

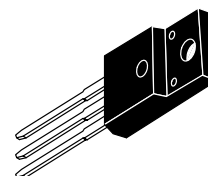
FULL PAK™**High Voltage NPN Power Transistor
For Isolated Package Applications**

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, $T_A = 25^\circ\text{C}$, Rel. Humidity < 30%) Per Figure 7 Per Figure 8 Per Figure 9 | V_{ISOL1} | 4500 | V |
| | V_{ISOL2} | 3500 | |
| | V_{ISOL3} | 2500 | |
| Collector Current — Continuous — Pulsed (1) | I_C | 5.0 | Adc |
| | I_{CM} | 10 | |
| Base Current — Continuous — Pulsed (1) | I_B | 2.0 | Adc |
| | I_{BM} | 4.0 | |
| Total Power Dissipation @ $T_C = 25^\circ\text{C}$ * Derated above 25°C | P_D | 40 0.32 | Watts 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 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) ($I_C = 100\text{ mAdc}$, $I_B = 0$, $L = 25\text{ }\mu\text{H}$) | $V_{CE(sus)}$ | 450 | — | — | Vdc |
| Collector Cutoff Current ($V_{CE} = 1000\text{ Vdc}$, $V_{BE} = 0$) ($V_{CE} = 1000\text{ Vdc}$, $V_{BE} = 0$, $T_J = 125^\circ\text{C}$) | I_{CES} | — — | — — | 1.0 2.0 | mAdc |
| Emitter-Base Leakage ($V_{EB} = 9.0\text{ Vdc}$, $I_C = 0$) | I_{EBO} | — | — | 10 | mAdc |

ON CHARACTERISTICS (1)

| | | | | | |
|---|---------------|----|--------|--------|-----|
| Collector-Emitter Saturation Voltage ($I_C = 2.5\text{ Adc}$, $I_B = 0.5\text{ Adc}$) | $V_{CE(sat)}$ | — | — | 1.5 | Vdc |
| Base-Emitter Saturation Voltage ($I_C = 2.5\text{ Adc}$, $I_B = 0.5\text{ Adc}$) | $V_{BE(sat)}$ | — | — | 1.5 | Vdc |
| DC Current Gain ($I_C = 5.0\text{ mAdc}$, $V_{CE} = 5.0\text{ Vdc}$) | 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 | |
| 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 μs , Duty Cycle $\leq 2.0\%$.

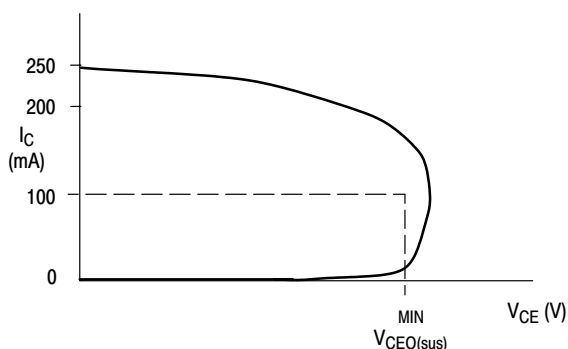


Figure 1. Oscilloscope Display for Sustaining Voltage

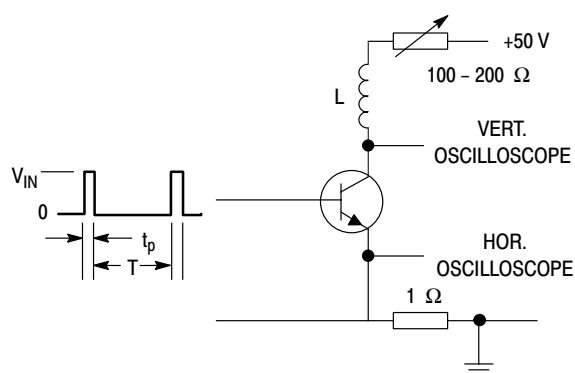


Figure 2. Test Circuit for $V_{CE(sus)}$

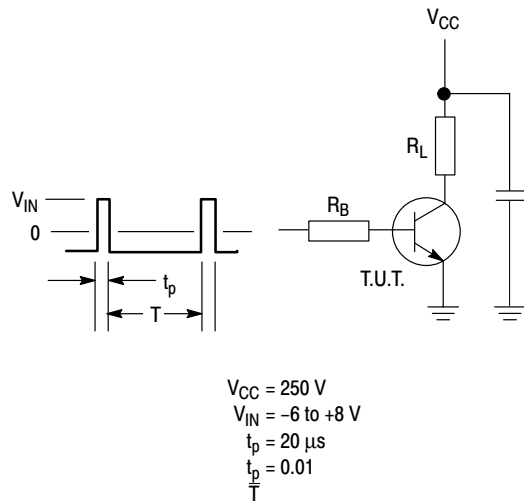


Figure 3. Test Circuit Resistive Load

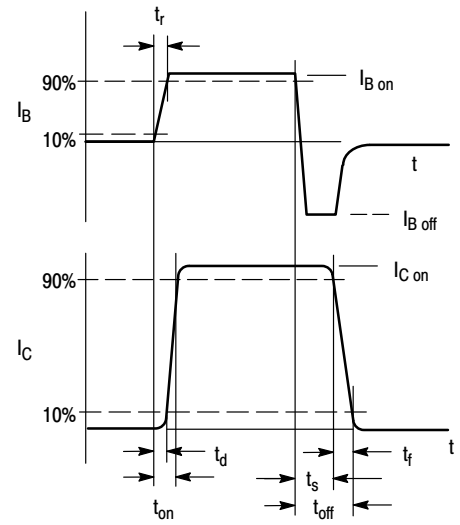


Figure 4. Switching Times Waveforms with Resistive Load

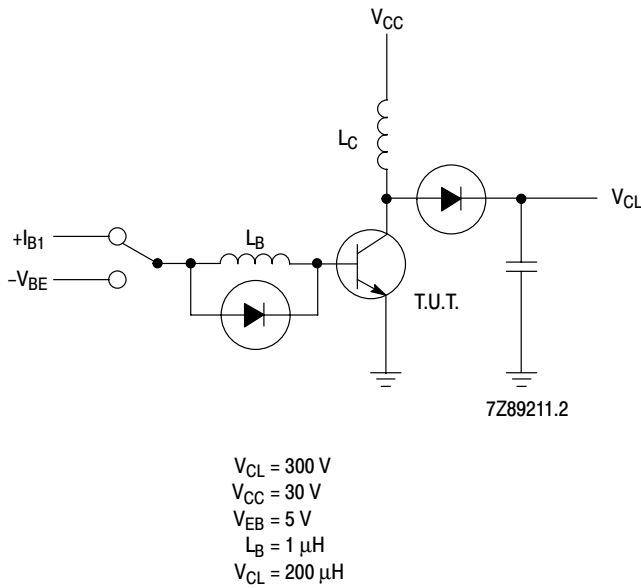


Figure 5. Test Circuit Inductive Load

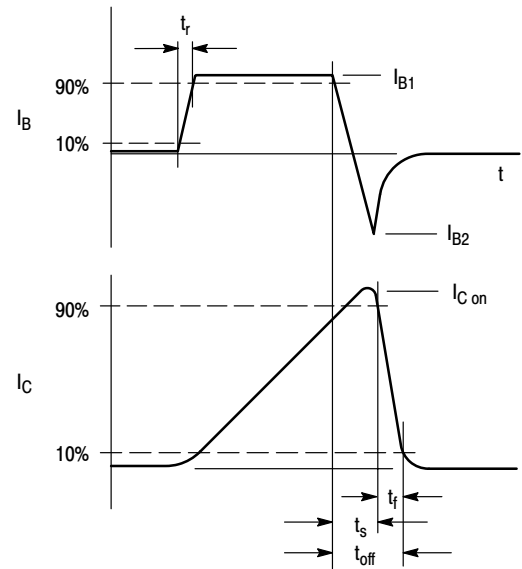


Figure 6. Switching Times Waveforms with Inductive Load

TEST CONDITIONS FOR ISOLATION TESTS*

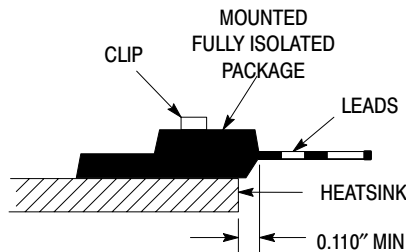


Figure 7. Screw or Clip Mounting Position for Isolation Test Number 1

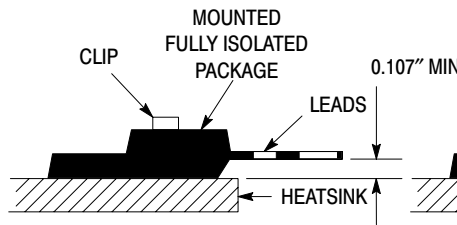


Figure 8. Clip Mounting Position for Isolation Test Number 2

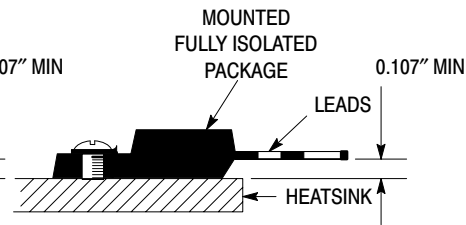


Figure 9. Screw Mounting Position for Isolation Test Number 3

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

MOUNTING INFORMATION

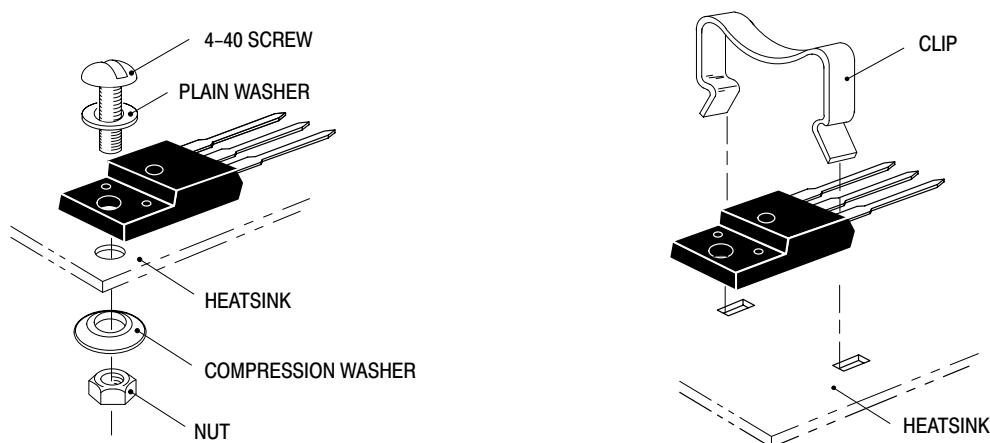


Figure 10. Typical Mounting Techniques for Isolated Package

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.

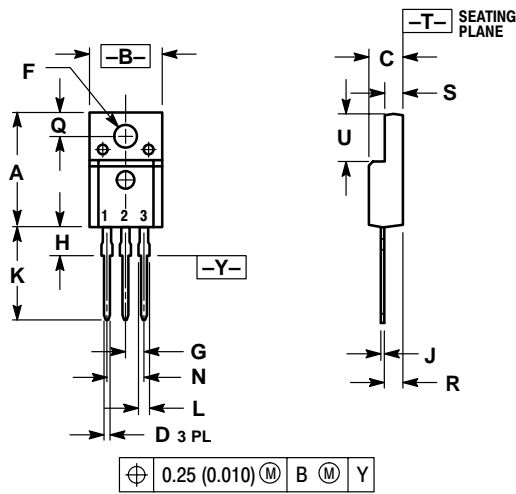
Destructive laboratory tests show that using a hex head 4–40 screw, without washers, and applying a torque in excess of 20 in · lbs will cause the plastic to crack around the mounting hole, resulting in a loss of isolation capability.

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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