

# MJF6388 (NPN), MJF6668 (PNP)

## Complementary Power Darlington

### For Isolated Package Applications

Designed for general-purpose amplifiers and switching applications, where the mounting surface of the device is required to be electrically isolated from the heatsink or chassis.

#### Features

- Isolated Overmold Package
- Electrically Similar to the Popular 2N6388, 2N6668, TIP102, and TIP107
- No Isolating Washers Required, Reduced System Cost
- High DC Current Gain
- High Isolation Voltage
- UL Recognized at 3500 VRMS: File #E69369
- These Devices are Pb-Free and are RoHS Compliant\*

#### MAXIMUM RATINGS

| Rating                                                                                                            | Symbol         | Value           | Unit                     |
|-------------------------------------------------------------------------------------------------------------------|----------------|-----------------|--------------------------|
| Collector-Emitter Voltage                                                                                         | $V_{CEO}$      | 100             | Vdc                      |
| Collector-Base Voltage                                                                                            | $V_{CB}$       | 100             | Vdc                      |
| Emitter-Base Voltage                                                                                              | $V_{EB}$       | 5.0             | Vdc                      |
| RMS Isolation Voltage (Note 1)<br>( $t = 0.3$ sec, R.H. $\leq 30\%$ , $T_A = 25^\circ\text{C}$ )<br>Per Figure 14 | $V_{ISOL}$     | 4500            | V                        |
| Collector Current – Continuous                                                                                    | $I_C$          | 10              | Adc                      |
| Collector Current – Peak (Note 2)                                                                                 | $I_{CM}$       | 15              | Adc                      |
| Base Current – Continuous                                                                                         | $I_B$          | 1.0             | Adc                      |
| Total Power Dissipation (Note 3)<br>@ $T_C = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$                 | $P_D$          | 40<br>0.31      | W<br>W/ $^\circ\text{C}$ |
| Total Power Dissipation<br>@ $T_A = 25^\circ\text{C}$<br>Derate above $25^\circ\text{C}$                          | $P_D$          | 2.0<br>0.016    | W<br>W/ $^\circ\text{C}$ |
| Operating and Storage Temperature Range                                                                           | $T_J, T_{stg}$ | $-65$ to $+150$ | $^\circ\text{C}$         |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Proper strike and creepage distance must be provided.
2. Pulse Test: Pulse Width = 5.0 ms, Duty Cycle  $\leq 10\%$ .
3. Measurement made with thermocouple contacting the bottom insulated surface (in a location beneath the die), the devices mounted on a heatsink with thermal grease and a mounting torque of  $\geq 6$  in. lbs.

#### THERMAL CHARACTERISTICS

| Characteristic                                | Symbol          | Max  | Unit               |
|-----------------------------------------------|-----------------|------|--------------------|
| Thermal Resistance, Junction-to-Case (Note 4) | $R_{\theta JC}$ | 4.0  | $^\circ\text{C/W}$ |
| Thermal Resistance, Junction-to-Ambient       | $R_{\theta JA}$ | 62.5 | $^\circ\text{C/W}$ |
| Lead Temperature for Soldering Purposes       | $T_L$           | 260  | $^\circ\text{C}$   |

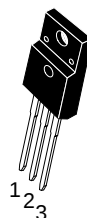
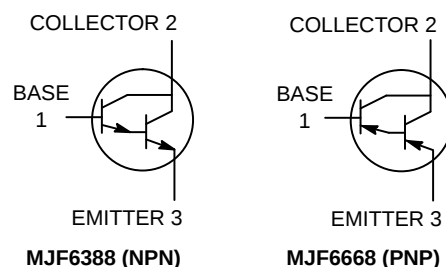
4. Measurement made with thermocouple contacting the bottom insulated surface (in a location beneath the die), the devices mounted on a heatsink with thermal grease and a mounting torque of  $\geq 6$  in. lbs.



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### COMPLEMENTARY SILICON POWER DARLINGTONS 10 AMPERES 100 VOLTS, 40 WATTS



TO-220 FULLPACK  
CASE 221D  
STYLE 2  
UL RECOGNIZED

#### MARKING DIAGRAM



MJF6xy8 = Specific Device Code  
 x = 3 or 6  
 y = 6 or 8  
 G = Pb-Free Package  
 A = Assembly Location  
 Y = Year  
 WW = Work Week

#### ORDERING INFORMATION

| Device   | Package                   | Shipping      |
|----------|---------------------------|---------------|
| MJF6388G | TO-220 FULLPACK (Pb-Free) | 50 Units/Rail |
| MJF6668G | TO-220 FULLPACK (Pb-Free) | 50 Units/Rail |

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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

| Characteristic                                                                                                                                                                                                                                                    | Symbol         | Min                        | Max                      | Unit                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------|--------------------------|-------------------------|
| <b>OFF CHARACTERISTICS</b>                                                                                                                                                                                                                                        |                |                            |                          |                         |
| Collector-Emitter Sustaining Voltage (Note 5)<br>( $I_C = 30\text{ mAdc}$ , $I_B = 0$ )                                                                                                                                                                           | $V_{CEO(sus)}$ | 100                        | –                        | Vdc                     |
| Collector Cutoff Current<br>( $V_{CE} = 80\text{ Vdc}$ , $I_B = 0$ )                                                                                                                                                                                              | $I_{CEO}$      | –                          | 10                       | $\mu\text{Adc}$         |
| Collector Cutoff Current<br>( $V_{CE} = 100\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ )<br>( $V_{CE} = 100\text{ Vdc}$ , $V_{EB(off)} = 1.5\text{ Vdc}$ , $T_C = 125^\circ\text{C}$ )                                                                          | $I_{CEX}$      | –<br>–                     | 10<br>3.0                | $\mu\text{Adc}$<br>mAdc |
| Collector Cutoff Current<br>( $V_{CB} = 100\text{ Vdc}$ , $I_E = 0$ )                                                                                                                                                                                             | $I_{CBO}$      | –                          | 10                       | $\mu\text{Adc}$         |
| Emitter Cutoff Current<br>( $V_{BE} = 5.0\text{ Vdc}$ , $I_C = 0$ )                                                                                                                                                                                               | $I_{EBO}$      | –                          | 2.0                      | mAdc                    |
| <b>ON CHARACTERISTICS (Note 5)</b>                                                                                                                                                                                                                                |                |                            |                          |                         |
| DC Current Gain<br>( $I_C = 3.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )<br>( $I_C = 5.0\text{ Adc}$ , $V_{CE} = 3.0\text{ Vdc}$ )<br>( $I_C = 8.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )<br>( $I_C = 10\text{ Adc}$ , $V_{CE} = 3.0\text{ Vdc}$ )            | $h_{FE}$       | 3000<br>1000<br>200<br>100 | 15000<br>–<br>–<br>–     | –                       |
| Collector-Emitter Saturation Voltage<br>( $I_C = 3.0\text{ Adc}$ , $I_B = 6.0\text{ mAdc}$ )<br>( $I_C = 5.0\text{ Adc}$ , $I_B = 0.01\text{ Adc}$ )<br>( $I_C = 8.0\text{ Adc}$ , $I_B = 80\text{ mAdc}$ )<br>( $I_C = 10\text{ Adc}$ , $I_B = 0.1\text{ Adc}$ ) | $V_{CE(sat)}$  | –<br>–<br>–<br>–           | 2.0<br>2.0<br>2.5<br>3.0 | Vdc                     |
| Base-Emitter Saturation Voltage<br>( $I_C = 5.0\text{ Adc}$ , $I_B = 0.01\text{ Adc}$ )<br>( $I_C = 10\text{ Adc}$ , $I_B = 0.1\text{ Adc}$ )                                                                                                                     | $V_{BE(sat)}$  | –<br>–                     | 2.8<br>4.5               | Vdc                     |
| Base-Emitter On Voltage<br>( $I_C = 8.0\text{ Adc}$ , $V_{CE} = 4.0\text{ Vdc}$ )                                                                                                                                                                                 | $V_{BE(on)}$   | –                          | 2.5                      | Vdc                     |
| <b>DYNAMIC CHARACTERISTICS</b>                                                                                                                                                                                                                                    |                |                            |                          |                         |
| Small-Signal Current Gain<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 5.0\text{ Vdc}$ , $f_{test} = 1.0\text{ MHz}$ )                                                                                                                                                 | $ h_{fe} $     | 20                         | –                        | –                       |
| Output Capacitance<br>( $V_{CB} = 10\text{ Vdc}$ , $I_E = 0$ , $f = 1.0\text{ MHz}$ )<br>MJF6388<br>MJF6668                                                                                                                                                       | $C_{ob}$       | –<br>–                     | 200<br>300               | pF                      |
| Insulation Capacitance<br>(Collector-to-External Heatsink)                                                                                                                                                                                                        | $C_{c-hs}$     | –                          | 3.0 Typ                  | pF                      |
| Small-Signal Current Gain<br>( $I_C = 1.0\text{ Adc}$ , $V_{CE} = 5.0\text{ Vdc}$ , $f = 1.0\text{ kHz}$ )                                                                                                                                                        | $h_{fe}$       | 1000                       | –                        | –                       |

5. Pulse Test: Pulse Width  $\leq 300\text{ }\mu\text{s}$ , Duty Cycle  $\leq 2.0\%$ .

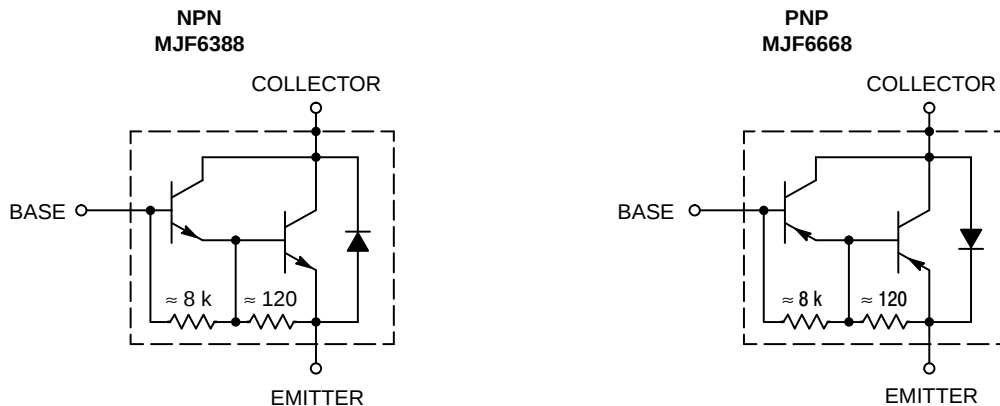


Figure 1. Darlington Schematic

## MJF6388 (NPN), MJF6668 (PNP)

$R_B$  &  $R_C$  VARIED TO OBTAIN DESIRED CURRENT LEVELS

$D_1$ , MUST BE FAST RECOVERY TYPES, e.g.,

MUR110 USED ABOVE  $I_B \approx 100$  mA

MSD6100 USED BELOW  $I_B \approx 100$  mA

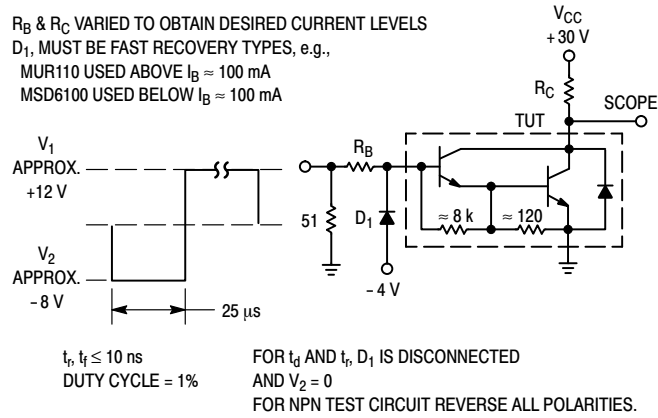


Figure 2. Switching Times Test Circuit

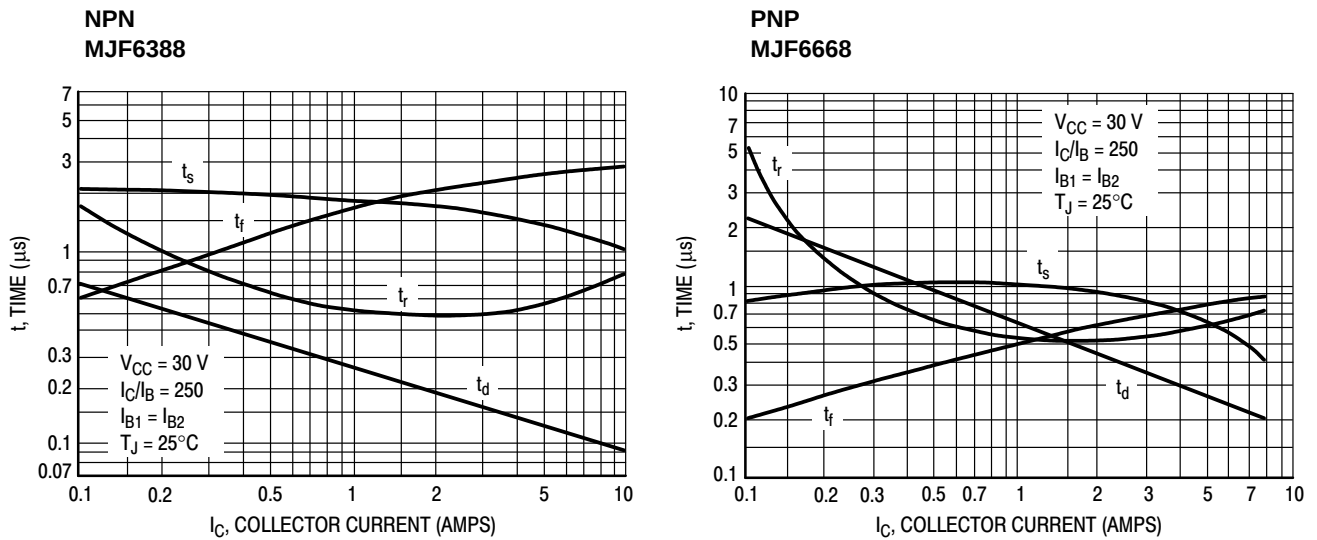


Figure 3. Typical Switching Times

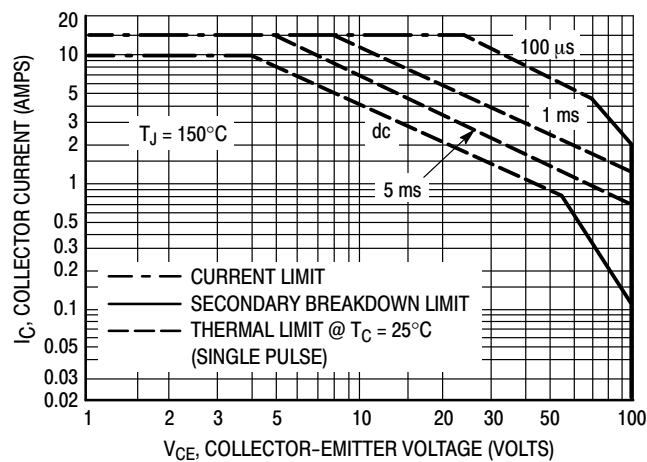


Figure 4. Maximum Forward Bias  
Safe Operating Area

## MJF6388 (NPN), MJF6668 (PNP)

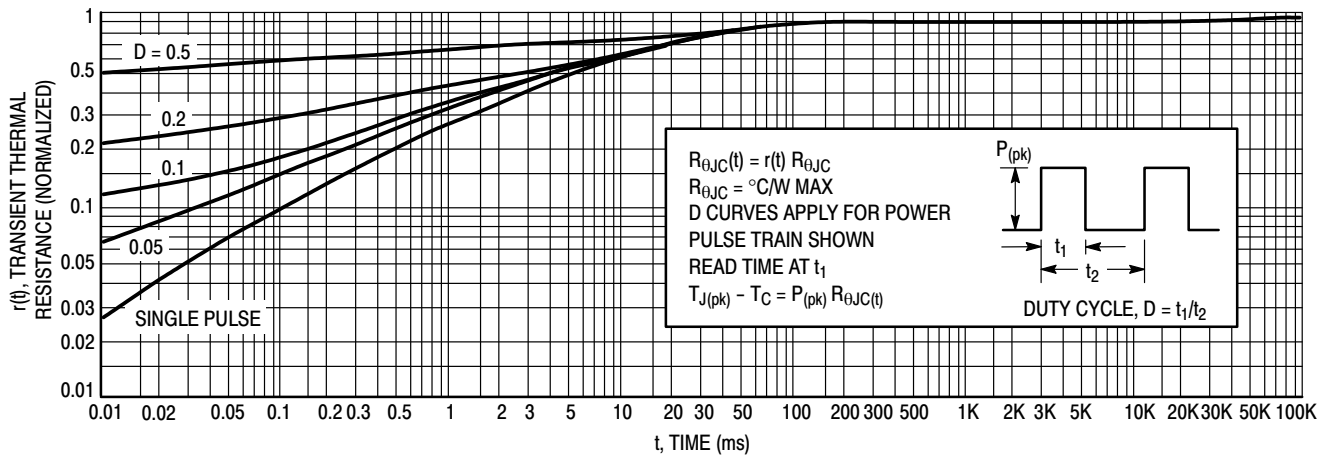


Figure 5. Thermal Response

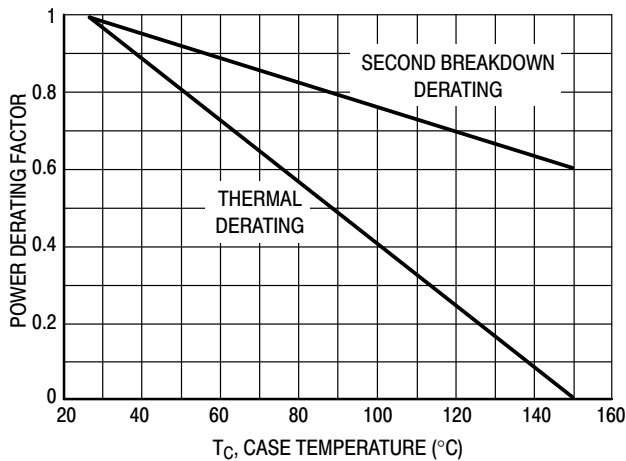


Figure 6. Maximum Power Derating

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 4 is based on  $T_{J(pk)} = 150^\circ\text{C}$ ;  $T_C$  is variable depending on conditions. Secondary breakdown pulse limits are valid for duty cycles to 10% provided  $T_{J(pk)} < 150^\circ\text{C}$ .  $T_{J(pk)}$  may be calculated from the data in Figure 5. At high case temperatures, thermal limitations will reduce the power that can be handled to values less than the limitations imposed by secondary breakdown.

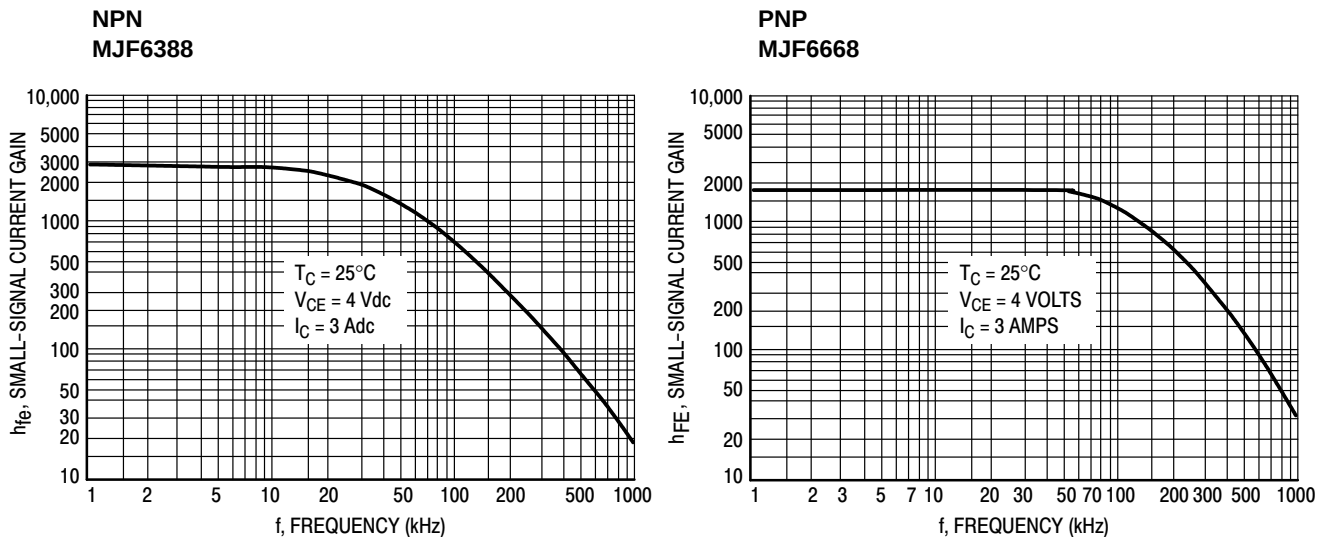


Figure 7. Typical Small-Signal Current Gain

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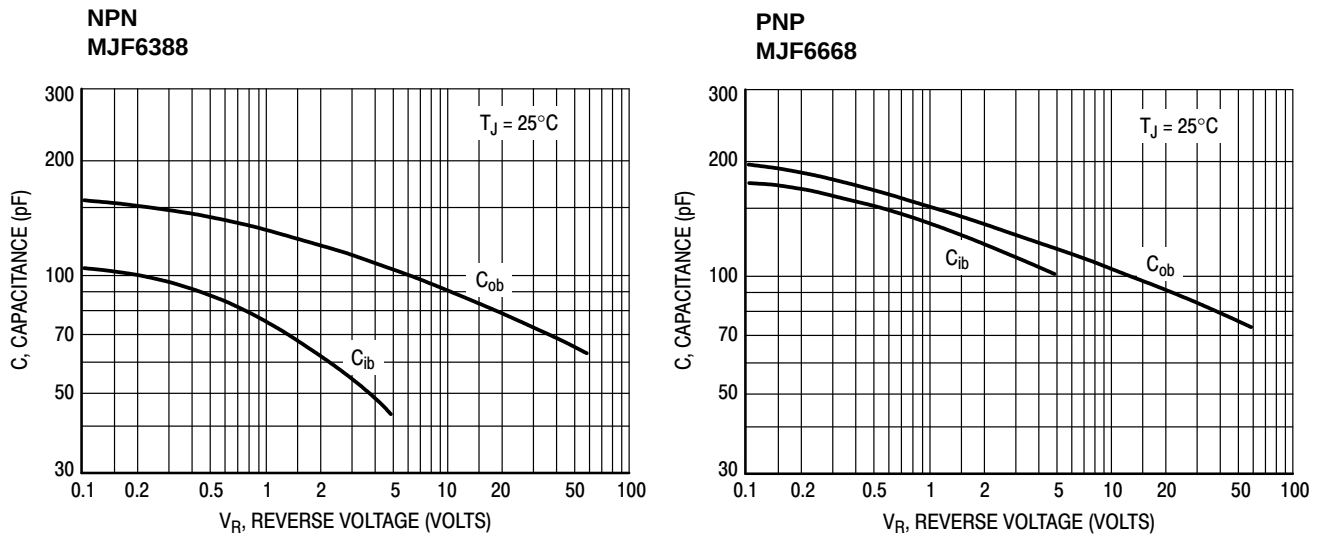


Figure 8. Typical Capacitance

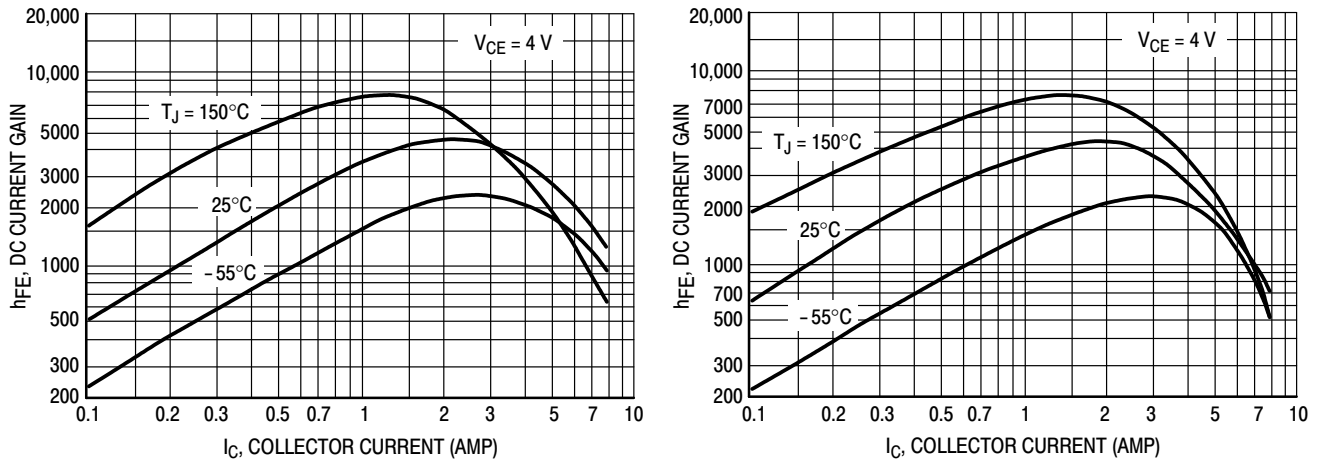


Figure 9. Typical DC Current Gain

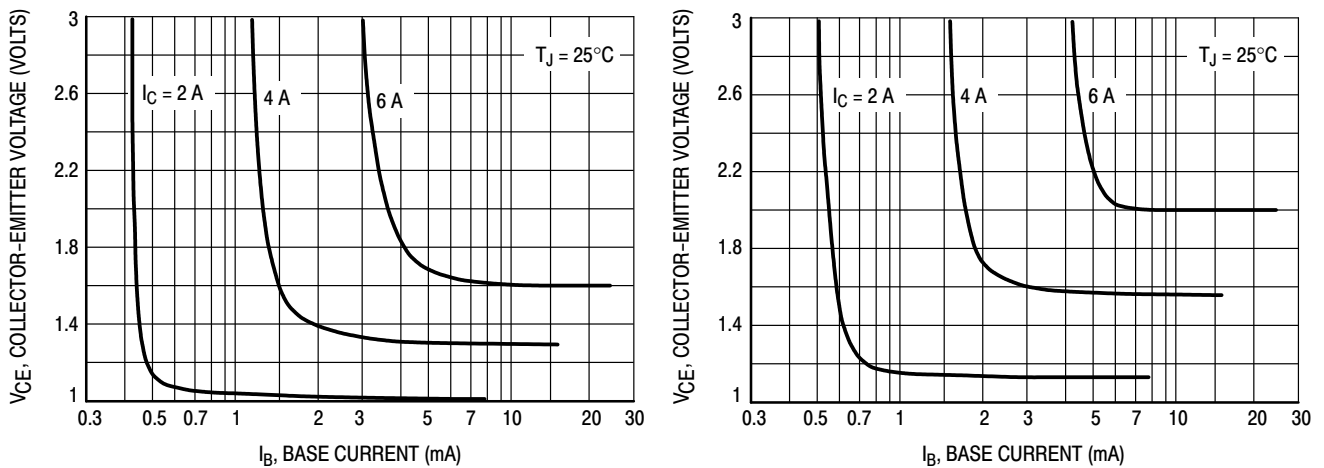


Figure 10. Typical Collector Saturation Region

# MJF6388 (NPN), MJF6668 (PNP)

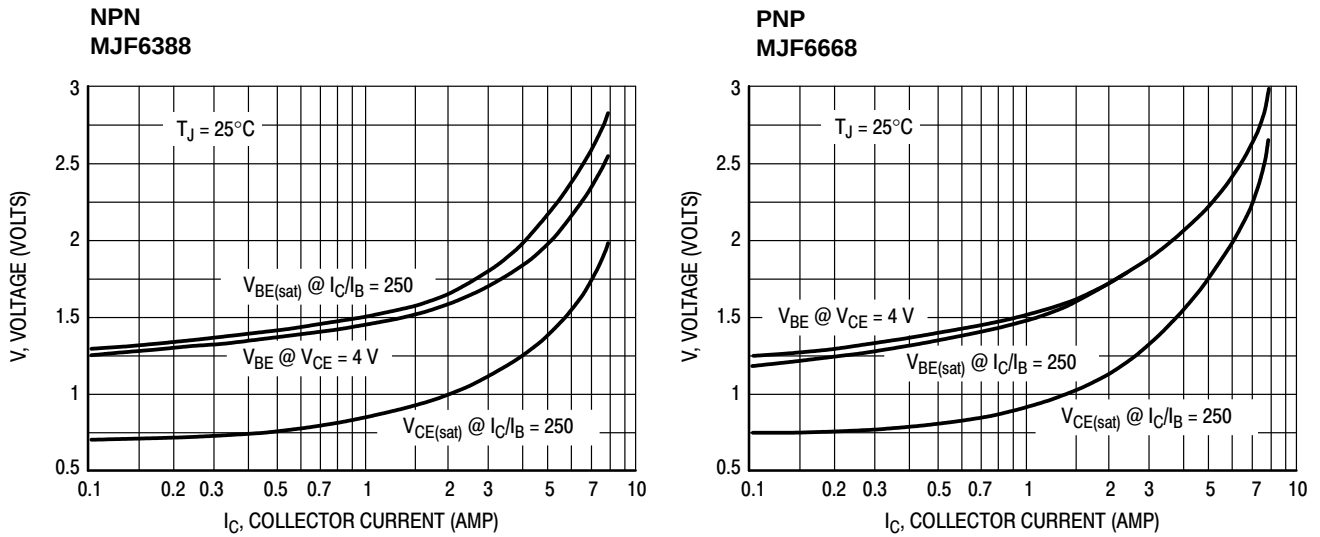


Figure 11. Typical "On" Voltages

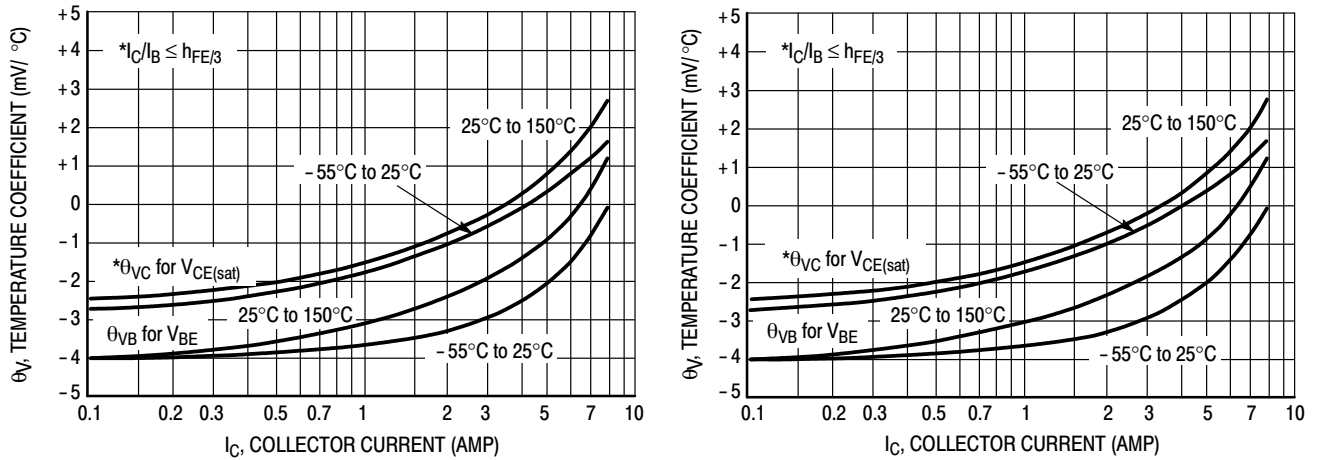


Figure 12. Typical Temperature Coefficients

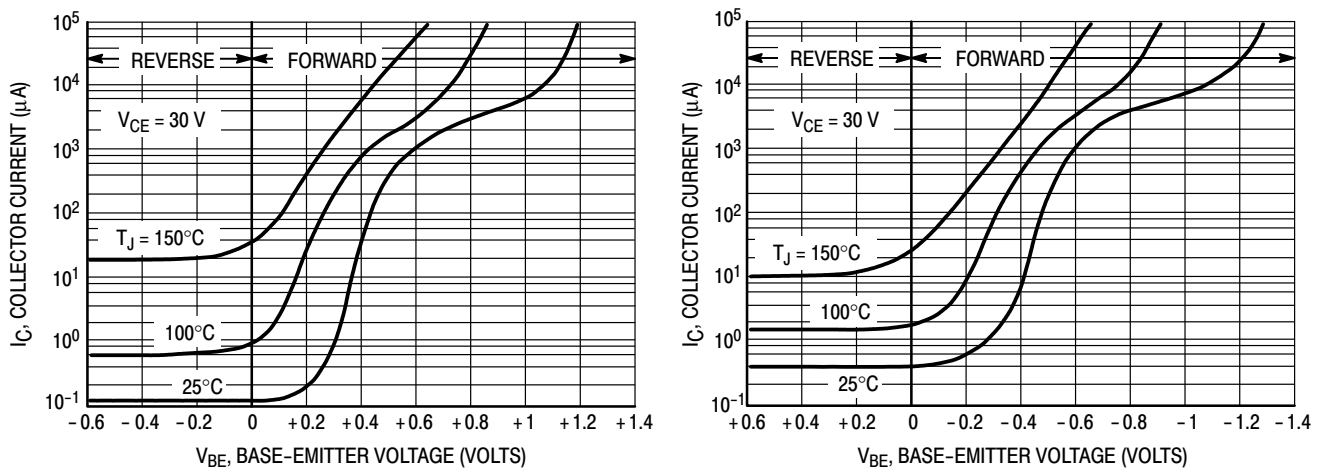
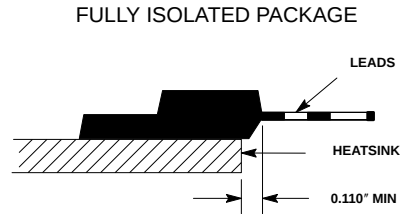


Figure 13. Typical Collector Cut-Off Region

## MJF6388 (NPN), MJF6668 (PNP)

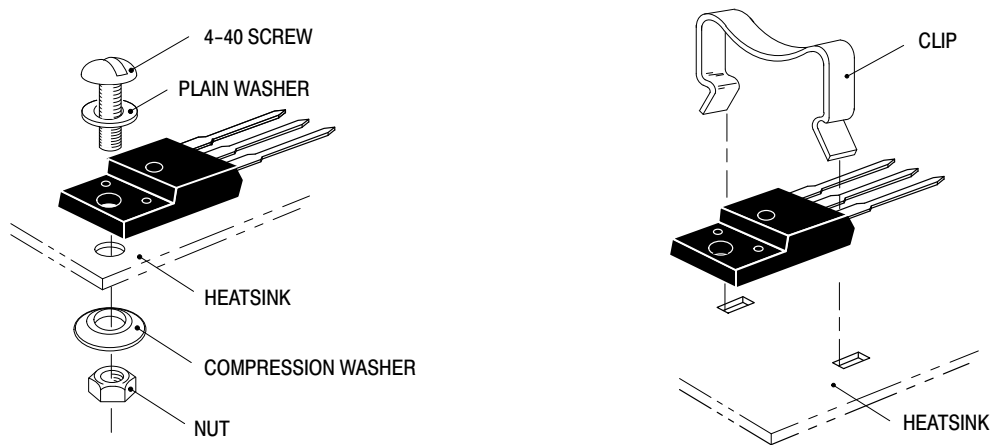
### TEST CONDITION FOR ISOLATION TEST\*



**Figure 14. Mounting Position**

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

### MOUNTING INFORMATION



**Figure 15. Typical Mounting Techniques\***

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.

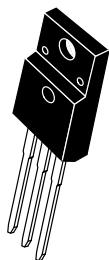
Destructive laboratory tests show that using a hex head 4-40 screw, without washers, and applying a torque in excess of 20 in · lbs will cause the plastic to crack around the mounting hole, resulting in a loss of isolation capability.

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](http://onsemi.com/AN1040).

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

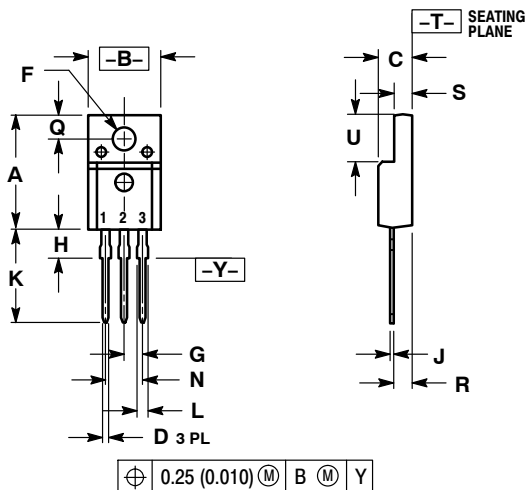
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SCALE 1:1

## TO-220 FULLPAK CASE 221D-03 ISSUE K

DATE 27 FEB 2009

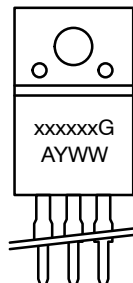


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  2. CONTROLLING DIMENSION: INCH
  3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.617     | 0.635 | 15.67       | 16.12 |
| B   | 0.392     | 0.419 | 9.96        | 10.63 |
| C   | 0.177     | 0.193 | 4.50        | 4.90  |
| D   | 0.024     | 0.039 | 0.60        | 1.00  |
| F   | 0.116     | 0.129 | 2.95        | 3.28  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.118     | 0.135 | 3.00        | 3.43  |
| J   | 0.018     | 0.025 | 0.45        | 0.63  |
| K   | 0.503     | 0.541 | 12.78       | 13.73 |
| L   | 0.048     | 0.058 | 1.23        | 1.47  |
| N   | 0.200 BSC |       | 5.08 BSC    |       |
| Q   | 0.122     | 0.138 | 3.10        | 3.50  |
| R   | 0.099     | 0.117 | 2.51        | 2.96  |
| S   | 0.092     | 0.113 | 2.34        | 2.87  |
| U   | 0.239     | 0.271 | 6.06        | 6.88  |

## MARKING DIAGRAMS

- STYLE 1:  
PIN 1. GATE  
2. DRAIN  
3. SOURCE
- STYLE 2:  
PIN 1. BASE  
2. COLLECTOR  
3. EMITTER
- STYLE 3:  
PIN 1. ANODE  
2. CATHODE  
3. ANODE
- STYLE 4:  
PIN 1. CATHODE  
2. ANODE  
3. CATHODE
- STYLE 5:  
PIN 1. CATHODE  
2. ANODE  
3. GATE
- STYLE 6:  
PIN 1. MT 1  
2. MT 2  
3. GATE



Bipolar



Rectifier

xxxxxx = Specific Device Code  
G = Pb-Free Package  
A = Assembly Location  
Y = Year  
WW = Work Week

A = Assembly Location  
Y = Year  
WW = Work Week  
xxxxxx = Device Code  
G = Pb-Free Package  
AKA = Polarity Designator

|                  |                |                                                                                                                                                                                     |
|------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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| DESCRIPTION:     | TO-220 FULLPAK | PAGE 1 OF 1                                                                                                                                                                         |

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