | –<br>– |   |
|                             | $I_C = 1\text{ Adc}$<br>$I_{B1} = 100\text{ mAdc}$<br>$V_{CC} = 300\text{ Vdc}$  | @ $1\text{ }\mu\text{s}$ | @ $T_C = 25^\circ\text{C}$<br>@ $T_C = 125^\circ\text{C}$ |                | –<br>– | 4.5<br>10  | –<br>– |   |
|                             |                                                                                  | @ $3\text{ }\mu\text{s}$ | @ $T_C = 25^\circ\text{C}$                                |                | –<br>– | 1.0<br>3.0 | –<br>– |   |
|                             |                                                                                  |                          |                                                           |                |        |            |        |   |
|                             |                                                                                  |                          |                                                           |                |        |            |        |   |

### DYNAMIC CHARACTERISTICS

|                                                                                               |          |   |     |      |     |
|-----------------------------------------------------------------------------------------------|----------|---|-----|------|-----|
| Current Gain Bandwidth $I_C = 0.5\text{ Adc}$ , $V_{CE} = 10\text{ Vdc}$ , $f = 1\text{ MHz}$ | $f_T$    | – | 13  | –    | MHz |
| Output Capacitance @ $V_{cb} = 10\text{ V}$ , $I_E = 0$ , $f = 1\text{ MHz}$                  | $C_{ob}$ | – | 70  | 150  | pF  |
| Input Capacitance @ $V_{EB} = 8\text{ V}$ , $f = 1\text{ MHz}$                                | $C_{ib}$ | – | 500 | 1000 | pF  |

### DIODE CHARACTERISTICS

|                                                                                         |          |        |            |            |   |
|-----------------------------------------------------------------------------------------|----------|--------|------------|------------|---|
| Forward Diode Voltage<br>( $I_{EC} = 0.5\text{ Adc}$ )<br>( $I_{EC} = 1.0\text{ Adc}$ ) | $V_{EC}$ | –<br>– | 0.8<br>1.0 | 1.5<br>2.0 | V |
|-----------------------------------------------------------------------------------------|----------|--------|------------|------------|---|

### SWITCHING CHARACTERISTICS: Resistive Load ( $D.C. \leq 10\%$ , Pulse Width = $70\text{ }\mu\text{s}$ )

|              |                          |       |   |     |      |               |
|--------------|--------------------------|-------|---|-----|------|---------------|
| Delay Time   | $I_C = 0.5\text{ Adc}$   | $t_d$ | – | 60  | 400  | ns            |
| Rise Time    | $I_{B1} = 45\text{ mA}$  | $t_r$ | – | 160 | 1100 | ns            |
| Storage Time | $I_{B2} = 500\text{ mA}$ | $t_s$ | – | 0.5 | 1400 | $\mu\text{s}$ |
| Fall Time    | $V_{CC} = 125\text{ V}$  | $t_f$ | – | 0.4 | 600  | ns            |

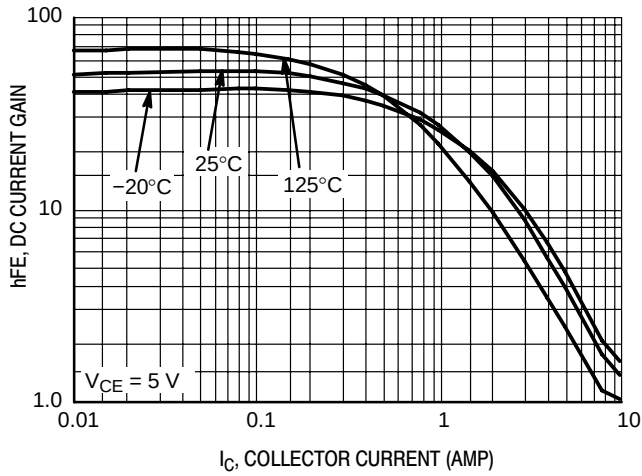


Figure 1. DC Current Gain

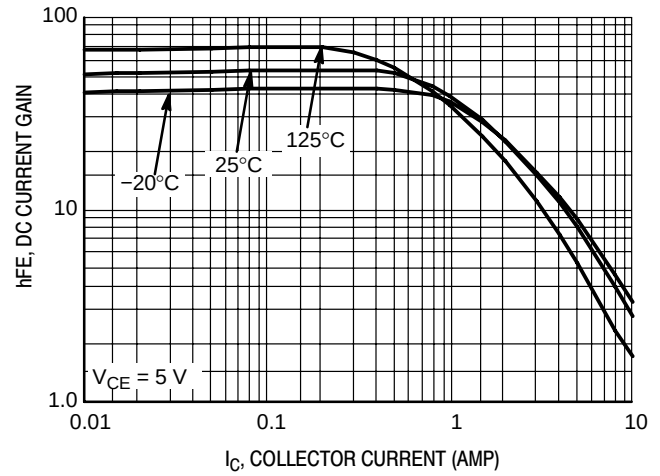


Figure 2. DC Current Gain

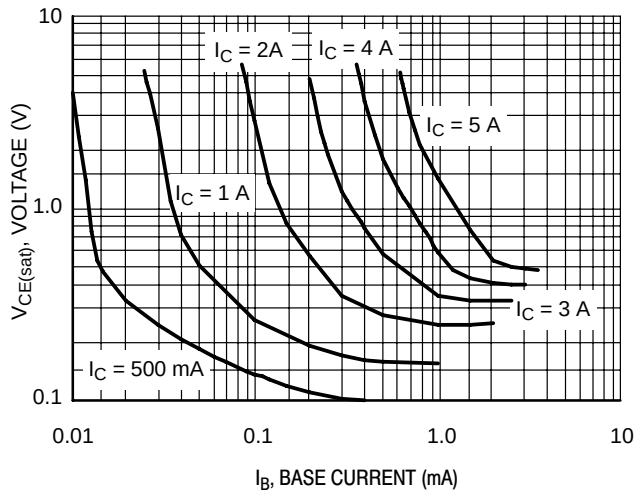


Figure 3. Collector Saturation Region

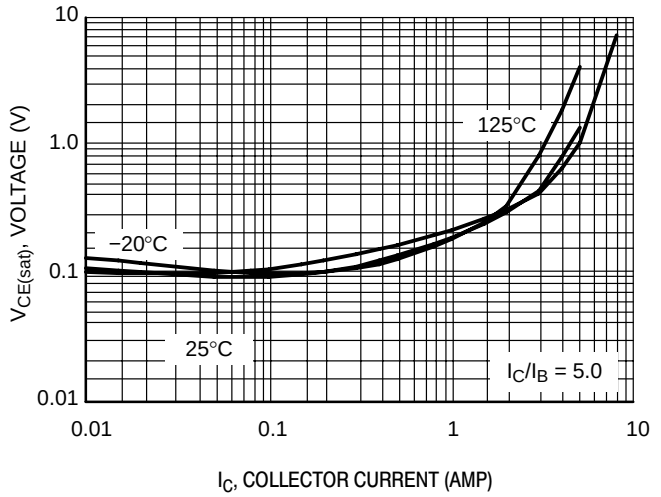


Figure 4. Collector-Emitter Saturation Voltage

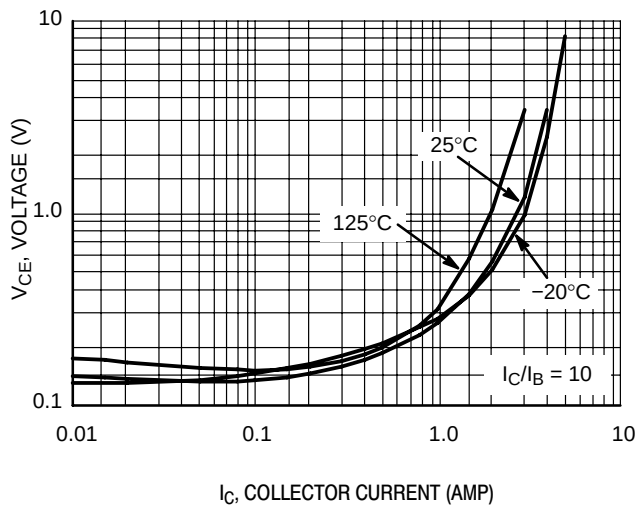


Figure 5. Collector-Emitter Saturation Voltage

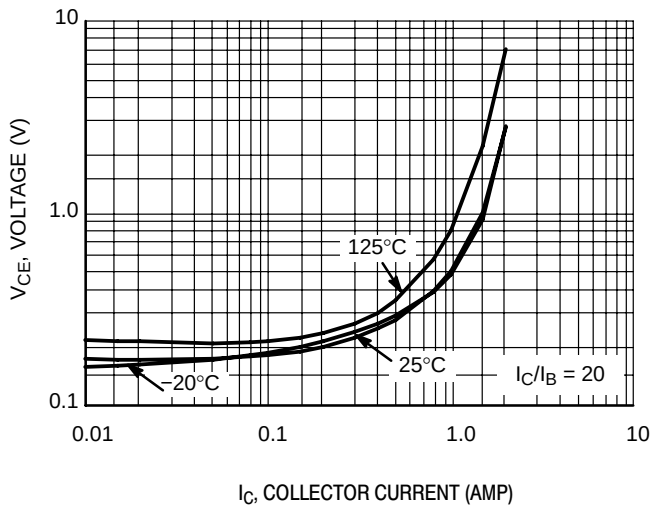


Figure 6. Collector-Emitter Saturation Voltage

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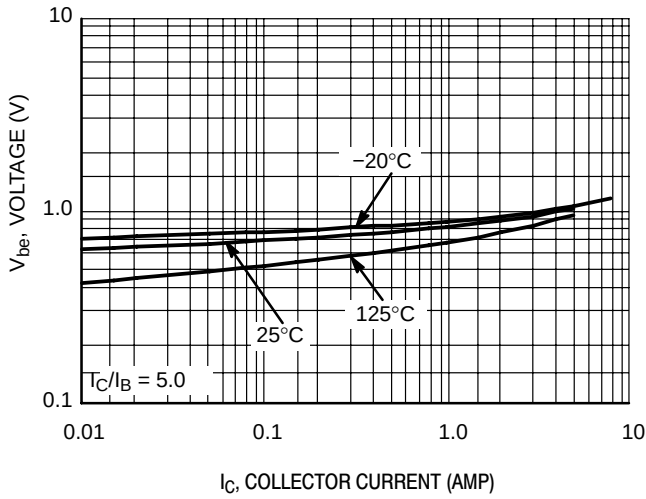


Figure 7. Base-Emitter Saturation Voltage

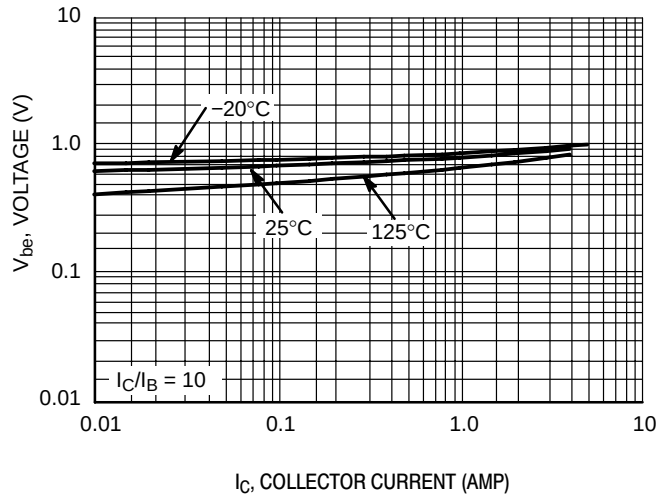


Figure 8. Base-Emitter Saturation Voltage

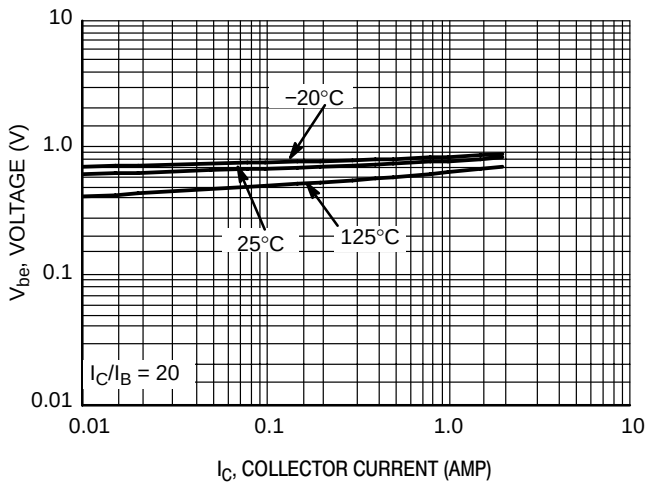


Figure 9. Base-Emitter Saturation Voltage

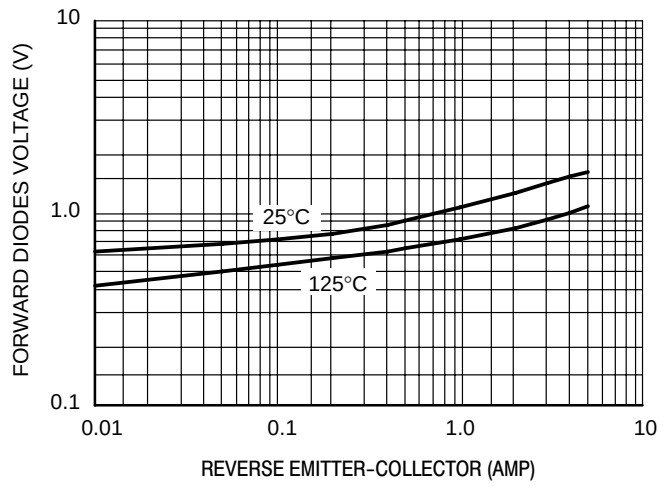


Figure 10. Forward Diode Voltage

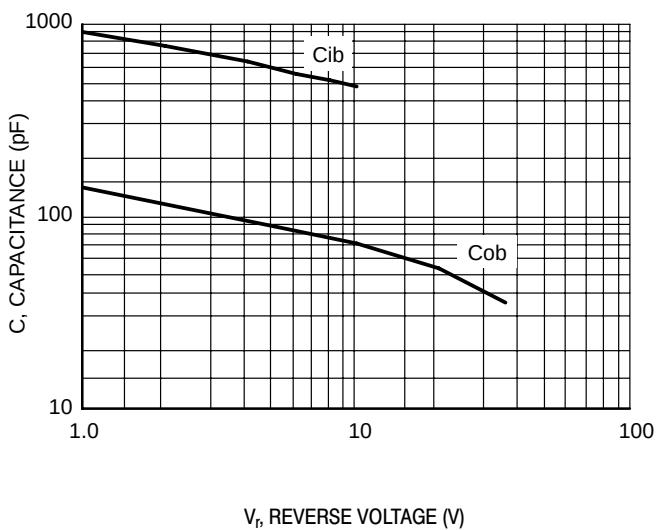


Figure 11. Capacitance

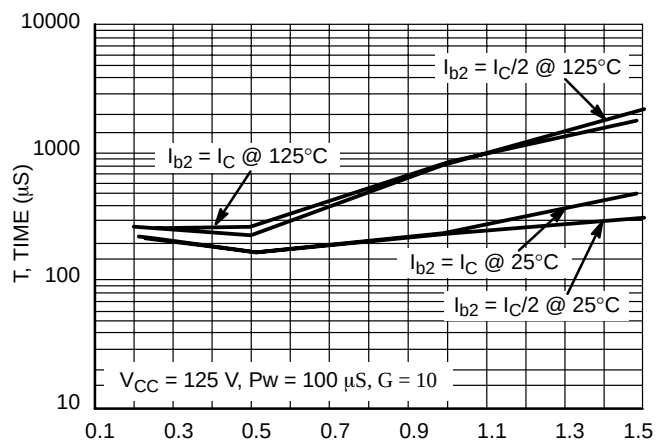


Figure 12. Resistive Switch Time, Storage Time  $T_{ON}$

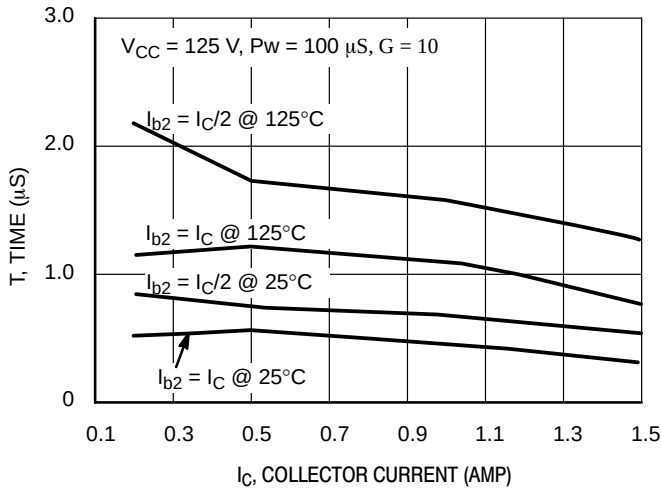


Figure 13. Resistive Switch Time, Storage Time

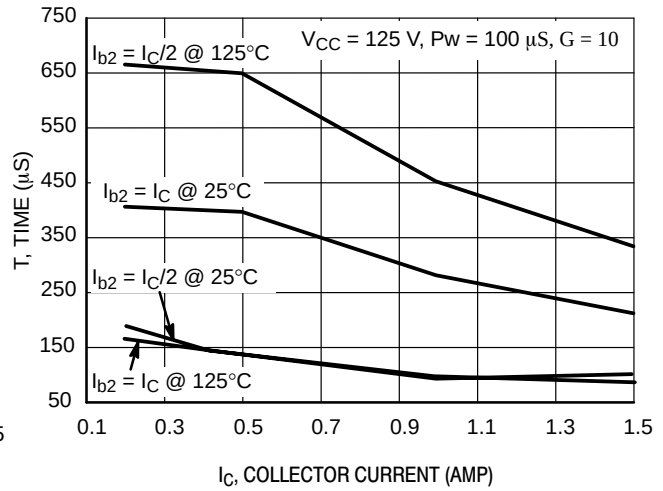


Figure 14. Resistive Switch Time, Fall Time

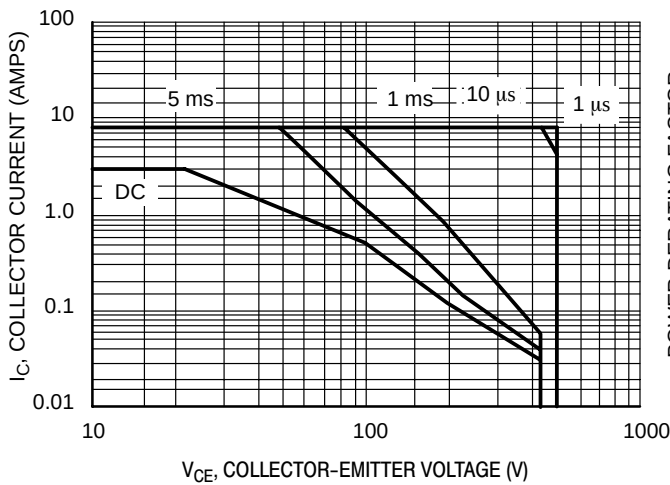


Figure 15.

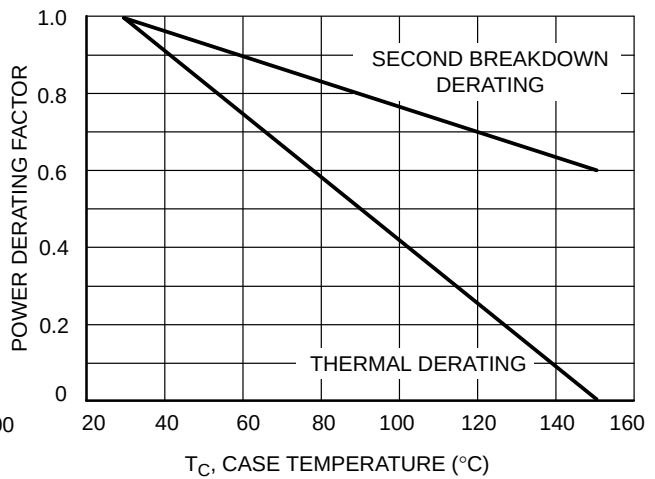


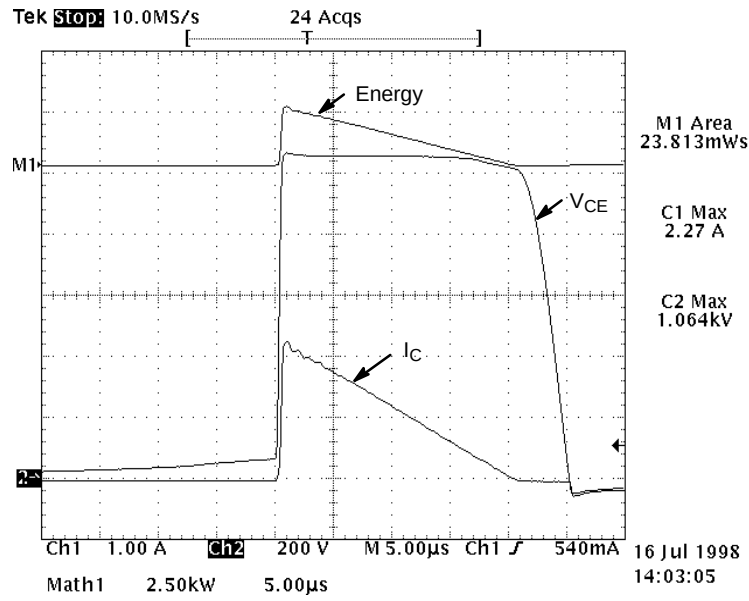
Figure 16. Power Derating

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 15 is based on  $T_C = 25^\circ\text{C}$ ;  $T_{j(pk)}$  is variable depending on power level. Second breakdown pulse limits do not derate like

thermal limitations. Allowable current at the voltages shown on Figure 10 may be found at any case temperature by using the appropriate curve on Figure 16.

$T_{j(pk)}$  may be calculated from the data in Figure 18. At any case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown.

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Figure 17. Typical Avalanche Energy Test/Waveforms

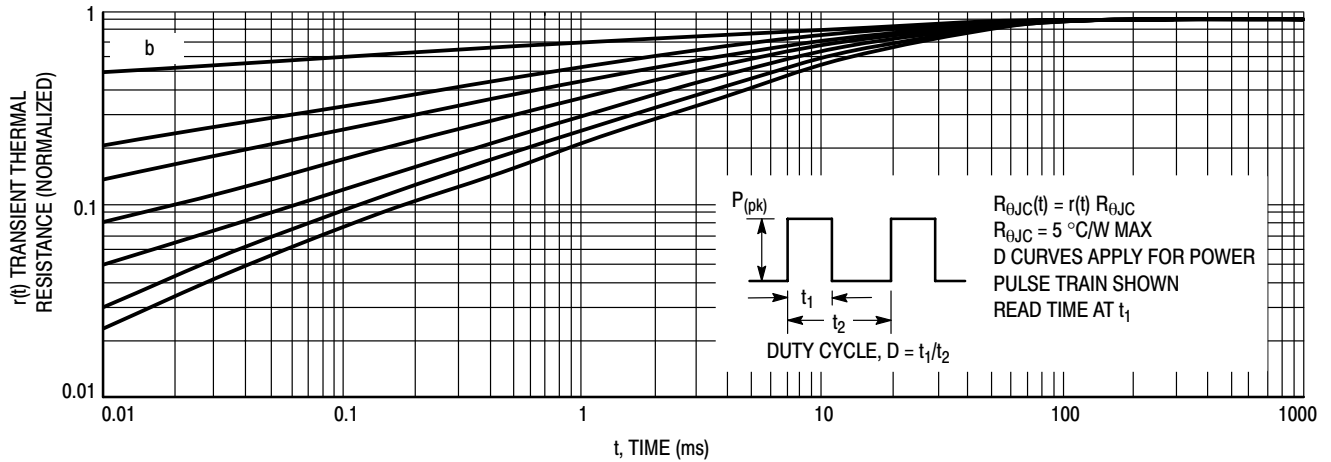


Figure 18. Thermal Response

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