

**SWITCHMODE™****NPN Bipolar Power Transistor  
For Switching Power Supply Applications**

The BUL146/BUL146F have an applications specific state-of-the-art die designed for use in fluorescent electric lamp ballasts to 130 Watts and in Switchmode Power supplies for all types of electronic equipment. These high voltage/high speed transistors offer the following:

- Improved Efficiency Due to Low Base Drive Requirements:
  - High and Flat DC Current Gain
  - Fast Switching
  - No Coil Required in Base Circuit for Turn-Off (No Current Tail)
- Full Characterization at 125°C
- Two Packages Choices: Standard TO220 or Isolated TO220
- Parametric Distributions are Tight and Consistent Lot-to-Lot
- BUL146F, Case 221D, is UL Recognized to 3500 VRMS: File # E69369

**MAXIMUM RATINGS**

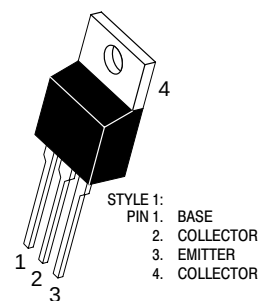
| Rating                                                                                   | Sym-<br>bol                               | BUL146      | BUL146F              | Unit          |
|------------------------------------------------------------------------------------------|-------------------------------------------|-------------|----------------------|---------------|
| Collector-Emitter Sustaining Voltage                                                     | $V_{CEO}$                                 | 400         |                      | Vdc           |
| Collector-Emitter Breakdown Voltage                                                      | $V_{CES}$                                 | 700         |                      | Vdc           |
| Emitter-Base Voltage                                                                     | $V_{EBO}$                                 | 9.0         |                      | Vdc           |
| Collector Current – Continuous                                                           | $I_C$                                     | 6.0         |                      | Adc           |
| – Peak(1)                                                                                | $I_{CM}$                                  | 15          |                      |               |
| Base Current – Continuous                                                                | $I_B$                                     | 4.0         |                      | Adc           |
| – Peak(1)                                                                                | $I_{BM}$                                  | 8.0         |                      |               |
| RMS Isolation Voltage: (2)<br>(for 1 sec, R.H. $\leq$ 30%,<br>$T_C = 25^\circ\text{C}$ ) | $V_{ISOL1}$<br>$V_{ISOL2}$<br>$V_{ISOL3}$ | –<br>–<br>– | 4500<br>3500<br>1500 | Volts         |
| Total Device Dissipation<br>Derate above 25°C ( $T_C = 25^\circ\text{C}$ )               | $P_D$                                     | 100<br>0.8  | 40<br>0.32           | Watts<br>W/°C |
| Operating and Storage Temperature                                                        | $T_J, T_{stg}$                            | – 65 to 150 |                      | °C            |

**THERMAL CHARACTERISTICS**

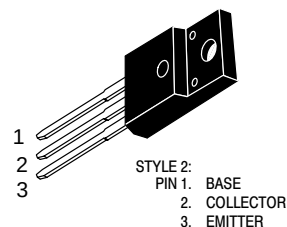
| Rating                                                                           | Sym-<br>bol                        | BUL146       | BUL146F       | Unit |
|----------------------------------------------------------------------------------|------------------------------------|--------------|---------------|------|
| Thermal Resistance – Junction to Case<br>– Junction to Ambient                   | $R_{\theta JC}$<br>$R_{\theta JA}$ | 1.25<br>62.5 | 3.125<br>62.5 | °C/W |
| Maximum Lead Temperature for Soldering<br>Purposes: 1/8" from Case for 5 Seconds | $T_L$                              | 260          |               | °C   |

**BUL146  
BUL146F**

**POWER TRANSISTOR  
6.0 AMPERES  
700 VOLTS  
40 and 100 WATTS**



**BUL146  
CASE 221A-09  
TO-220AB**



**CASE 221D-02  
ISOLATED TO-220 TYPE  
BUL146F**

# BUL146 BUL146F

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

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

### OFF CHARACTERISTICS

|                                                                                           |                       |     |   |     |      |
|-------------------------------------------------------------------------------------------|-----------------------|-----|---|-----|------|
| Collector–Emitter Sustaining Voltage (I <sub>C</sub> = 100 mA, L = 25 mH)                 | V <sub>CEO(sus)</sub> | 400 | – | –   | Vdc  |
| Collector Cutoff Current (V <sub>CE</sub> = Rated V <sub>CEO</sub> , I <sub>B</sub> = 0)  | I <sub>CEO</sub>      | –   | – | 100 | μAdc |
| Collector Cutoff Current (V <sub>CE</sub> = Rated V <sub>CES</sub> , V <sub>EB</sub> = 0) | I <sub>CES</sub>      | –   | – | 100 | μAdc |
| (T <sub>C</sub> = 125°C)                                                                  |                       | –   | – | 500 |      |
| (V <sub>CE</sub> = 500 V, V <sub>EB</sub> = 0) (T <sub>C</sub> = 125°C)                   |                       | –   | – | 100 |      |
| Emitter Cutoff Current (V <sub>EB</sub> = 9.0 Vdc, I <sub>C</sub> = 0)                    | I <sub>EBO</sub>      | –   | – | 100 | μAdc |

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

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

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

### ON CHARACTERISTICS

|                                                                                            |                      |     |      |      |     |
|--------------------------------------------------------------------------------------------|----------------------|-----|------|------|-----|
| Base–Emitter Saturation Voltage (I <sub>C</sub> = 1.3 Adc, I <sub>B</sub> = 0.13 Adc)      | V <sub>BE(sat)</sub> | –   | 0.82 | 1.1  | Vdc |
| (I <sub>C</sub> = 3.0 Adc, I <sub>B</sub> = 0.6 Adc)                                       |                      | –   | 0.93 | 1.25 |     |
| Collector–Emitter Saturation Voltage (I <sub>C</sub> = 1.3 Adc, I <sub>B</sub> = 0.13 Adc) | V <sub>CE(sat)</sub> | –   | 0.22 | 0.5  | Vdc |
| (T <sub>C</sub> = 125°C)                                                                   |                      | –   | 0.20 | 0.5  |     |
| (I <sub>C</sub> = 3.0 Adc, I <sub>B</sub> = 0.6 Adc)                                       |                      | –   | 0.30 | 0.7  |     |
| (T <sub>C</sub> = 125°C)                                                                   |                      | –   | 0.30 | 0.7  |     |
| DC Current Gain (I <sub>C</sub> = 0.5 Adc, V <sub>CE</sub> = 5.0 Vdc)                      | h <sub>FE</sub>      | 14  | –    | 34   | –   |
| (T <sub>C</sub> = 125°C)                                                                   |                      | –   | 30   | –    |     |
| (I <sub>C</sub> = 1.3 Adc, V <sub>CE</sub> = 1.0 Vdc)                                      |                      | 12  | 20   | –    |     |
| (T <sub>C</sub> = 125°C)                                                                   |                      | 12  | 20   | –    |     |
| (I <sub>C</sub> = 3.0 Adc, V <sub>CE</sub> = 1.0 Vdc)                                      |                      | 8.0 | 13   | –    |     |
| (T <sub>C</sub> = 125°C)                                                                   |                      | 7.0 | 12   | –    |     |
| (I <sub>C</sub> = 10 mAdc, V <sub>CE</sub> = 5.0 Vdc)                                      |                      | 10  | 20   | –    |     |

### DYNAMIC CHARACTERISTICS

|                                                                                                                                                                    |                                                                                       |                   |                             |                       |   |      |      |     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-------------------|-----------------------------|-----------------------|---|------|------|-----|
| Current Gain Bandwidth ( $I_C = 0.5 \text{ Adc}$ , $V_{CE} = 10 \text{ Vdc}$ , $f = 1.0 \text{ MHz}$ )                                                             |                                                                                       |                   |                             | $f_T$                 | – | 14   | –    | MHz |
| Output Capacitance ( $V_{CB} = 10 \text{ Vdc}$ , $I_E = 0$ , $f = 1.0 \text{ MHz}$ )                                                                               |                                                                                       |                   |                             | $C_{OB}$              | – | 95   | 150  | pF  |
| Input Capacitance ( $V_{EB} = 8.0 \text{ V}$ )                                                                                                                     |                                                                                       |                   |                             | $C_{IB}$              | – | 1000 | 1500 | pF  |
| Dynamic Saturation Voltage:<br>Determined 1.0 $\mu\text{s}$ and 3.0 $\mu\text{s}$ respectively after rising $I_{B1}$ reaches 90% of final $I_{B1}$ (see Figure 18) | $(I_C = 1.3 \text{ Adc}$<br>$I_{B1} = 300 \text{ mAdc}$<br>$V_{CC} = 300 \text{ V}$ ) | 1.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ | $V_{CE}(\text{dsat})$ | – | 2.5  | –    | V   |
|                                                                                                                                                                    |                                                                                       | 3.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 6.5  | –    |     |
|                                                                                                                                                                    | $(I_C = 3.0 \text{ Adc}$<br>$I_{B1} = 0.6 \text{ Adc}$<br>$V_{CC} = 300 \text{ V}$ )  | 1.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 0.6  | –    |     |
|                                                                                                                                                                    |                                                                                       | 3.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 2.5  | –    |     |
|                                                                                                                                                                    |                                                                                       | 1.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 3.0  | –    |     |
|                                                                                                                                                                    |                                                                                       | 3.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 7.0  | –    |     |
|                                                                                                                                                                    |                                                                                       | 1.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 0.75 | –    |     |
|                                                                                                                                                                    |                                                                                       | 3.0 $\mu\text{s}$ | $(T_C = 125^\circ\text{C})$ |                       | – | 1.4  | –    |     |

# BUL146 BUL146F

## SWITCHING CHARACTERISTICS: Resistive Load ( $D.C. \leq 10\%$ , Pulse Width = 20 $\mu s$ )

|               |                                                                                                                                              |           |   |      |     |         |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------|-----------|---|------|-----|---------|
| Turn-On Time  | $(I_C = 1.3 \text{ Adc}, I_{B1} = 0.13 \text{ Adc}$<br>$I_{B2} = 0.65 \text{ Adc}, V_{CC} = 300 \text{ V})$<br>( $T_C = 125^\circ\text{C}$ ) | $t_{on}$  | – | 100  | 200 | ns      |
| Turn-Off Time |                                                                                                                                              | $t_{off}$ | – | 90   | –   | –       |
| Turn-On Time  | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 1.5 \text{ Adc}, V_{CC} = 300 \text{ V})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{on}$  | – | 1.35 | 2.5 | $\mu s$ |
| Turn-Off Time |                                                                                                                                              | $t_{off}$ | – | 1.90 | –   | –       |
| Turn-On Time  | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 1.5 \text{ Adc}, V_{CC} = 300 \text{ V})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{on}$  | – | 90   | 150 | ns      |
| Turn-Off Time |                                                                                                                                              | $t_{off}$ | – | 100  | –   | –       |
| Turn-On Time  | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 1.5 \text{ Adc}, V_{CC} = 300 \text{ V})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{on}$  | – | 1.7  | 2.5 | $\mu s$ |
| Turn-Off Time |                                                                                                                                              | $t_{off}$ | – | 2.1  | –   | –       |

## SWITCHING CHARACTERISTICS: Inductive Load ( $V_{clamp} = 300 \text{ V}$ , $V_{CC} = 15 \text{ V}$ , $L = 200 \mu H$ )

|                |                                                                                                                      |          |     |      |     |         |
|----------------|----------------------------------------------------------------------------------------------------------------------|----------|-----|------|-----|---------|
| Fall Time      | $(I_C = 1.3 \text{ Adc}, I_{B1} = 0.13 \text{ Adc}$<br>$I_{B2} = 0.65 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ ) | $t_{fi}$ | –   | 115  | 200 | ns      |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 120  | –   | –       |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 1.35 | 2.5 | $\mu s$ |
| Fall Time      | $(I_C = 1.3 \text{ Adc}, I_{B1} = 0.13 \text{ Adc}$<br>$I_{B2} = 0.65 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ ) | $t_{fi}$ | –   | 1.75 | –   | –       |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 210  | 350 | ns      |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 210  | –   | –       |
| Fall Time      | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 1.5 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{fi}$ | –   | 85   | 150 | ns      |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 100  | –   | –       |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 1.75 | 2.5 | $\mu s$ |
| Fall Time      | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 1.5 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{fi}$ | –   | 2.25 | –   | –       |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 200  | 300 | ns      |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 200  | –   | –       |
| Fall Time      | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 0.6 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{fi}$ | 80  | –    | 180 | ns      |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 210  | –   | –       |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 2.6  | 3.8 | $\mu s$ |
| Fall Time      | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 0.6 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{fi}$ | 2.6 | –    | –   | –       |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | 4.5  | –   | –       |
| Crossover Time |                                                                                                                      | $t_c$    | –   | 230  | 350 | ns      |
| Fall Time      | $(I_C = 3.0 \text{ Adc}, I_{B1} = 0.6 \text{ Adc}$<br>$I_{B2} = 0.6 \text{ Adc})$<br>( $T_C = 125^\circ\text{C}$ )   | $t_{fi}$ | –   | 400  | –   | –       |
| Storage Time   |                                                                                                                      | $t_{si}$ | –   | –    | –   | –       |
| Crossover Time |                                                                                                                      | $t_c$    | –   | –    | –   | –       |

TYPICAL STATIC CHARACTERISTICS

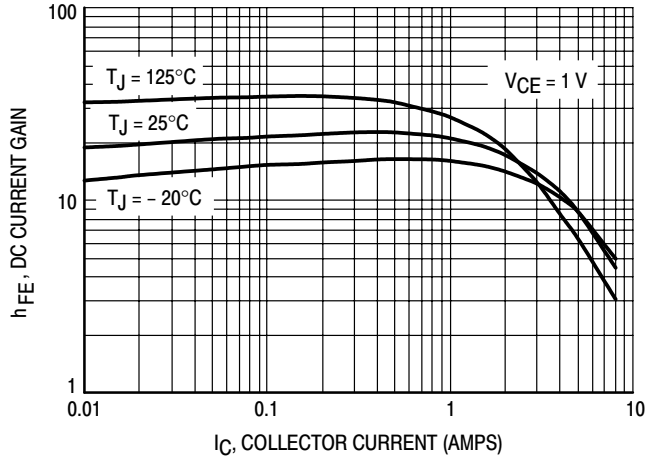


Figure 1. DC Current Gain @ 1 Volt

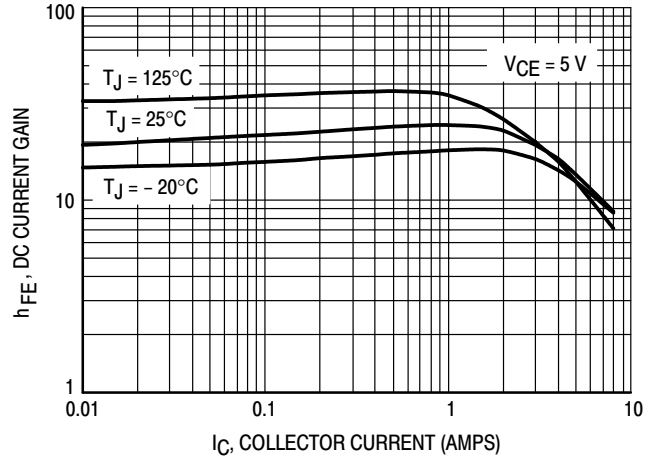


Figure 2. DC Current Gain @ 5 Volts

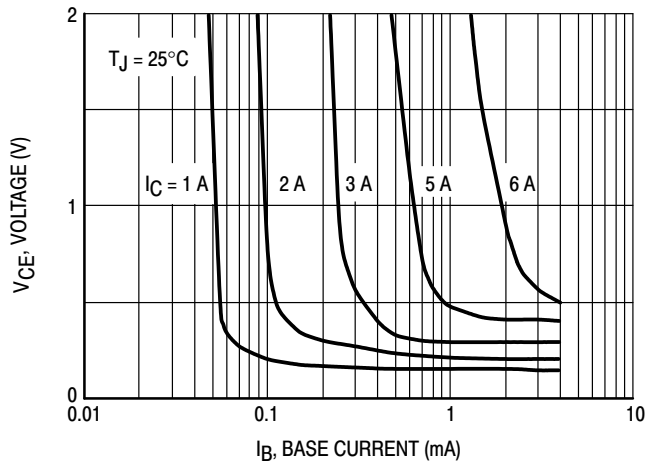


Figure 3. Collector Saturation Region

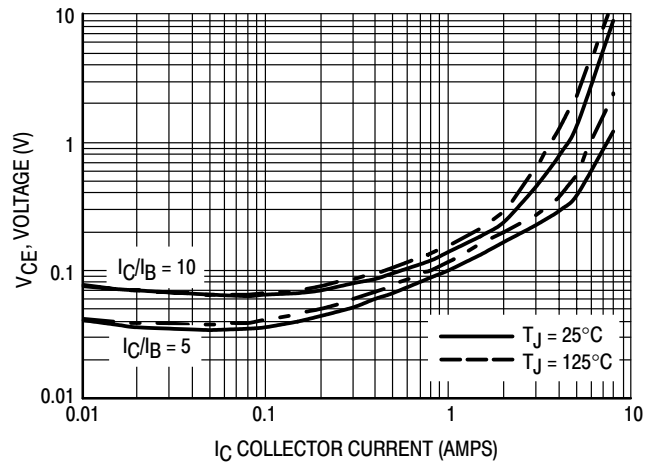


Figure 4. Collector-Emitter Saturation Voltage

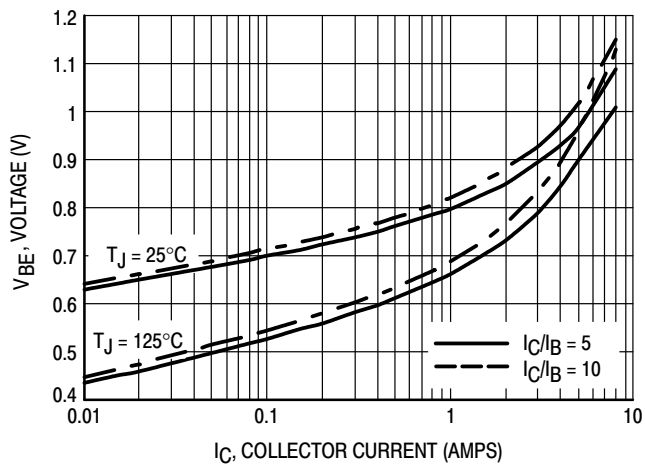


Figure 5. Base-Emitter Saturation Region

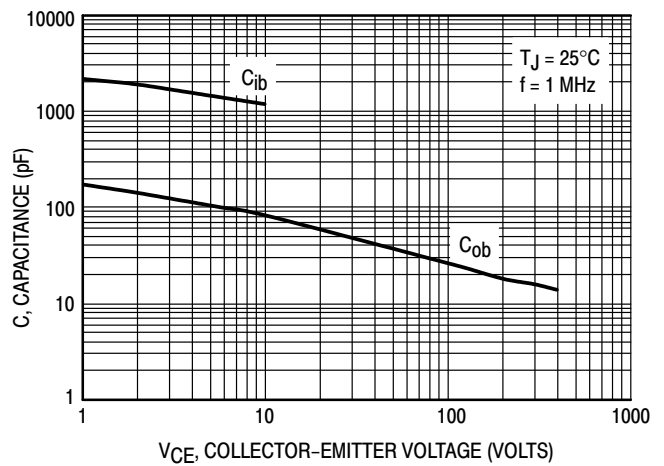


Figure 6. Capacitance

TYPICAL SWITCHING CHARACTERISTICS  
( $I_{B2} = I_C/2$  for all switching)

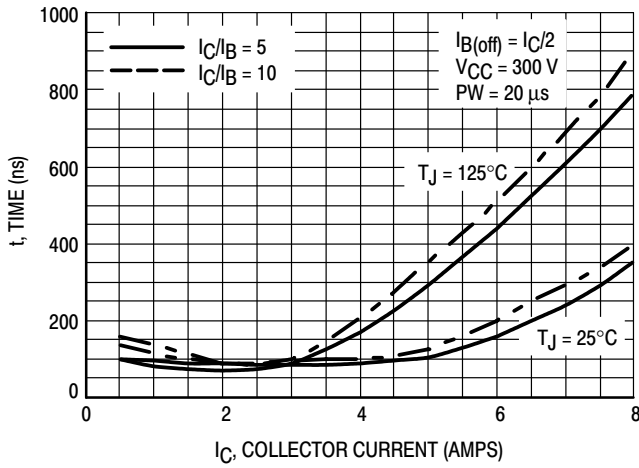


Figure 7. Resistive Switching,  $t_{on}$

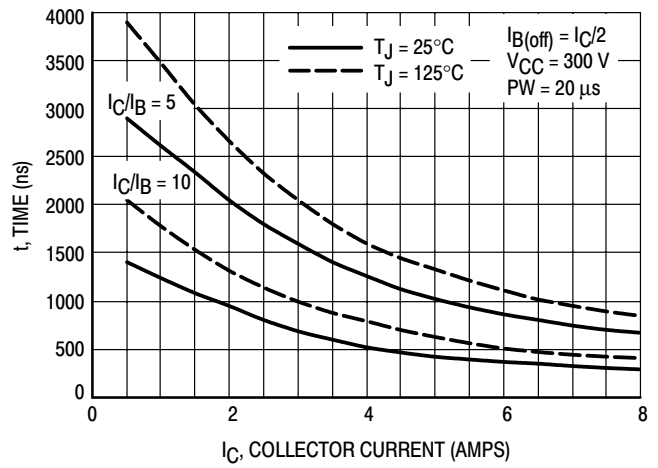


Figure 8. Resistive Switching,  $t_{off}$

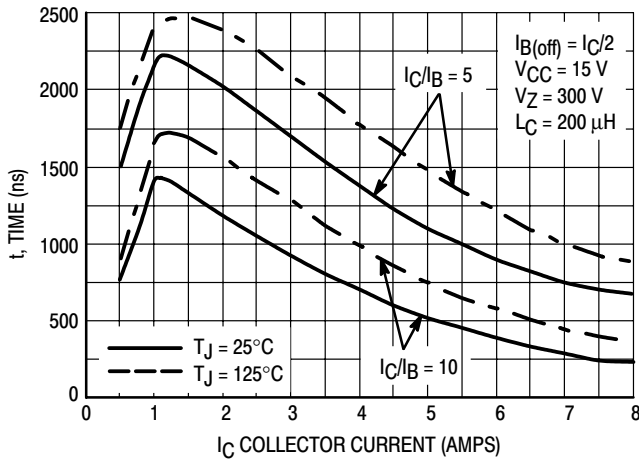


Figure 9. Inductive Storage Time,  $t_{si}$

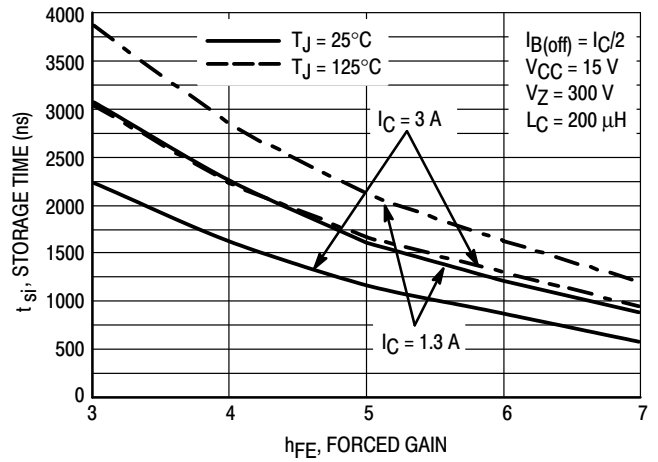


Figure 10. Inductive Storage Time,  $t_{si}(h_{FE})$

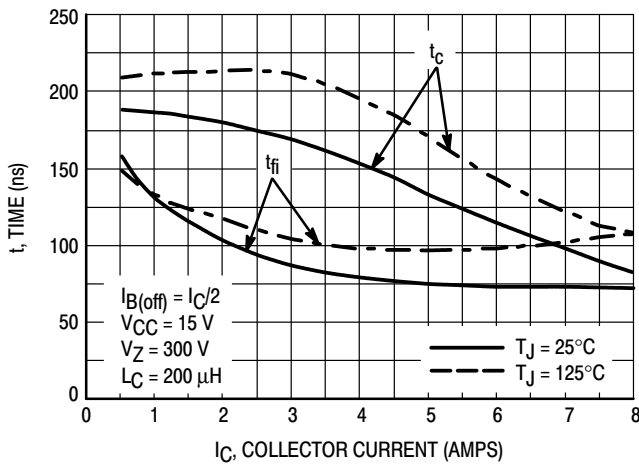


Figure 11. Inductive Switching,  $t_c$  and  $t_{fi}$   
 $I_C/I_B = 5$

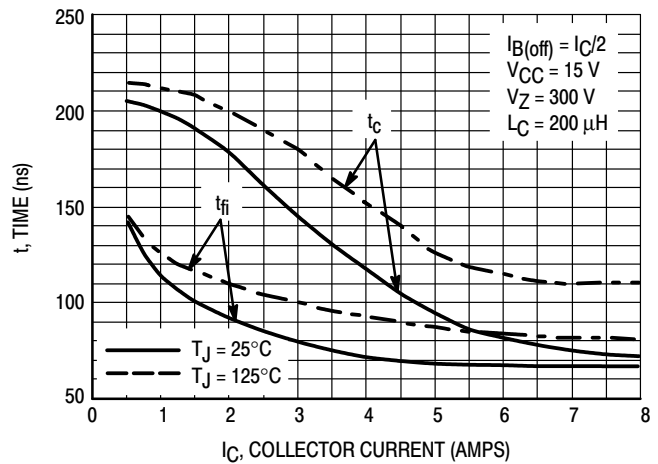


Figure 12. Inductive Switching,  $t_c$  and  $t_{fi}$   
 $I_C/I_B = 10$

**TYPICAL SWITCHING CHARACTERISTICS**  
( $I_{B2} = I_C/2$  for all switching)

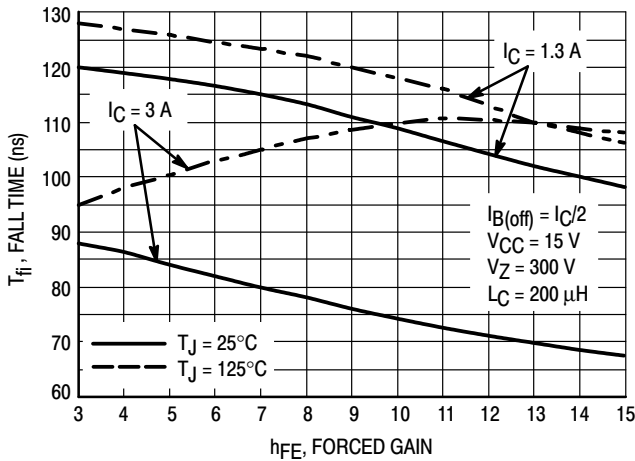


Figure 13. Inductive Fall Time

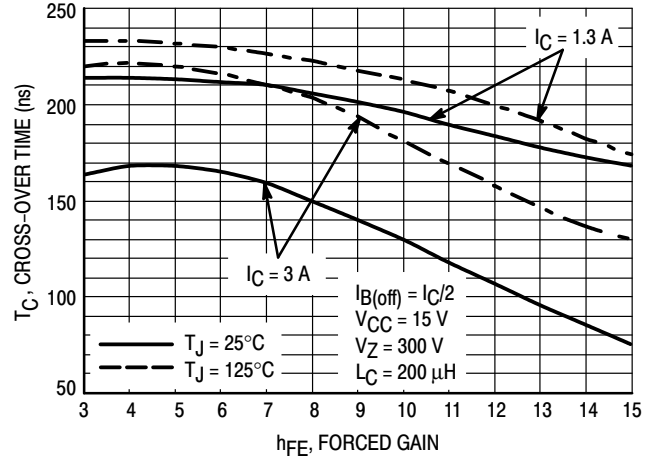


Figure 14. Inductive Cross-Over Time

**GUARANTEED SAFE OPERATING AREA INFORMATION**

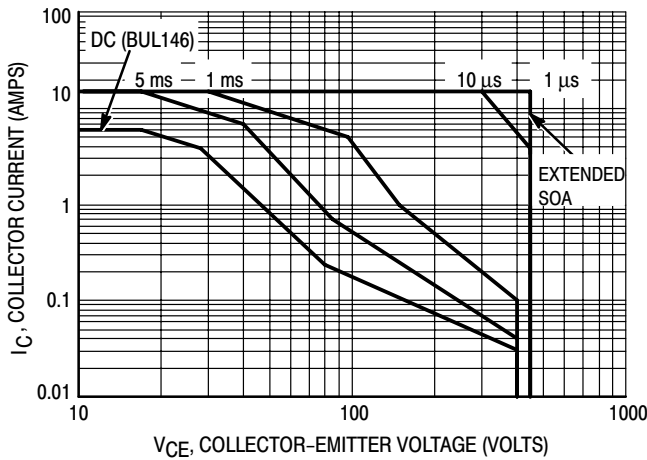


Figure 15. Forward Bias Safe Operating Area

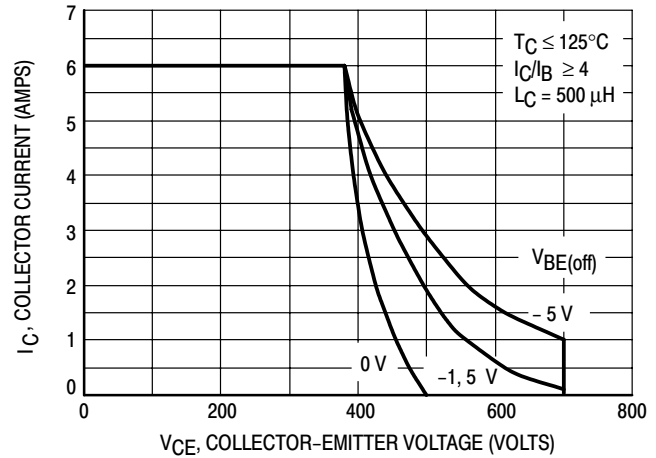


Figure 16. Reverse Bias Switching Safe Operating Area

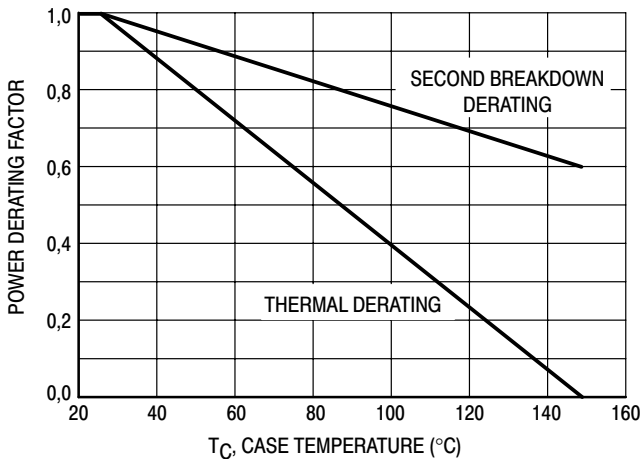


Figure 17. Forward Bias Power Derating

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 15 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 in Figure 15 may be found at any case temperature by using the appropriate curve on Figure 17.  $T_{J(pk)}$  may be calculated from the data in Figure 20. 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 16). This rating is verified under clamped conditions so that the device is never subjected to an avalanche mode.

BUL146 BUL146F

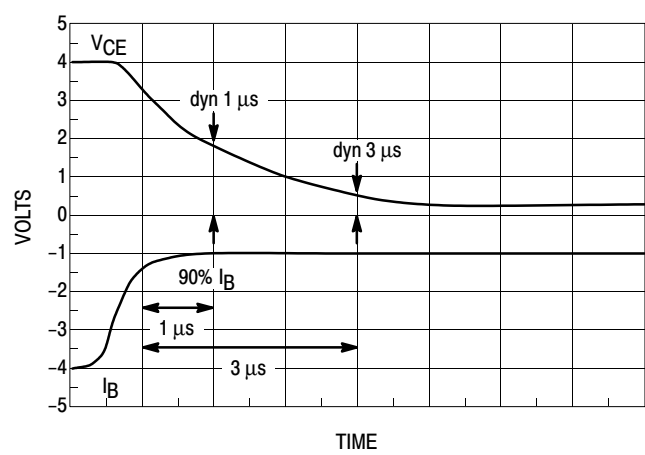


Figure 18. Dynamic Saturation Voltage Measurements

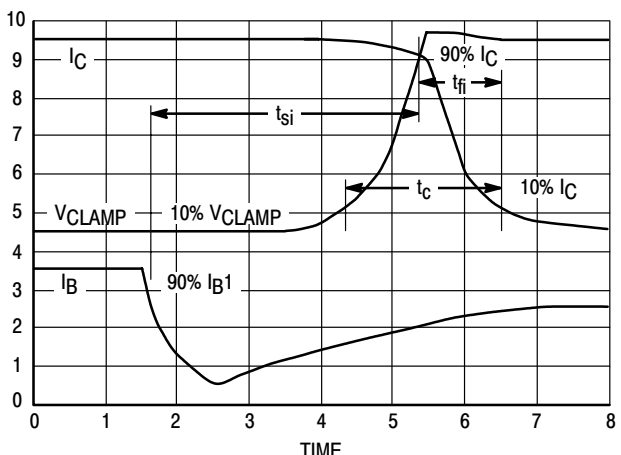


Figure 19. Inductive Switching Measurements

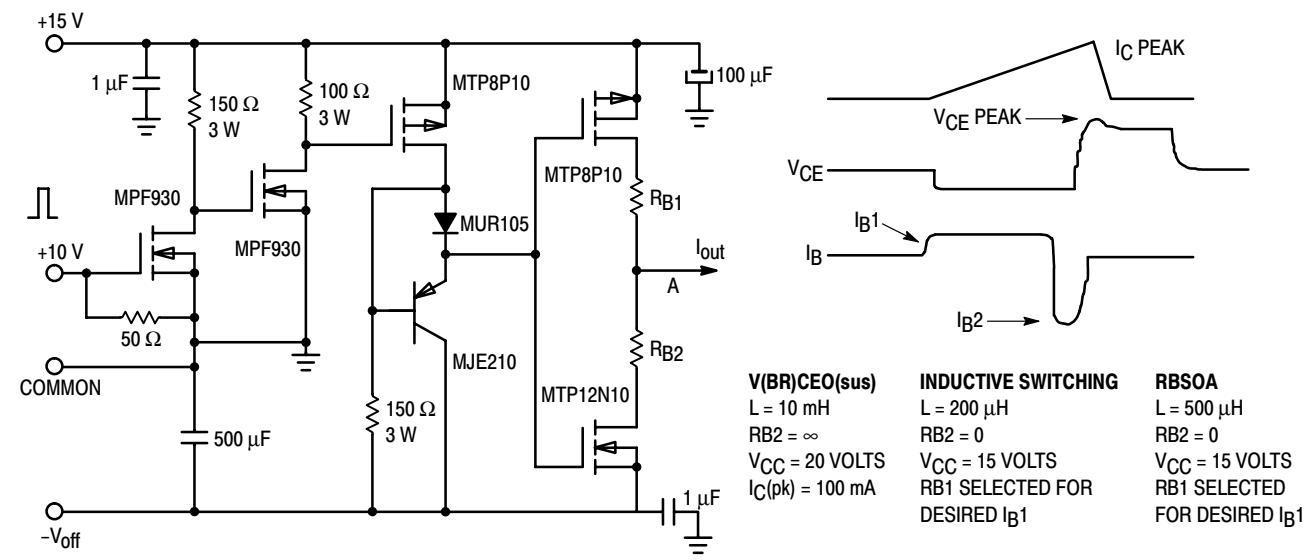


Table 1. Inductive Load Switching Drive Circuit

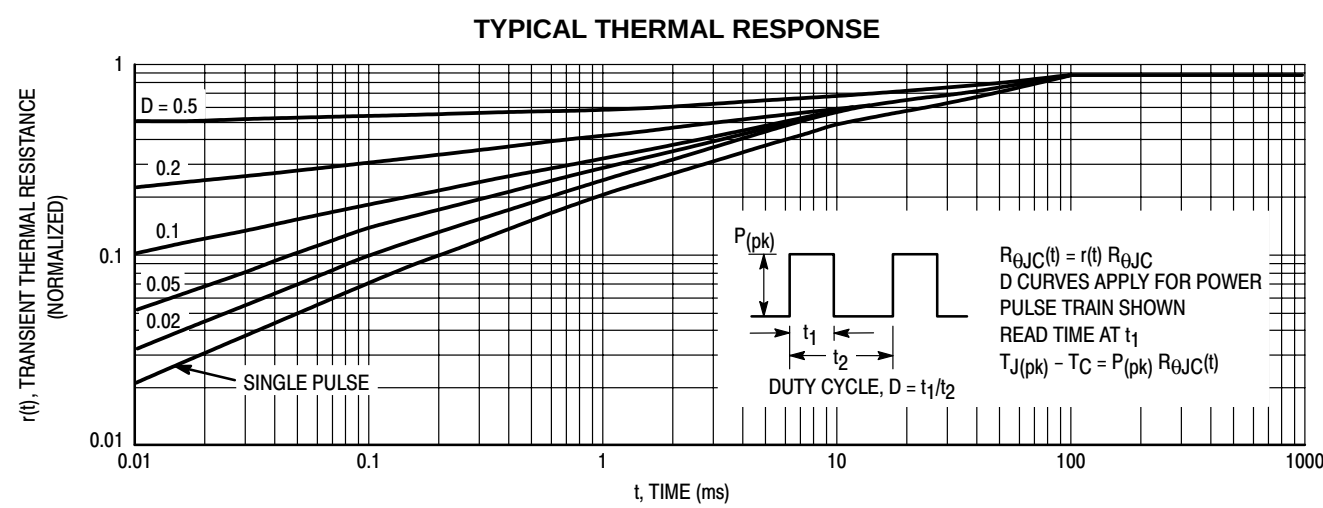


Figure 20. Typical Thermal Response ( $Z_{\theta JC}(t)$ ) for BUL146

# BUL146 BUL146F

## TYPICAL THERMAL RESPONSE

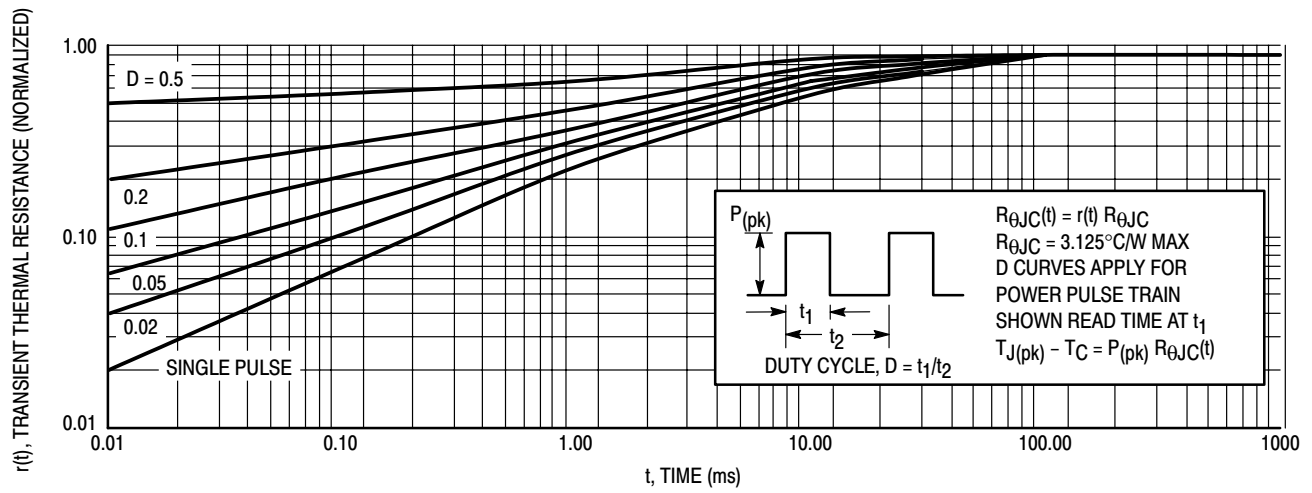


Figure 21. Typical Thermal Response for BUL146F



TEST CONDITIONS FOR ISOLATION TESTS\*

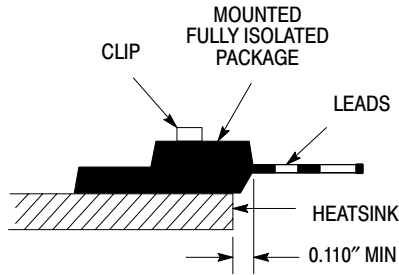


Figure 22a. Screw or Clip Mounting Position for Isolation Test Number 1

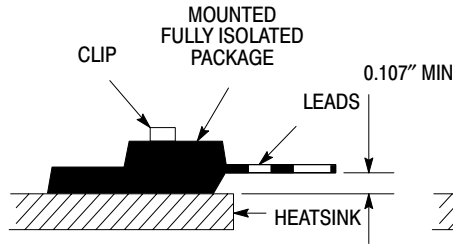


Figure 22b. Clip Mounting Position for Isolation Test Number 2

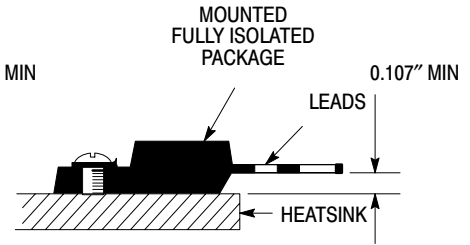


Figure 22c. Screw Mounting Position for Isolation Test Number 3

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

MOUNTING INFORMATION\*\*

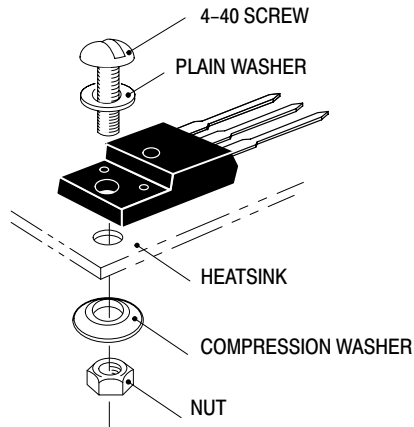


Figure 23a. Screw-Mounted

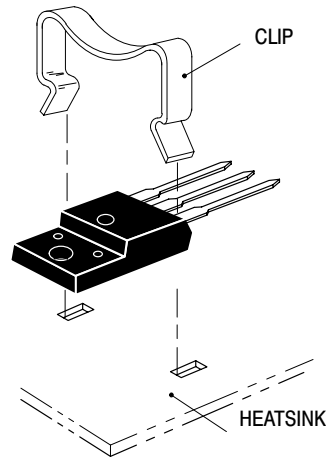


Figure 23b. Clip-Mounted

Figure 23. 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.

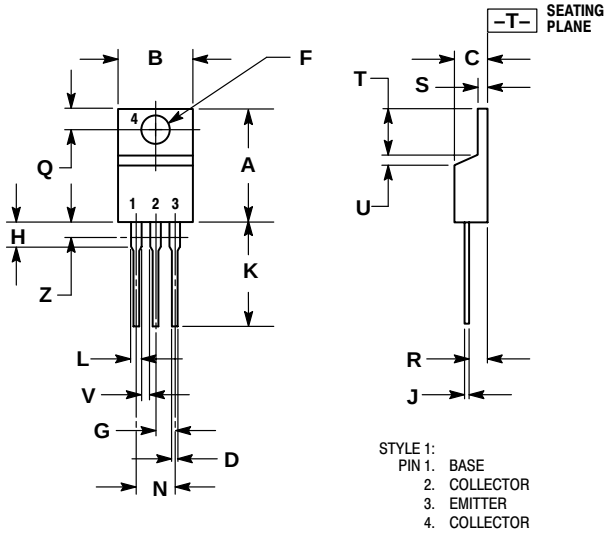
Additional tests on slotted 4–40 screws indicate that the screw slot fails between 15 to 20 in · lbs without adversely affecting the package. However, in order to positively ensure the package integrity of the fully isolated device, ON Semiconductor does not recommend exceeding 10 in · lbs of mounting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

\*\* For more information about mounting power semiconductors see Application Note AN1040.

# BUL146 BUL146F

## PACKAGE DIMENSIONS

### TO-220AB CASE 221A-09 ISSUE AA



#### NOTES:

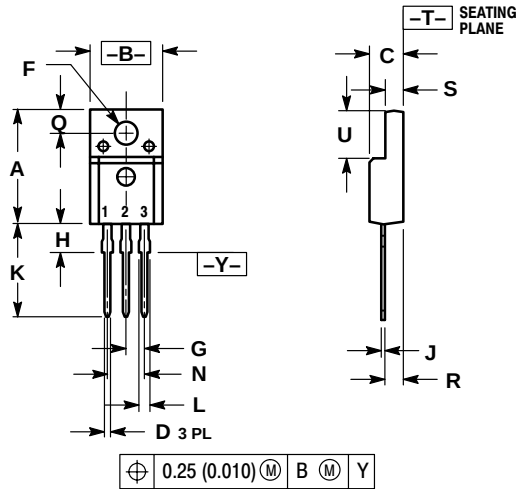
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

| 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  | 0.035 | 0.64        | 0.88  |
| F   | 0.142  | 0.147 | 3.61        | 3.73  |
| G   | 0.095  | 0.105 | 2.42        | 2.66  |
| H   | 0.110  | 0.155 | 2.80        | 3.93  |
| J   | 0.018  | 0.025 | 0.46        | 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  |

# BUL146 BUL146F

## PACKAGE DIMENSIONS

CASE 221D-02  
(ISOLATED TO-220 TYPE)  
UL RECOGNIZED: FILE #E69369  
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  |

### STYLE 2:

1. BASE
2. COLLECTOR
3. EMITTER

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