

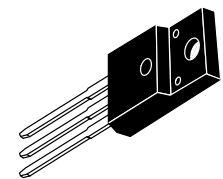
**BUT11AF**

## 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  $V_{RMS}$ )

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)	$I_C$ $I_{CM}$	5.0 10	A <sub>dc</sub>
Base Current — Continuous — Pulsed (1)	$I_B$ $I_{BM}$	2.0 4.0	A <sub>dc</sub>
Total Power Dissipation @ $T_C = 25^\circ\text{C}$ * Derated above $25^\circ\text{C}$	$P_D$	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	$^\circ\text{C}/\text{W}$
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.

Full Pak is a registered trademark of Motorola Inc.

# BUT11AF

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

Characteristic	Symbol	Min	Typ	Max	Unit
<b>OFF CHARACTERISTICS (1)</b>					
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
---	------------	---	----	---	----

## 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  $\leq 2.0\%$ .

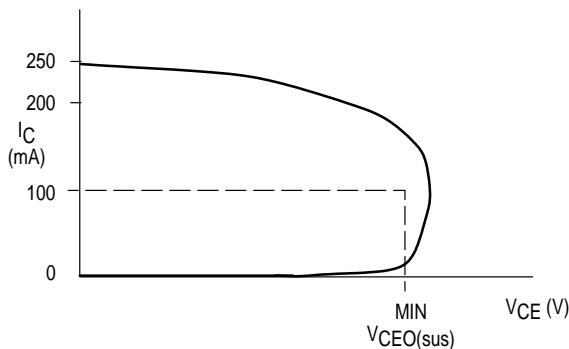


Figure 1. Oscilloscope Display for Sustaining Voltage

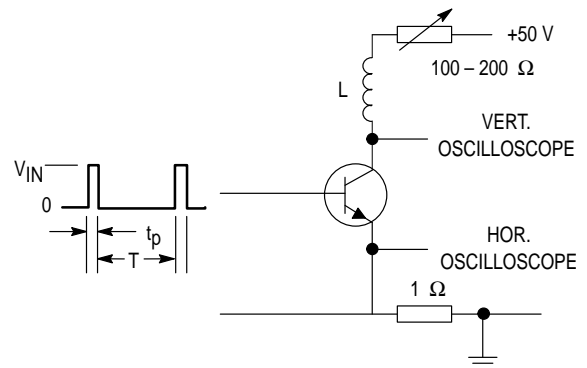


Figure 2. Test Circuit for  $V_{CE(sus)}$

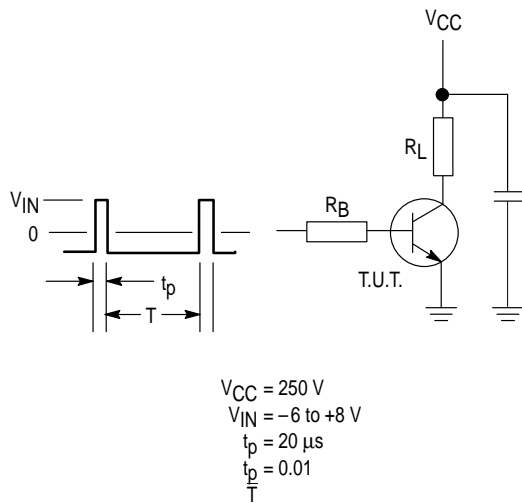


Figure 3. Test Circuit Resistive Load

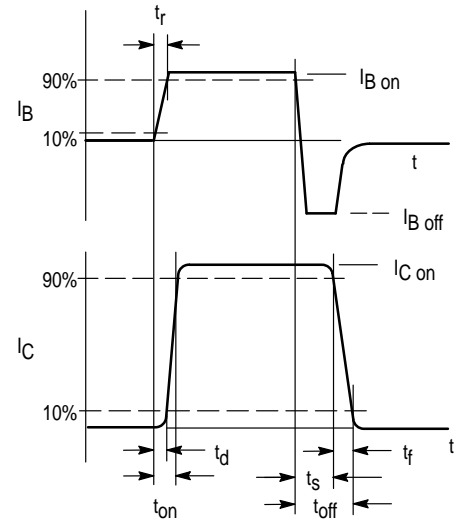


Figure 4. Switching Times Waveforms with Resistive Load

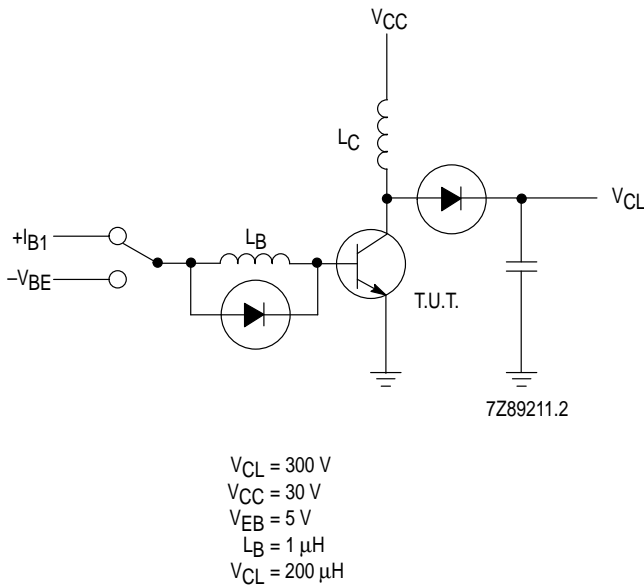


Figure 5. Test Circuit Inductive Load

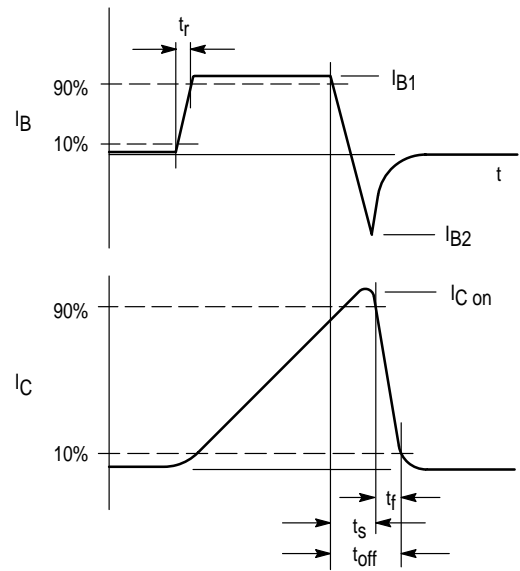
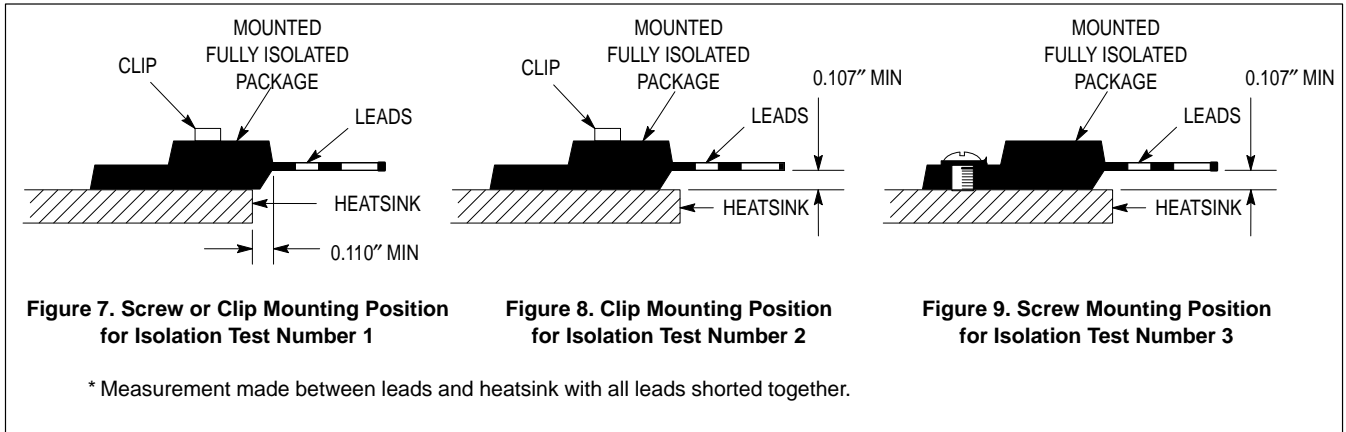
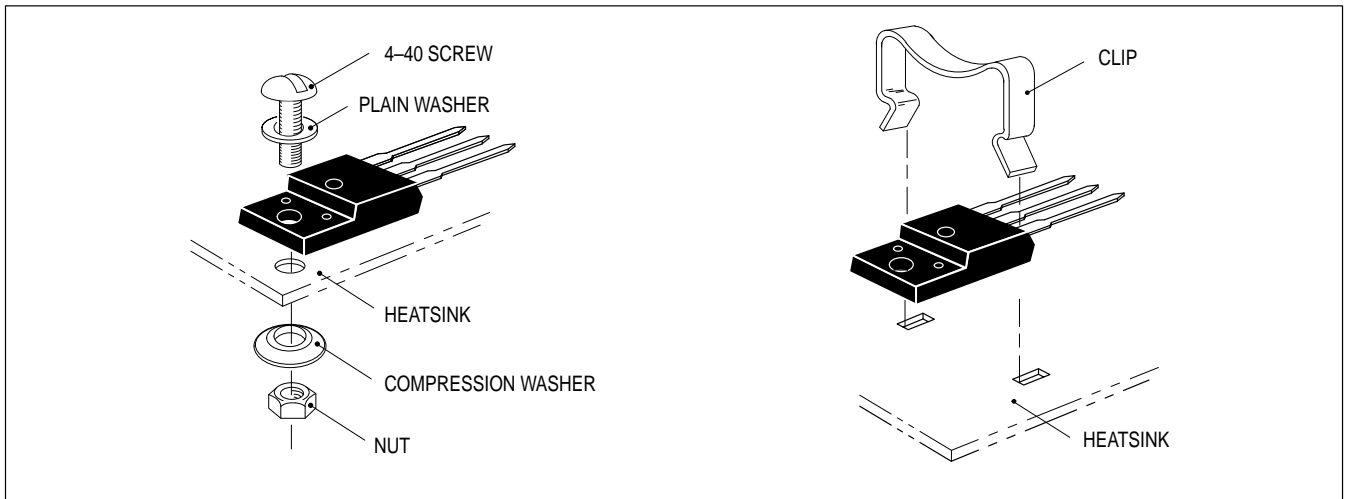


Figure 6. Switching Times Waveforms with Inductive Load

**TEST CONDITIONS FOR ISOLATION TESTS\***



**MOUNTING INFORMATION**



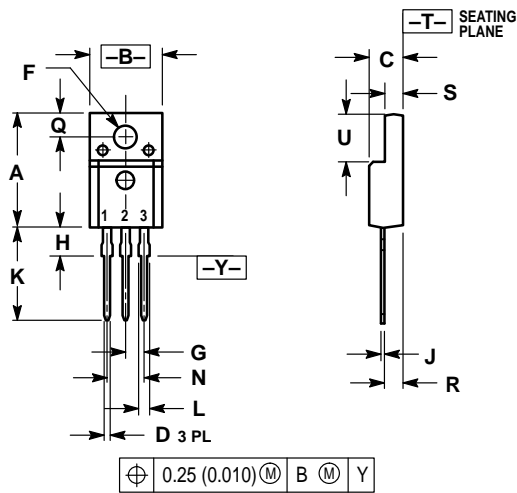
**Figure 10. Typical Mounting Techniques for Isolated Package**

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, Motorola does not recommend exceeding 10 in · lbs of mounting torque under any mounting conditions.

PACKAGE DIMENSIONS




- 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

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

CASE 221D-02  
 TO-220 TYPE  
 ISSUE D

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

**How to reach us:**

**USA / EUROPE:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, Toshikatsu Otsuki,  
6F Seibu-Butsuryu-Center, 3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-3521-8315

**MFAX:** RMFAX0@email.sps.mot.com - TOUCHTONE (602) 244-6609  
**INTERNET:** <http://Design-NET.com>

**HONG KONG:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

