

# FULL PAK™

## High Voltage NPN Power Transistor

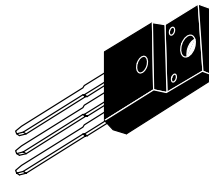
### For Isolated Package Applications

The BUT11AF was designed for use in line operated switching power supplies in a wide range of end use applications. This device combines the latest state of the art bipolar fabrication techniques to provide excellent switching, high voltage capability and low saturation voltage.

- 1000 Volt  $V_{CES}$  Rating
- Low Base Drive Requirements
- Isolated Overmold Package
- Improved System Efficiency
- No Isolating Washers Required
- Reduced System Cost
- High Isolation Voltage Capability (4500  $V_{RMS}$ )

**BUT11AF**

POWER TRANSISTOR  
5.0 AMPERES  
450 VOLTS  
40 WATTS



CASE 221D-02  
TO-220 TYPE

#### MAXIMUM RATINGS

| Rating   | Symbol                      | Value        | Unit                         |
|--|-----------------------------|--------------|------------------------------|
| Collector–Emitter Sustaining Voltage   | $V_{CEO(sus)}$              | 450          | Vdc                          |
| Collector–Emitter Breakdown Voltage  | $V_{CES}$                   | 1000         | Vdc                          |
| Emitter–Base Voltage   | $V_{EBO}$                   | 9.0          | Vdc                          |
| RMS Isolation Voltage (For 1 sec,<br>$T_A = 25^\circ\text{C}$ , Rel. Humidity < 30%)     | Per Figure 7<br>$V_{ISOL1}$ | 4500         | V                            |
|  | Per Figure 8<br>$V_{ISOL2}$ | 3500         |                              |
|  | Per Figure 9<br>$V_{ISOL3}$ | 2500         |                              |
| Collector Current — Continuous<br>— Pulsed (1)   | $I_C$<br>$I_{CM}$           | 5.0<br>10    | Adc                          |
| Base Current — Continuous<br>— Pulsed (1)  | $I_B$<br>$I_{BM}$           | 2.0<br>4.0   | Adc                          |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$ *<br>Derated above $25^\circ\text{C}$ | $P_D$                       | 40<br>0.32   | Watts<br>W/ $^\circ\text{C}$ |
| Operating and Storage Temperature Range  | $T_J, T_{stg}$              | – 65 to +150 | $^\circ\text{C}$             |

#### THERMAL CHARACTERISTICS

|  |                 |       |                    |
|--|-----------------|-------|--------------------|
| Thermal Resistance — Junction to Case*                                       | $R_{\theta JC}$ | 3.125 | $^\circ\text{C/W}$ |
| Maximum Lead Temperature for soldering purposes<br>1/8" from case for 5 sec. | $T_L$           | 260   | $^\circ\text{C}$   |

(1) Pulse Test: Pulse Width = 5.0 ms, Duty Cycle  $\leq$  10%.

\*Measurement made with thermocouple contacting the bottom insulated mounting surface of the package (in a location beneath the die), the device mounted on a heatsink, thermal grease applied, and a mounting torque of 6 to 8 in · lbs.

# BUT11AF

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

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

### OFF CHARACTERISTICS (1)

|  |               |     |   |            |      |
|--|---------------|-----|---|------------|------|
| Collector-Emitter Sustaining Voltage (Figures 1 & 2)<br>( $I_C = 100\text{ mA}$ , $I_B = 0$ , $L = 25\ \mu\text{H}$ )                                  | $V_{CE(sus)}$ | 450 | – | –          | Vdc  |
| Collector Cutoff Current<br>( $V_{CE} = 1000\text{ Vdc}$ , $V_{BE} = 0$ )<br>( $V_{CE} = 1000\text{ Vdc}$ , $V_{BE} = 0$ , $T_J = 125^\circ\text{C}$ ) | $I_{CES}$     | –   | – | 1.0<br>2.0 | mAdc |
| Emitter-Base Leakage<br>( $V_{EB} = 9.0\text{ Vdc}$ , $I_C = 0$ )  | $I_{EBO}$     | –   | – | 10         | mAdc |

### ON CHARACTERISTICS (1)

|   |               |    |   |     |     |
|---|---------------|----|---|-----|-----|
| Collector-Emitter Saturation Voltage<br>( $I_C = 2.5\text{ Adc}$ , $I_B = 0.5\text{ Adc}$ ) | $V_{CE(sat)}$ | –  | – | 1.5 | Vdc |
| Base-Emitter Saturation Voltage<br>( $I_C = 2.5\text{ Adc}$ , $I_B = 0.5\text{ Adc}$ )      | $V_{BE(sat)}$ | –  | – | 1.5 | Vdc |
| DC Current Gain<br>( $I_C = 5.0\text{ mAdc}$ , $V_{CE} = 5.0\text{ Vdc}$ )                  | $h_{FE}$      | 10 | – | –   | –   |

### DYNAMIC CHARACTERISTICS

|   |            |   |    |   |    |
|---|------------|---|----|---|----|
| Insulation Capacitance (Collector to External Heatsink) | $C_{c-hs}$ | – | 15 | – | pF |
|---|------------|---|----|---|----|

### SWITCHING CHARACTERISTICS

| Inductive Load (Figures 3 & 4) |   |                           |          |   |      |      |    |
|--------------------------------|---|---------------------------|----------|---|------|------|----|
| Storage                        | $I_C = 2.5\text{ Adc}$ , $I_{B1} = 0.5\text{ Adc}$          | $T_J = 25^\circ\text{C}$  | $t_s$    | – | 1100 | 1400 | ns |
| Fall Time                      |   |                           | $t_{fi}$ | – | 80   | 150  |    |
| Storage                        |   | $T_J = 100^\circ\text{C}$ | $t_s$    | – | 1200 | 1500 | ns |
| Fall Time                      |   |                           | $t_{fi}$ | – | 140  | 300  |    |
| Resistive Load (Figures 5 & 6) |   |                           |          |   |      |      |    |
| Turn-On Time                   | $I_C = 2.5\text{ Adc}$ , $I_{B1} = I_{B2} = 0.5\text{ Adc}$ | $t_{on}$                  | –        | – | 1000 | ns   |    |
| Storage Time                   |   | $t_s$                     | –        | – | 4000 |      |    |
| Fall Time                      |   | $t_f$                     | –        | – | 800  |      |    |

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

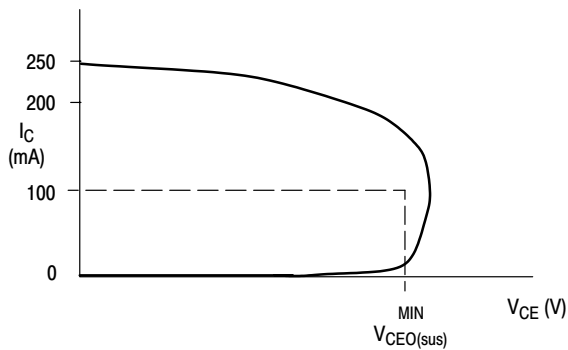


Figure 1. Oscilloscope Display for Sustaining Voltage

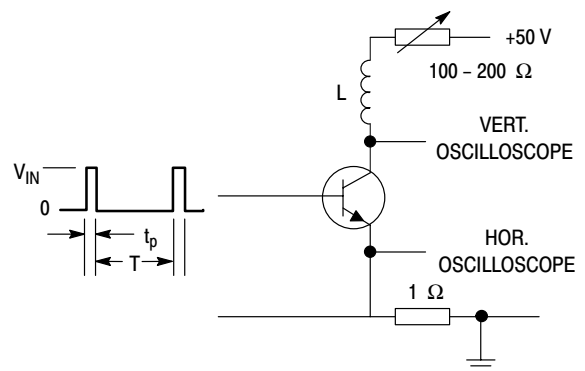


Figure 2. Test Circuit for  $V_{CE(sus)}$

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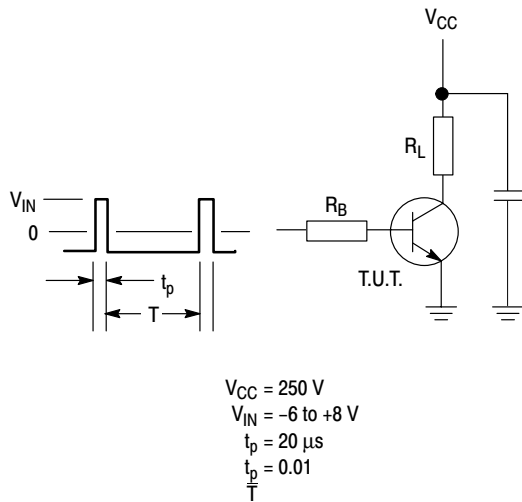


Figure 3. Test Circuit Resistive Load

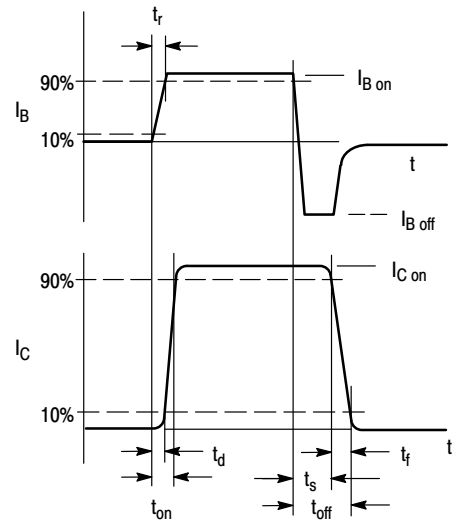


Figure 4. Switching Times Waveforms with Resistive Load

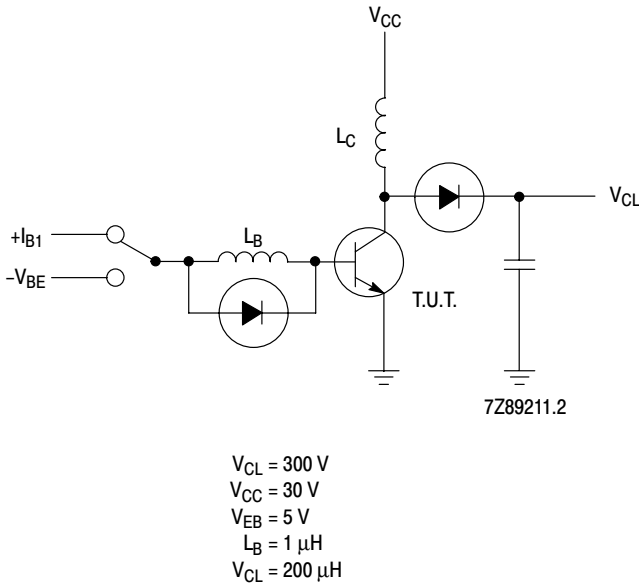


Figure 5. Test Circuit Inductive Load

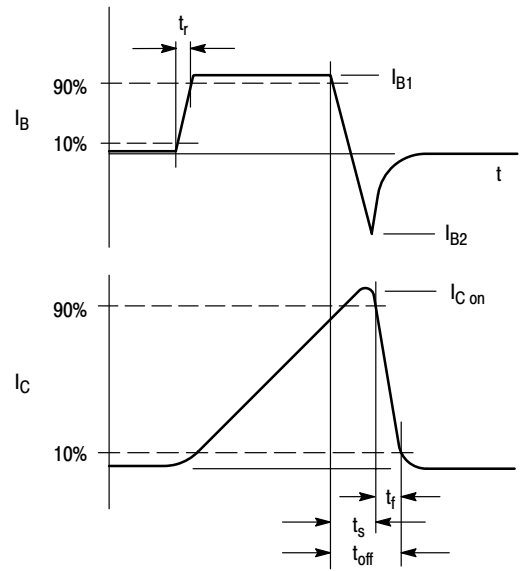


Figure 6. Switching Times Waveforms with Inductive Load

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## TEST CONDITIONS FOR ISOLATION TESTS\*

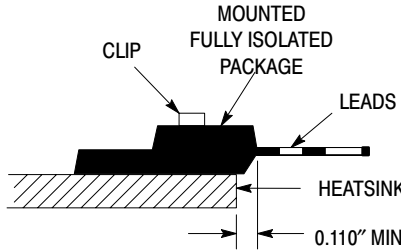


Figure 7. Screw or Clip Mounting Position for Isolation Test Number 1

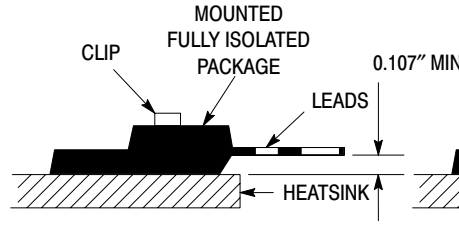


Figure 8. Clip Mounting Position for Isolation Test Number 2

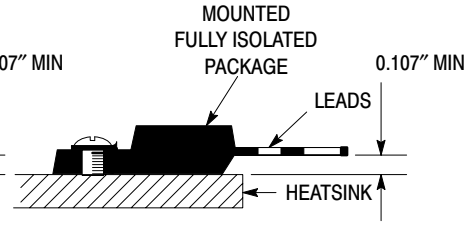


Figure 9. Screw Mounting Position for Isolation Test Number 3

\*Measurement made between leads and heatsink with all leads shorted together.

## MOUNTING INFORMATION

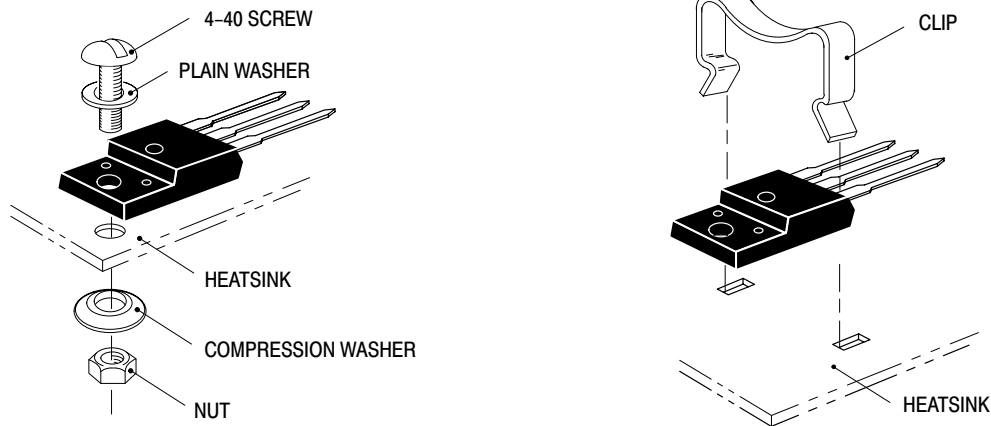


Figure 10. Typical Mounting Techniques for Isolated Package

Laboratory tests on a limited number of samples indicate, when using the screw and compression washer mounting technique, a screw torque of 6 to 8 in · lbs is sufficient to provide maximum power dissipation capability. The compression washer helps to maintain a constant pressure on the package over time and during large temperature excursions.

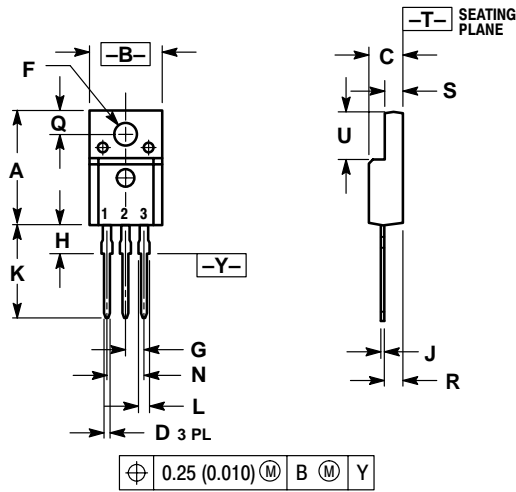
Destructive laboratory tests show that using a hex head 4–40 screw, without washers, and applying a torque in excess of 20 in · lbs will cause the plastic to crack around the mounting hole, resulting in a loss of isolation capability.

Additional tests on slotted 4–40 screws indicate that the screw slot fails between 15 to 20 in · lbs without adversely affecting the package. However, in order to positively ensure the package integrity of the fully isolated device, ON Semiconductor does not recommend exceeding 10 in · lbs of mounting torque under any mounting conditions.

# BUT11AF

## PACKAGE DIMENSIONS

### TO-220 FULLPAK CASE 221D-02 ISSUE D



- NOTES:  
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.  
 2. CONTROLLING DIMENSION: INCH.


| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.621     | 0.629 | 15.78       | 15.97 |
| B   | 0.394     | 0.402 | 10.01       | 10.21 |
| C   | 0.181     | 0.189 | 4.60        | 4.80  |
| D   | 0.026     | 0.034 | 0.67        | 0.86  |
| F   | 0.121     | 0.129 | 3.08        | 3.27  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.123     | 0.129 | 3.13        | 3.27  |
| J   | 0.018     | 0.025 | 0.46        | 0.64  |
| K   | 0.500     | 0.562 | 12.70       | 14.27 |
| L   | 0.045     | 0.060 | 1.14        | 1.52  |
| N   | 0.200 BSC |       | 5.08 BSC    |       |
| Q   | 0.126     | 0.134 | 3.21        | 3.40  |
| R   | 0.107     | 0.111 | 2.72        | 2.81  |
| S   | 0.096     | 0.104 | 2.44        | 2.64  |
| U   | 0.259     | 0.267 | 6.58        | 6.78  |

**Notes**

**Notes**

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