

# FULL PAK™

## High Voltage NPN Power Transistor

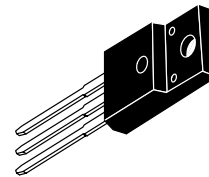
### For Isolated Package Applications

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 $V_{ISOL1}$	4500	V
	Per Figure 8 $V_{ISOL2}$	3500	
	Per Figure 9 $V_{ISOL3}$	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 $25^\circ\text{C}$	$P_D$	40	Watts
		0.32	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	$^\circ\text{C}/\text{W}$
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
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### OFF CHARACTERISTICS (1)

Collector-Emitter Sustaining Voltage (Figures 1 & 2) ( $I_C = 100\text{ mA}$ , $I_B = 0$ , $L = 25\ \mu\text{H}$ )	$V_{CE(sus)}$	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
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### 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  $\leq 2.0\%$ .

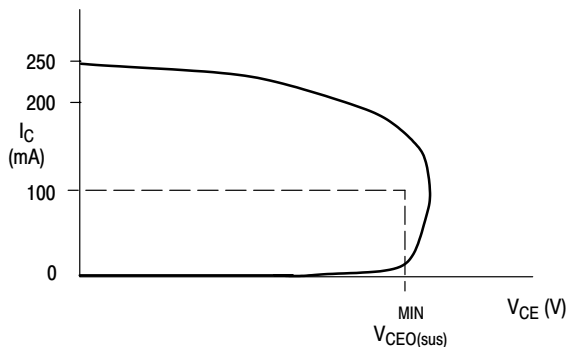


Figure 1. Oscilloscope Display for Sustaining Voltage

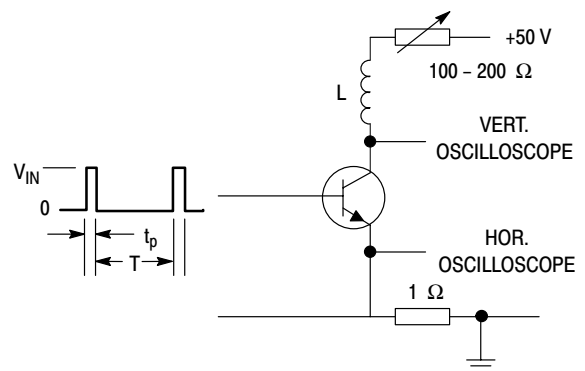


Figure 2. Test Circuit for  $V_{CE(sus)}$

# BUT11AF

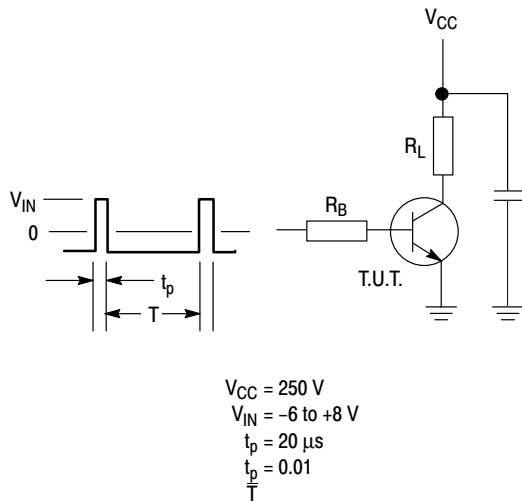


Figure 3. Test Circuit Resistive Load

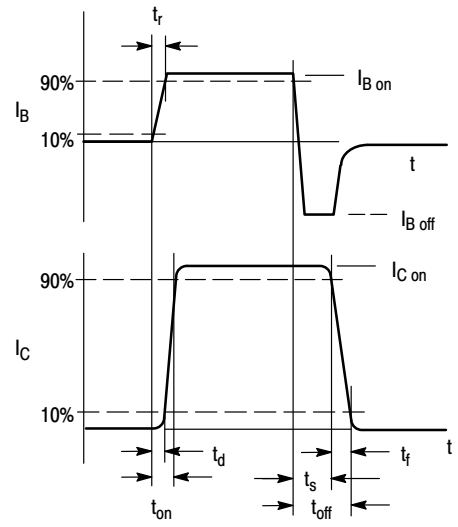


Figure 4. Switching Times Waveforms with Resistive Load

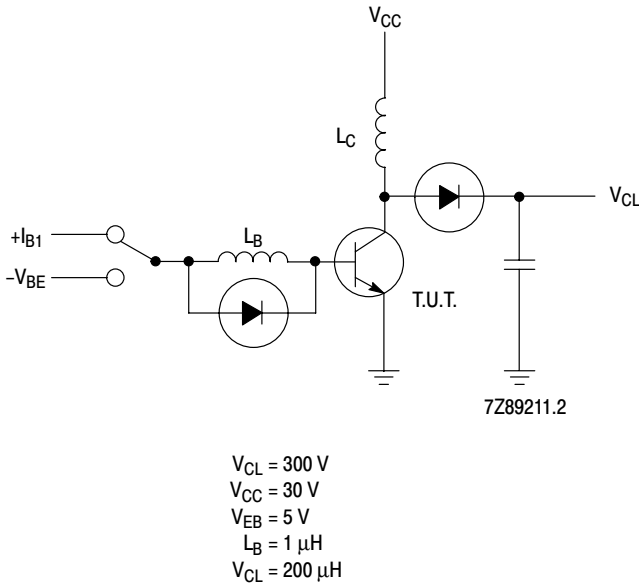


Figure 5. Test Circuit Inductive Load

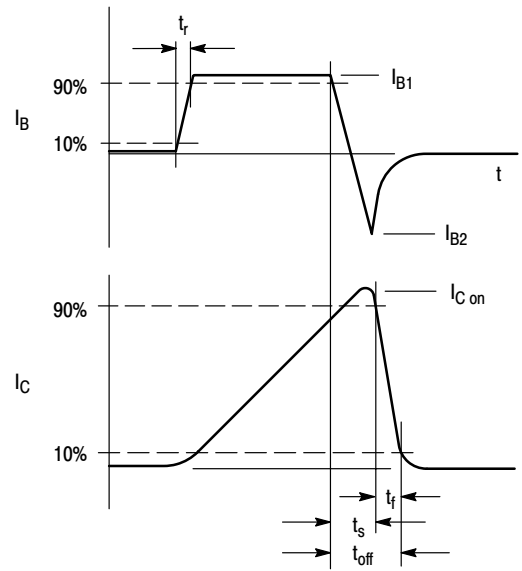


Figure 6. Switching Times Waveforms with Inductive Load

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## TEST CONDITIONS FOR ISOLATION TESTS\*

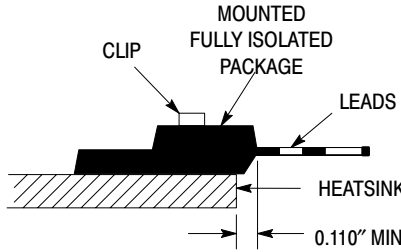


Figure 7. Screw or Clip Mounting Position for Isolation Test Number 1

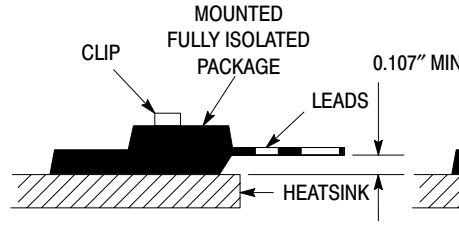


Figure 8. Clip Mounting Position for Isolation Test Number 2

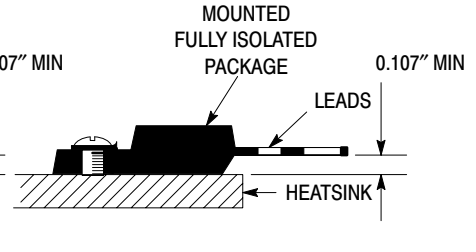


Figure 9. Screw Mounting Position for Isolation Test Number 3

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

## MOUNTING INFORMATION

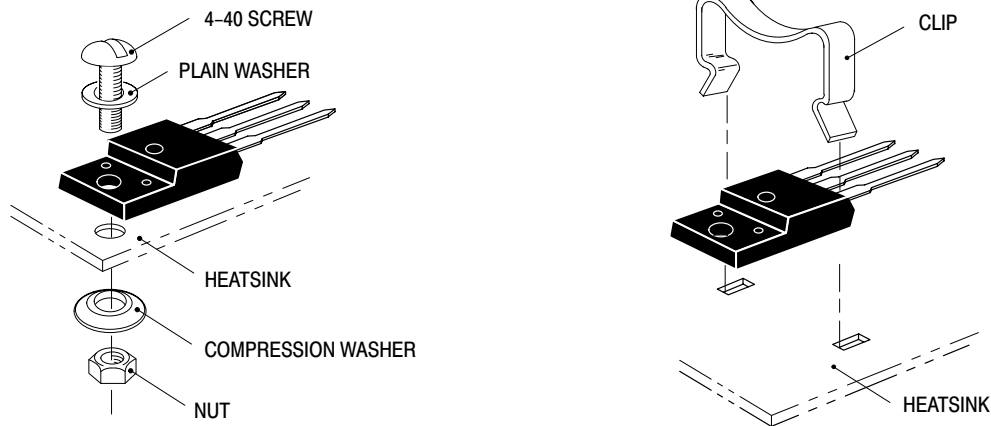


Figure 10. Typical Mounting Techniques for Isolated Package

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.

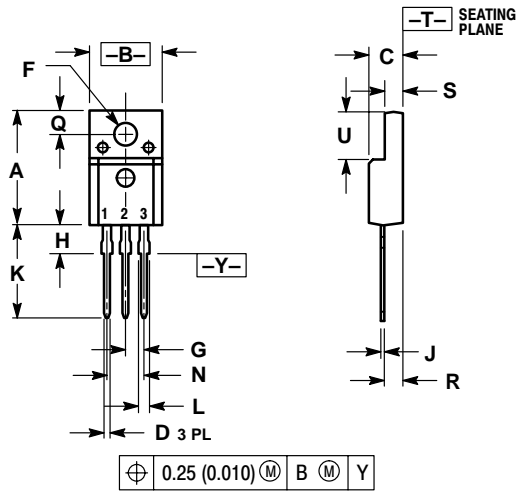
Destructive laboratory tests show that using a hex head 4–40 screw, without washers, and applying a torque in excess of 20 in · lbs will cause the plastic to crack around the mounting hole, resulting in a loss of isolation capability.

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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