

# BUH150G

## SWITCHMODE NPN Silicon Planar Power Transistor

The BUH150G has an application specific state-of-art die designed for use in 150 W Halogen electronic transformers.

This power transistor is specifically designed to sustain the large inrush current during either the startup conditions or under a short circuit across the load.

### Features

- Improved Efficiency Due to the Low Base Drive Requirements:  
High and Flat DC Current Gain  $h_{FE}$   
Fast Switching
- Robustness Due to the Technology Developed to Manufacture this Device
- ON Semiconductor Six Sigma Philosophy Provides Tight and Reproducible Parametric Distributions
- These Devices are Pb-Free and are RoHS Compliant\*

### MAXIMUM RATINGS

| Rating   | Symbol            | Value      | Unit                     |
|--|-------------------|------------|--------------------------|
| Collector-Emitter Sustaining Voltage   | $V_{CEO}$         | 400        | Vdc                      |
| Collector-Base Breakdown Voltage   | $V_{CBO}$         | 700        | Vdc                      |
| Collector-Emitter Breakdown Voltage  | $V_{CES}$         | 700        | Vdc                      |
| Emitter-Base Voltage   | $V_{EBO}$         | 10         | Vdc                      |
| Collector Current<br>– Continuous<br>– Peak (Note 1)                                   | $I_C$<br>$I_{CM}$ | 15<br>25   | Adc                      |
| Base Current<br>– Continuous<br>– Peak (Note 1)  | $I_B$<br>$I_{BM}$ | 6<br>12    | Adc                      |
| Total Device Dissipation @ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$ | $P_D$             | 150<br>1.2 | W<br>W/ $^\circ\text{C}$ |
| Operating and Storage Temperature  | $T_J, T_{stg}$    | -65 to 150 | $^\circ\text{C}$         |

### THERMAL CHARACTERISTICS

| Characteristics   | Symbol          | Max  | Unit               |
|---|-----------------|------|--------------------|
| Thermal Resistance, Junction-to-Case  | $R_{\theta JC}$ | 0.85 | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient   | $R_{\theta JA}$ | 62.5 | $^\circ\text{C/W}$ |
| Maximum Lead Temperature for Soldering<br>Purposes 1/8" from Case for 5 Seconds | $T_L$           | 260  | $^\circ\text{C}$   |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Pulse Test: Pulse Width = 5 ms, Duty Cycle  $\leq 10\%$ .

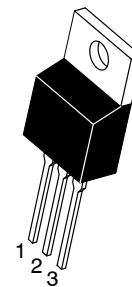
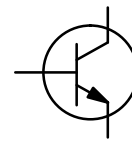
\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



ON Semiconductor®

<http://onsemi.com>

**POWER TRANSISTOR  
15 AMPERES  
700 VOLTS, 150 WATTS**



TO-220AB  
CASE 221A-09  
STYLE 1

### MARKING DIAGRAM



BUH150 = Device Code  
A = Assembly Location  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

| Device  | Package             | Shipping        |
|---------|---------------------|-----------------|
| BUH150G | TO-220<br>(Pb-Free) | 50 Units / Rail |

# BUH150G

## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

| Characteristic   | Symbol                | Min                      | Typ  | Max  | Unit |
|--|-----------------------|--------------------------|------|------|------|
| <b>OFF CHARACTERISTICS</b>   |                       |                          |      |      |      |
| Collector–Emitter Sustaining Voltage<br>(I <sub>C</sub> = 100 mA, L = 25 mH)                 | V <sub>CEO(sus)</sub> | 400                      | 460  |      | Vdc  |
| Collector–Base Breakdown Voltage<br>(I <sub>CBO</sub> = 1 mA)                                | V <sub>CBO</sub>      | 700                      | 860  |      | Vdc  |
| Emitter–Base Breakdown Voltage<br>(I <sub>EBO</sub> = 1 mA)                                  | V <sub>EBO</sub>      | 10                       | 12.3 |      | Vdc  |
| Collector Cutoff Current<br>(V <sub>CE</sub> = Rated V <sub>CEO</sub> , I <sub>B</sub> = 0)  | I <sub>CEO</sub>      |                          |      | 100  | μAdc |
| Collector Cutoff Current<br>(V <sub>CE</sub> = Rated V <sub>CES</sub> , V <sub>EB</sub> = 0) | I <sub>CES</sub>      | @ T <sub>C</sub> = 25°C  |      | 100  | μAdc |
|  |                       | @ T <sub>C</sub> = 125°C |      | 1000 |      |
| Collector Base Current<br>(V <sub>CB</sub> = Rated V <sub>CBO</sub> , V <sub>EB</sub> = 0)   | I <sub>CBO</sub>      | @ T <sub>C</sub> = 25°C  |      | 100  | μAdc |
|  |                       | @ T <sub>C</sub> = 125°C |      | 1000 |      |
| Emitter–Cutoff Current<br>(V <sub>EB</sub> = 9 Vdc, I <sub>C</sub> = 0)                      | I <sub>EBO</sub>      |                          |      | 100  | μAdc |

## ON CHARACTERISTICS

|  |                          |                          |      |      |     |
|--|--------------------------|--------------------------|------|------|-----|
| Base–Emitter Saturation Voltage<br>(I <sub>C</sub> = 10 Adc, I <sub>B</sub> = 2 Adc)       | V <sub>BE(sat)</sub>     |                          | 1    | 1.25 | Vdc |
| Collector–Emitter Saturation Voltage<br>(I <sub>C</sub> = 2 Adc, I <sub>B</sub> = 0.4 Adc) | V <sub>CE(sat)</sub>     | @ T <sub>C</sub> = 25°C  | 0.16 | 0.4  | Vdc |
|  |                          | @ T <sub>C</sub> = 125°C | 0.15 | 0.4  |     |
| (I <sub>C</sub> = 10 Adc, I <sub>B</sub> = 2 Adc)  |                          | @ T <sub>C</sub> = 25°C  | 0.45 | 1    |     |
| (I <sub>C</sub> = 20 Adc, I <sub>B</sub> = 4 Adc)  | @ T <sub>C</sub> = 25°C  | 2                        | 5    | Vdc  |     |
| DC Current Gain (I <sub>C</sub> = 20 Adc, V <sub>CE</sub> = 5 Vdc)                         | h <sub>FE</sub>          | @ T <sub>C</sub> = 25°C  | 4    | 7    | –   |
|  |                          | @ T <sub>C</sub> = 125°C | 2.5  | 4.5  |     |
| (I <sub>C</sub> = 10 Adc, V <sub>CE</sub> = 5 Vdc)   |                          | @ T <sub>C</sub> = 25°C  | 8    | 12   |     |
|  |                          | @ T <sub>C</sub> = 125°C | 6    | 10   |     |
| (I <sub>C</sub> = 2 Adc, V <sub>CE</sub> = 1 Vdc)  | @ T <sub>C</sub> = 25°C  | 12                       | 20   | –    |     |
|  | @ T <sub>C</sub> = 125°C | 14                       | 22   |      |     |
| (I <sub>C</sub> = 100 mAdc, V <sub>CE</sub> = 5 Vdc)                                       | @ T <sub>C</sub> = 25°C  | 10                       | 20   | –    |     |

## DYNAMIC SATURATION VOLTAGE

|  |   |                          |                       |     |   |
|--|---|--------------------------|-----------------------|-----|---|
| Dynamic Saturation Voltage:<br>Determined 3 μs after rising I <sub>B1</sub> reaches 90% of final I <sub>B1</sub> (see Figure 19) | I <sub>C</sub> = 5 Adc, I <sub>B1</sub> = 1 Adc<br>V <sub>CC</sub> = 300 V  | @ T <sub>C</sub> = 25°C  | V <sub>CE(dsat)</sub> | 1.5 | V |
|  |   | @ T <sub>C</sub> = 125°C |                       | 2.8 | V |
|  | I <sub>C</sub> = 10 Adc, I <sub>B1</sub> = 2 Adc<br>V <sub>CC</sub> = 300 V | @ T <sub>C</sub> = 25°C  | 2.4                   | V   |   |
|  |   | @ T <sub>C</sub> = 125°C | 5                     | V   |   |

## DYNAMIC CHARACTERISTICS

|   |                 |  |      |      |     |
|---|-----------------|--|------|------|-----|
| Current Gain Bandwidth<br>(I <sub>C</sub> = 1 Adc, V <sub>CE</sub> = 10 Vdc, f = 1 MHz) | f <sub>T</sub>  |  | 23   |      | MHz |
| Output Capacitance<br>(V <sub>CB</sub> = 10 Vdc, I <sub>E</sub> = 0, f = 1 MHz)         | C <sub>ob</sub> |  | 100  | 150  | pF  |
| Input Capacitance<br>(V <sub>EB</sub> = 8 Vdc, f = 1 MHz)                               | C <sub>ib</sub> |  | 1300 | 1750 | pF  |

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## ELECTRICAL CHARACTERISTICS (T<sub>C</sub> = 25°C unless otherwise noted)

| Characteristic   | Symbol  | Min                      | Typ              | Max          | Unit |    |
|--|---|--------------------------|------------------|--------------|------|----|
| <b>SWITCHING CHARACTERISTICS: Resistive Load</b> (D.C. ≤ 10%, Pulse Width = 40 μs) |   |                          |                  |              |      |    |
| Turn-on Time   | I <sub>C</sub> = 2 Adc, I <sub>B1</sub> = 0.2 Adc<br>I <sub>B2</sub> = 0.2 Adc<br>V <sub>CC</sub> = 300 Vdc | @ T <sub>C</sub> = 25°C  | t <sub>on</sub>  | 200          | 300  | ns |
| Storage Time   |   | @ T <sub>C</sub> = 25°C  | t <sub>s</sub>   | 5.3          | 6.5  | μs |
| Fall Time  |   | @ T <sub>C</sub> = 25°C  | t <sub>f</sub>   | 240          | 350  | ns |
| Turn-off Time  |   | @ T <sub>C</sub> = 25°C  | t <sub>off</sub> | 5.6          | 7    | μs |
| Turn-on Time   | I <sub>C</sub> = 2 Adc, I <sub>B1</sub> = 0.4 Adc<br>I <sub>B2</sub> = 0.4 Adc<br>V <sub>CC</sub> = 300 Vdc | @ T <sub>C</sub> = 25°C  | t <sub>on</sub>  | 100          | 200  | ns |
| Storage Time   |   | @ T <sub>C</sub> = 25°C  | t <sub>s</sub>   | 6.1          | 7.5  | μs |
| Fall Time  |   | @ T <sub>C</sub> = 25°C  | t <sub>f</sub>   | 320          | 500  | ns |
| Turn-off Time  |   | @ T <sub>C</sub> = 25°C  | t <sub>off</sub> | 6.5          | 8    | μs |
| Turn-on Time   | I <sub>C</sub> = 5 Adc, I <sub>B1</sub> = 0.5 Adc<br>I <sub>B2</sub> = 0.5 Adc<br>V <sub>CC</sub> = 300 Vdc | @ T <sub>C</sub> = 25°C  | t <sub>on</sub>  | 450          | 650  | ns |
| Turn-off Time  |   | @ T <sub>C</sub> = 125°C | t <sub>off</sub> | 2.5<br>3.9   | 3    | μs |
| Turn-on Time   | I <sub>C</sub> = 10 Adc, I <sub>B1</sub> = 2 Adc<br>I <sub>B2</sub> = 2 Adc<br>V <sub>CC</sub> = 300 Vdc    | @ T <sub>C</sub> = 25°C  | t <sub>on</sub>  | 500          | 700  | ns |
| Turn-off Time  |   | @ T <sub>C</sub> = 125°C | t <sub>off</sub> | 2.25<br>2.75 | 2.75 | μs |

## SWITCHING CHARACTERISTICS: Inductive Load (V<sub>clamp</sub> = 300 V, V<sub>CC</sub> = 15 V, L = 200 μH)

|                |  |                          |                 |             |      |    |
|----------------|--|--------------------------|-----------------|-------------|------|----|
| Fall Time      | I <sub>C</sub> = 2 Adc<br>I <sub>B1</sub> = 0.2 Adc<br>I <sub>B2</sub> = 0.2 Adc | @ T <sub>C</sub> = 25°C  | t <sub>fi</sub> | 110         | 250  | ns |
| Storage Time   |  | @ T <sub>C</sub> = 125°C | t <sub>si</sub> | 6.5<br>8    | 8    | μs |
| Crossover Time |  | @ T <sub>C</sub> = 25°C  | t <sub>c</sub>  | 235<br>240  | 350  | ns |
| Fall Time      | I <sub>C</sub> = 2 Adc<br>I <sub>B1</sub> = 0.4 Adc<br>I <sub>B2</sub> = 0.4 Adc | @ T <sub>C</sub> = 25°C  | t <sub>fi</sub> | 110         | 250  | ns |
| Storage Time   |  | @ T <sub>C</sub> = 125°C | t <sub>si</sub> | 6<br>7.8    | 7.5  | μs |
| Crossover Time |  | @ T <sub>C</sub> = 25°C  | t <sub>c</sub>  | 250<br>270  | 350  | ns |
| Fall Time      | I <sub>C</sub> = 5 Adc<br>I <sub>B1</sub> = 0.5 Adc<br>I <sub>B2</sub> = 0.5 Adc | @ T <sub>C</sub> = 25°C  | t <sub>fi</sub> | 110         | 150  | ns |
| Storage Time   |  | @ T <sub>C</sub> = 125°C | t <sub>si</sub> | 3.25<br>4.6 | 3.75 | μs |
| Crossover Time |  | @ T <sub>C</sub> = 25°C  | t <sub>c</sub>  | 275<br>450  | 350  | ns |
| Fall Time      | I <sub>C</sub> = 10 Adc<br>I <sub>B1</sub> = 2 Adc<br>I <sub>B2</sub> = 2 Adc    | @ T <sub>C</sub> = 25°C  | t <sub>fi</sub> | 110         | 175  | ns |
| Storage Time   |  | @ T <sub>C</sub> = 125°C | t <sub>si</sub> | 2.3<br>2.8  | 2.75 | μs |
| Crossover Time |  | @ T <sub>C</sub> = 25°C  | t <sub>c</sub>  | 250<br>475  | 350  | ns |

TYPICAL STATIC CHARACTERISTICS

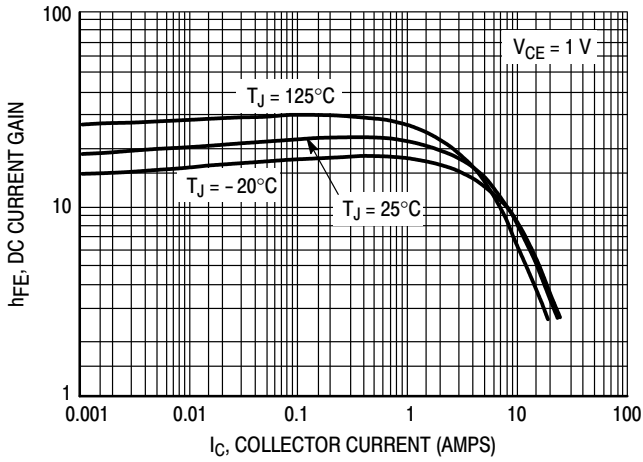


Figure 1. DC Current Gain @ 1 Volt

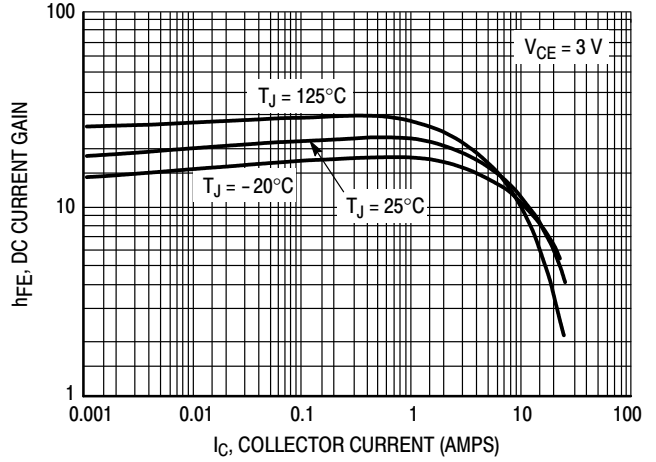


Figure 2. DC Current Gain @ 3 Volt

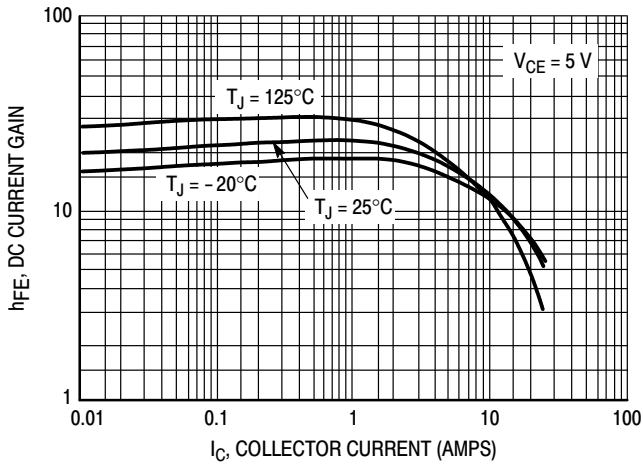


Figure 3. DC Current Gain @ 5 Volt

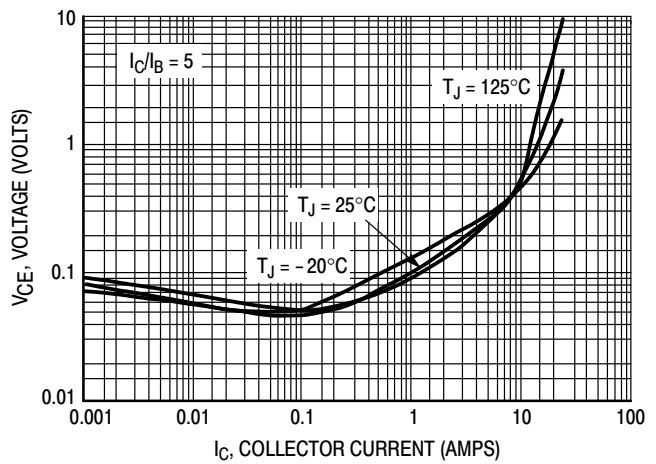


Figure 4. Collector-Emitter Saturation Voltage

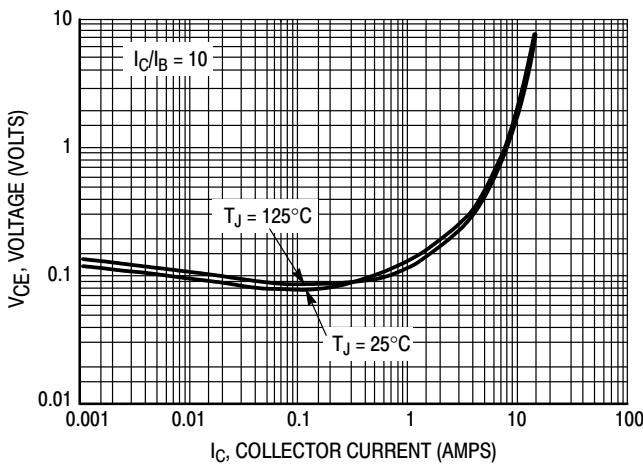


Figure 5. Collector-Emitter Saturation Voltage

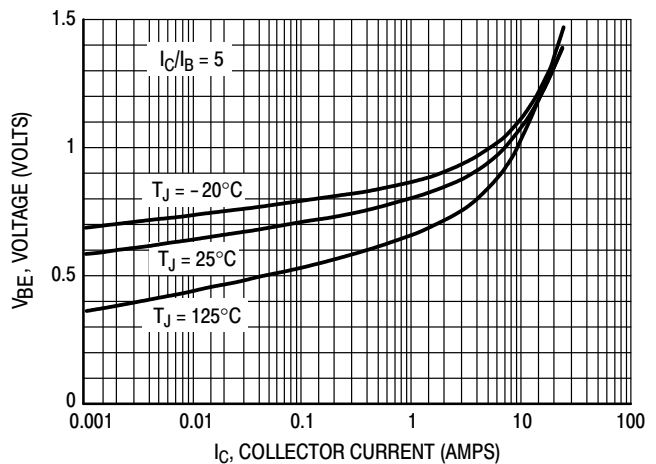


Figure 6. Base-Emitter Saturation Region

# BUH150G

## TYPICAL STATIC CHARACTERISTICS

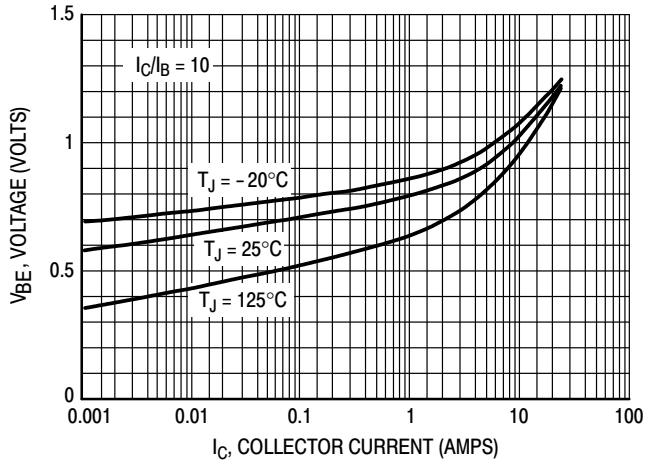


Figure 7. Base-Emitter Saturation Region

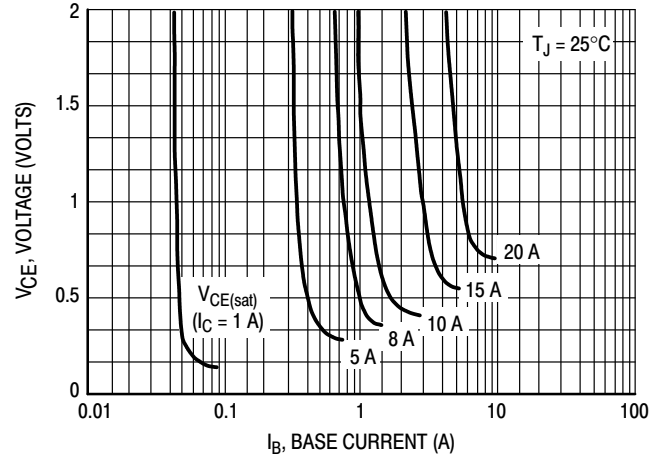


Figure 8. Collector Saturation Region

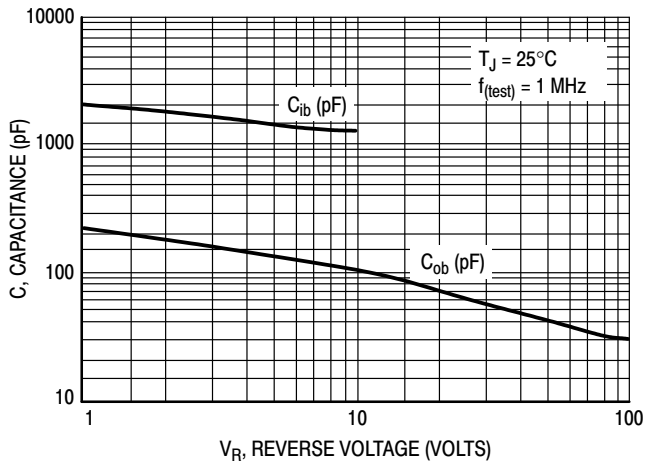


Figure 9. Capacitance

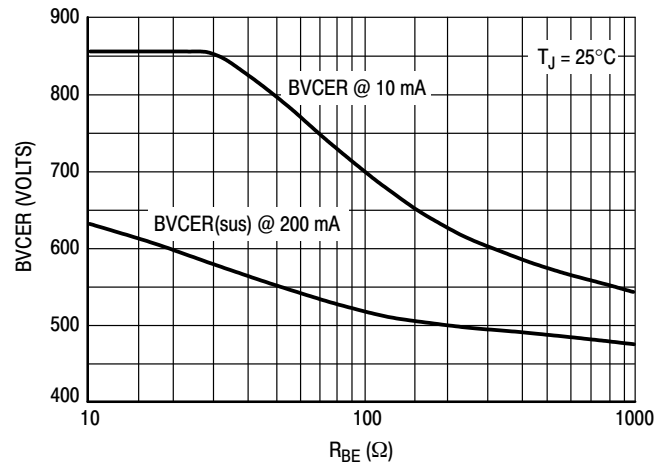


Figure 10. Resistive Breakdown

TYPICAL SWITCHING CHARACTERISTICS

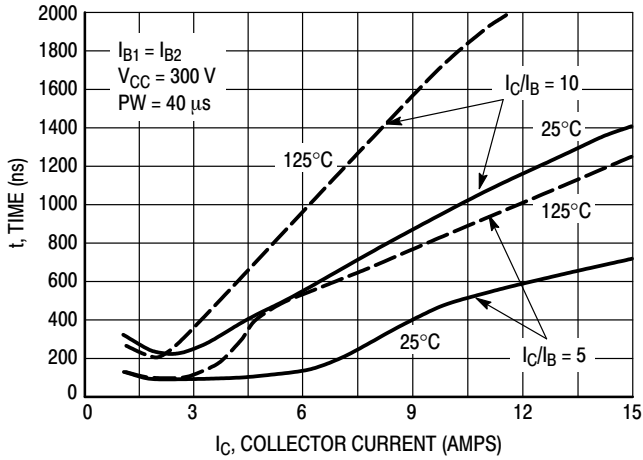


Figure 11. Resistive Switching,  $t_{on}$

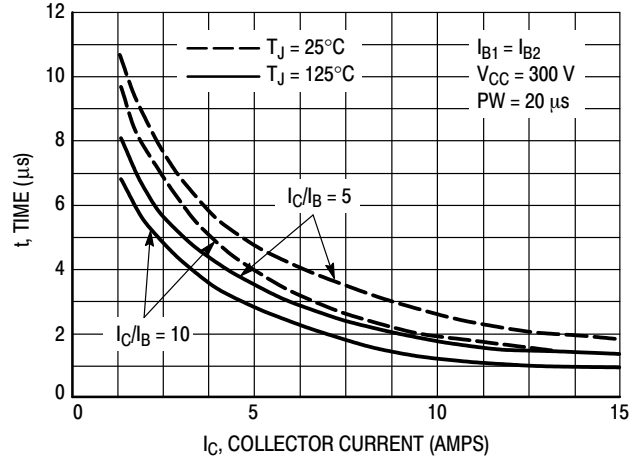


Figure 12. Resistive Switch Time,  $t_{off}$

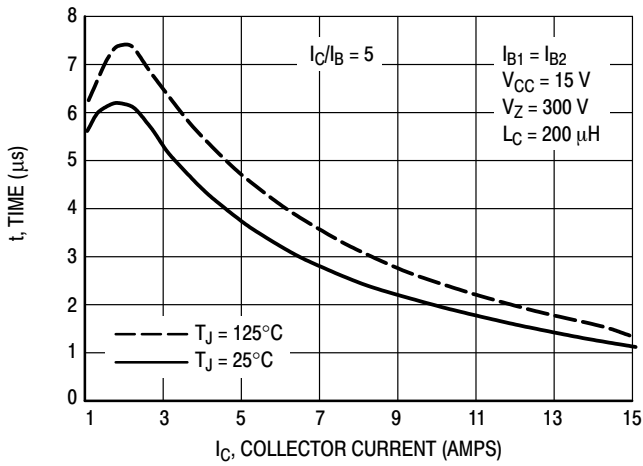


Figure 13. Inductive Storage Time,  $t_{si}$

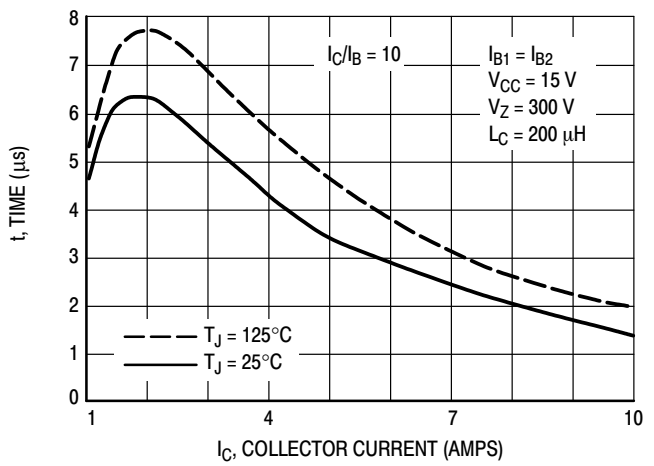


Figure 13 Bis. Inductive Storage Time,  $t_{si}$

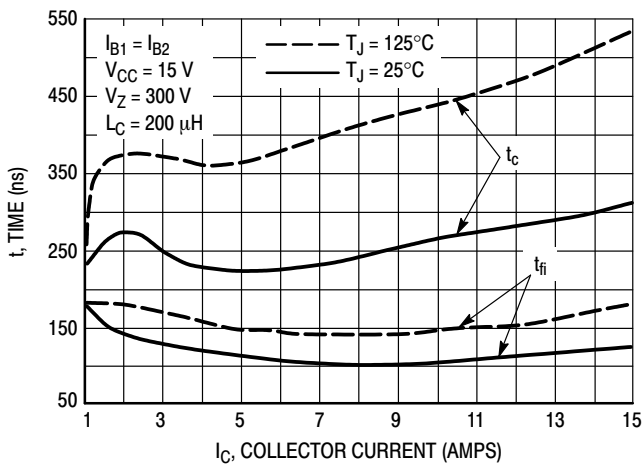


Figure 14. Inductive Storage Time,  $t_c$  &  $t_{fi}$  @  $I_C/I_B = 5$

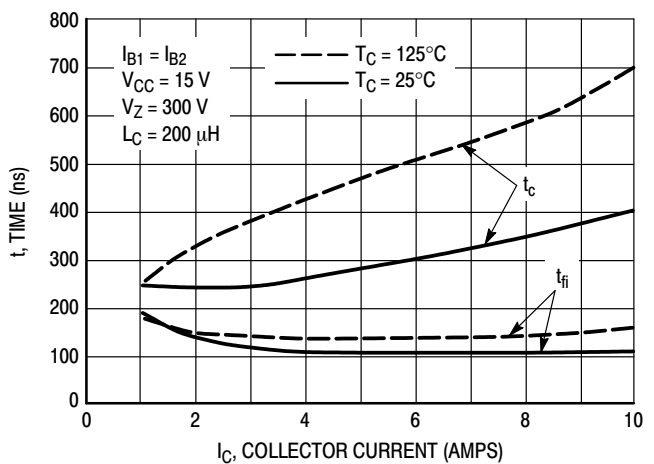


Figure 15. Inductive Storage Time,  $t_c$  &  $t_{fi}$  @  $I_C/I_B = 10$

# BUH150G

## TYPICAL SWITCHING CHARACTERISTICS

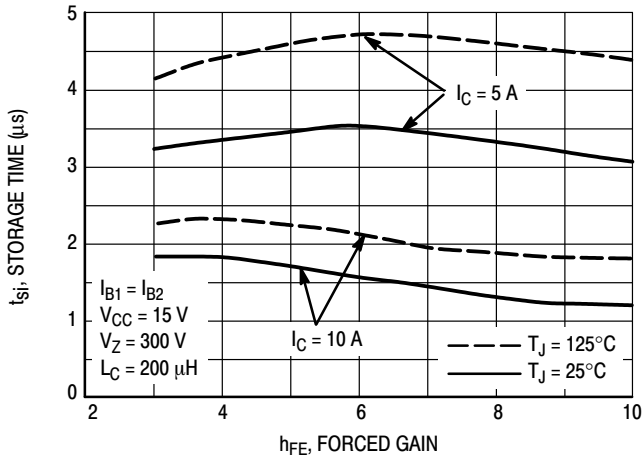


Figure 16. Inductive Storage Time

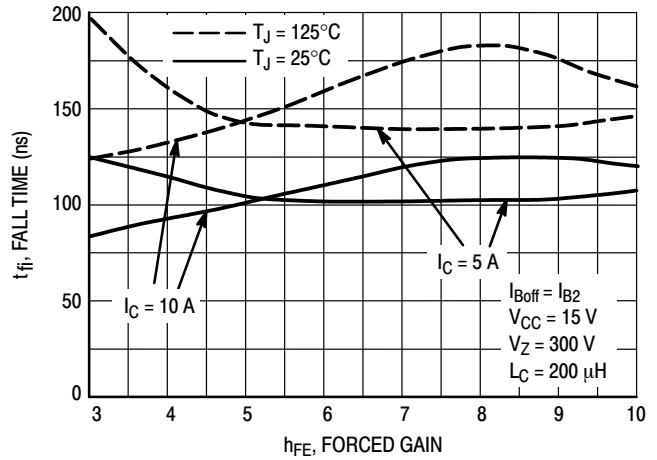


Figure 17. Inductive Fall Time

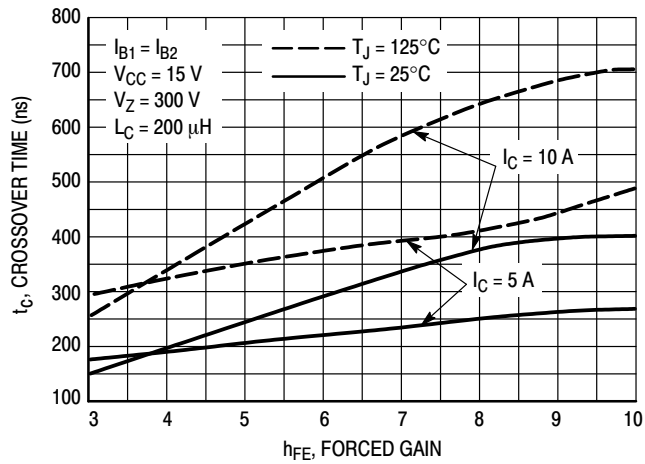


Figure 18. Inductive Crossover Time

# BUH150G

## TYPICAL SWITCHING CHARACTERISTICS

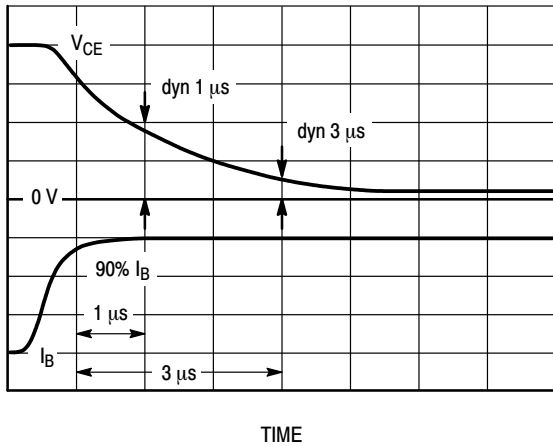


Figure 19. Dynamic Saturation Voltage Measurements

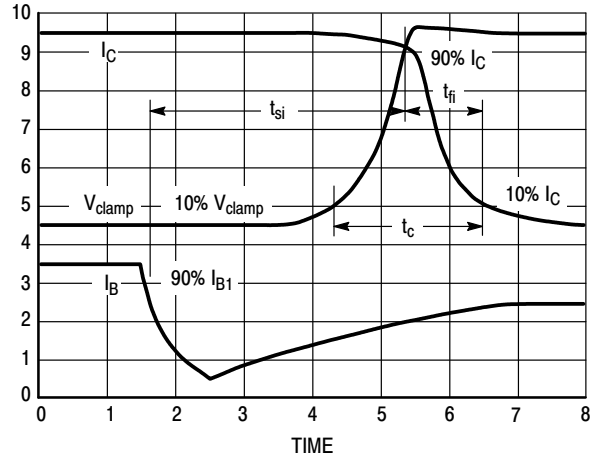
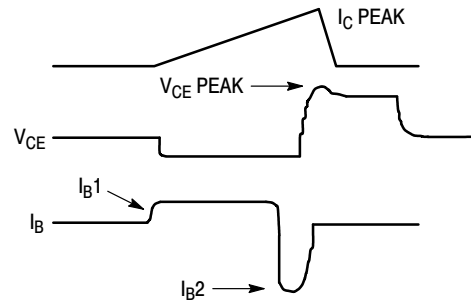
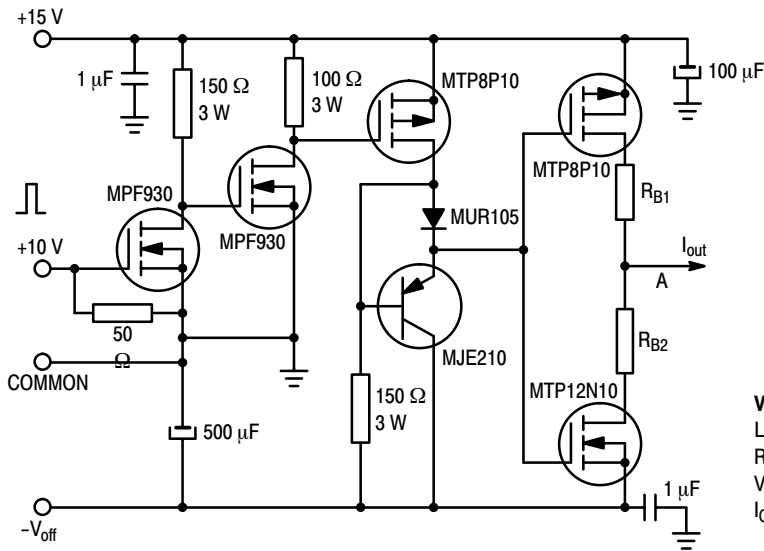


Figure 20. Inductive Switching Measurements

Table 1. Inductive Load Switching Drive Circuit



$V_{(BR)CEO(sus)}$   
 $L = 10 \text{ mH}$   
 $R_{B2} = \infty$   
 $V_{CC} = 20 \text{ Volts}$   
 $I_{C(pk)} = 100 \text{ mA}$

**Inductive Switching**  
 $L = 200 \mu\text{H}$   
 $R_{B2} = 0$   
 $V_{CC} = 15 \text{ Volts}$   
 $R_{B1}$  selected for desired  $I_{B1}$

**RBSOA**  
 $L = 500 \mu\text{H}$   
 $R_{B2} = 0$   
 $V_{CC} = 15 \text{ Volts}$   
 $R_{B1}$  selected for desired  $I_{B1}$



TYPICAL THERMAL RESPONSE

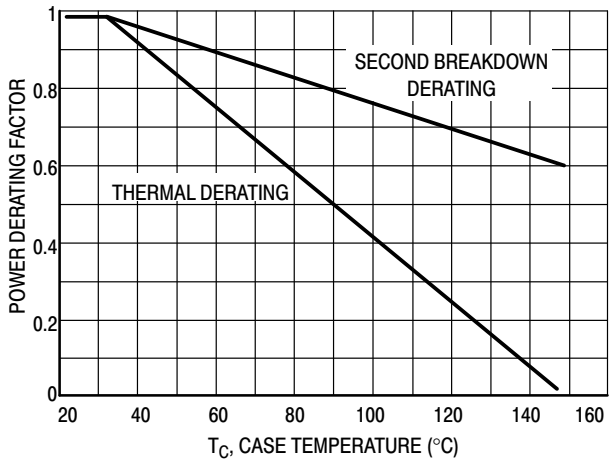


Figure 21. Forward Bias Power Derating

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 22 is based on  $T_C = 25^\circ\text{C}$ ;  $T_{J(pk)}$  is variable depending on power level. Second breakdown pulse limits are valid for duty cycles to 10% but must be derated when  $T_C > 25^\circ\text{C}$ . Second breakdown limitations do not derate the same as thermal limitations. Allowable current at the voltages shown on Figure 22 may be found at any case temperature by using the appropriate curve on Figure 21.

$T_{J(pk)}$  may be calculated from the data in Figure 24. At any case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by second breakdown. For inductive loads, high voltage and current must be sustained simultaneously during turn-off with the base to emitter junction reverse biased. The safe level is specified as a reverse biased safe operating area (Figure 23). This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode.

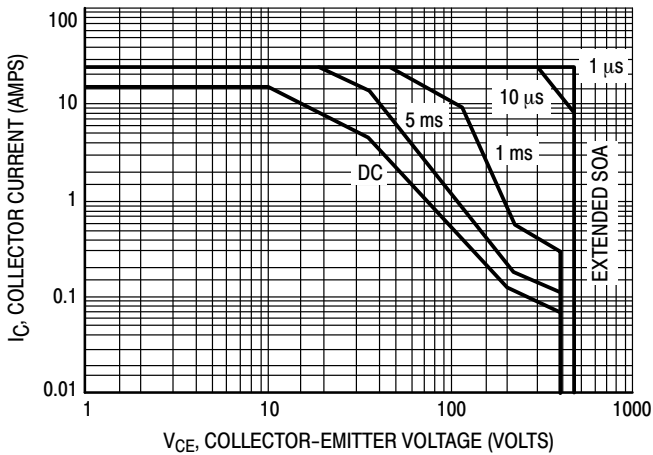


Figure 22. Forward Bias Safe Operating Area

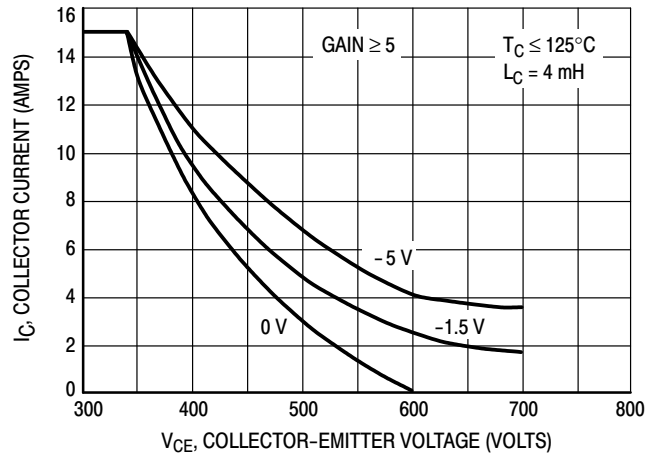


Figure 23. Reverse Bias Safe Operating Area

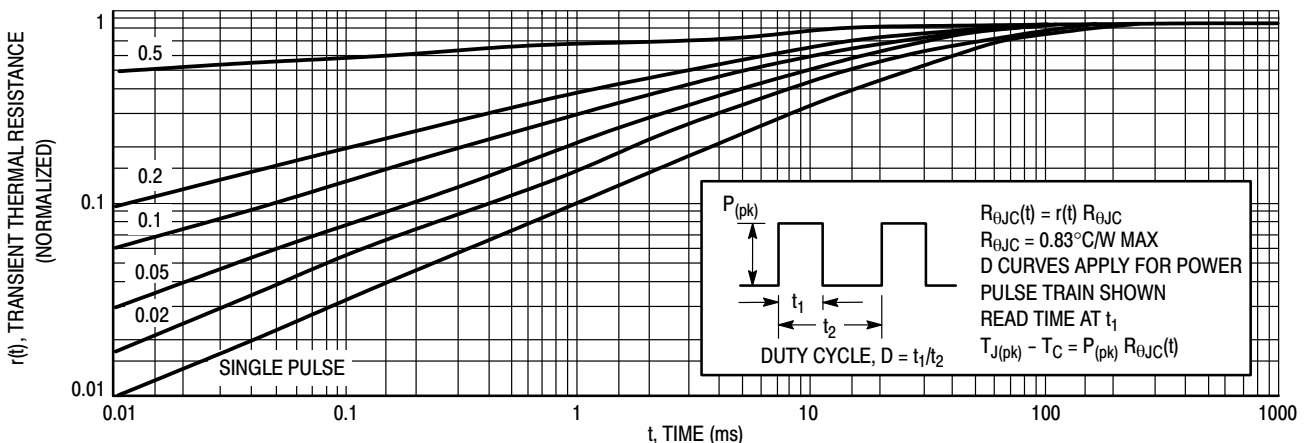
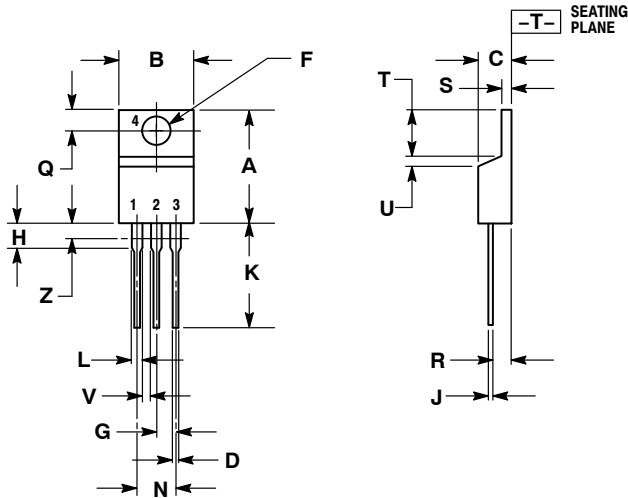


Figure 24. Typical Thermal Response ( $Z_{\theta JC}(t)$ ) for BUH150

# BUH150G

## PACKAGE DIMENSIONS

### TO-220 CASE 221A-09 ISSUE AG



**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN    | MAX   | MIN         | MAX   |
| A   | 0.570  | 0.620 | 14.48       | 15.75 |
| B   | 0.380  | 0.405 | 9.66        | 10.28 |
| C   | 0.160  | 0.190 | 4.07        | 4.82  |
| D   | 0.025  | 0.036 | 0.64        | 0.91  |
| F   | 0.142  | 0.161 | 3.61        | 4.09  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.161 | 2.80        | 4.10  |
| J   | 0.014  | 0.025 | 0.36        | 0.64  |
| K   | 0.500  | 0.562 | 12.70       | 14.27 |
| L   | 0.045  | 0.060 | 1.15        | 1.52  |
| N   | 0.190  | 0.210 | 4.83        | 5.33  |
| Q   | 0.100  | 0.120 | 2.54        | 3.04  |
| R   | 0.080  | 0.110 | 2.04        | 2.79  |
| S   | 0.045  | 0.055 | 1.15        | 1.39  |
| T   | 0.235  | 0.255 | 5.97        | 6.47  |
| U   | 0.000  | 0.050 | 0.00        | 1.27  |
| V   | 0.045  | ---   | 1.15        | ---   |
| Z   | ---    | 0.080 | ---         | 2.04  |

**STYLE 1:**

- PIN 1: BASE  
 2. COLLECTOR  
 3. EMITTER  
 4. COLLECTOR

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