

# MOSFET - P-Channel

## PowerTrench<sup>®</sup>

**-40 V, 7.5 mΩ, -90 A**



**ON Semiconductor<sup>®</sup>**

[www.onsemi.com](http://www.onsemi.com)

## FDD9509L-F085

### Features

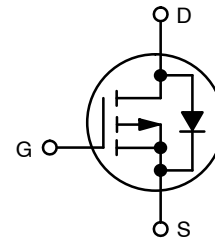
- Typ  $r_{DS(on)}$  = 6.0 mΩ at  $V_{GS} = -10$  V;  $I_D = -70$  A
- Typ  $Q_{g(tot)}$  = 50 nC at  $V_{GS} = -10$  V;  $I_D = -70$  A
- UIS Capability
- Qualified to AEC Q101
- These Devices are Pb-Free and are RoHS Compliant

### Applications

- Automotive Engine Control
- Powertrain Management
- Solenoid and Motor Drivers
- Electrical Power Steering
- Integrated Starter/Alternator
- Distributed Power Architectures and VRM
- Primary Switch for 12 V Systems



**DDPAK  
TO-252  
CASE 369AS**



### ABSOLUTE MAXIMUM RATINGS ( $T_J = 25^\circ\text{C}$ unless otherwise noted)

| Rating  | Symbol          | Value        | Unit                      |
|---|-----------------|--------------|---------------------------|
| Drain to Source Voltage   | $V_{DSS}$       | -40          | V                         |
| Gate to Source Voltage  | $V_{GS}$        | $\pm 16$     | V                         |
| Drain Current - Continuous<br>( $V_{GS} = -10$ V) ( $T_C = 25^\circ\text{C}$ ) (Note 1) | $I_D$           | -90          | A                         |
| Pulsed Drain Current ( $T_C = 25^\circ\text{C}$ )                                       | $I_D$           | See Figure 4 | A                         |
| Single Pulse Avalanche Energy (Note 2)  | $E_{AS}$        | 82           | mJ                        |
| Power Dissipation   | $P_D$           | 150          | W                         |
| Derate above $25^\circ\text{C}$   | $P_D$           | 1.0          | W/ $^\circ\text{C}$       |
| Operating and Storage Temperature Range   | $T_J, T_{STG}$  | -55 to +175  | $^\circ\text{C}$          |
| Thermal Resistance (Junction to Case)   | $R_{\theta JC}$ | 1.0          | $^\circ\text{C}/\text{W}$ |
| Maximum Thermal Resistance (Junction to Ambient) (Note 3)                               | $R_{\theta JA}$ | 52           | $^\circ\text{C}/\text{W}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Current is limited by wirebond configuration
2. Starting  $T_J = 25^\circ\text{C}$ ,  $L = 40 \mu\text{H}$ ,  $I_{AS} = -64$  A,  $V_{DD} = -40$  V during inductor charging and  $V_{DD} = 0$  V during time in avalanche
3.  $R_{\theta JA}$  is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins.  $R_{\theta JC}$  is guaranteed by design while  $R_{\theta JA}$  is determined by the user's board design. The maximum rating presented here is based on mounting on a 1 in<sup>2</sup> pad of 2 oz copper.

### ORDERING INFORMATION

See detailed ordering and shipping information on page 2 of this data sheet.

# FDD9509L-F085

## PACKAGE MARKING AND ORDERING INFORMATION

| Device        | Device Marking | Package        | Reel Size | Tape Width | Quantity   |
|---------------|----------------|----------------|-----------|------------|------------|
| FDD9509L-F085 | FDD9509L       | D-PAK (TO-252) | 13"       | 12 mm      | 2500 Units |

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

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Unit |
|--------|-----------|-----------------|-----|-----|-----|------|
|--------|-----------|-----------------|-----|-----|-----|------|

### OFF CHARACTERISTICS

|                   |                                   |   |                                 |   |      |    |    |
|-------------------|-----------------------------------|---|---------------------------------|---|------|----|----|
| BV <sub>DSS</sub> | Drain to Source Breakdown Voltage | V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA   | -40                             | - | -    | V  |    |
| I <sub>DSS</sub>  | Drain to Source Leakage Current   | V <sub>DS</sub> = -40 V,<br>V <sub>GS</sub> = 0 V | T <sub>J</sub> = 25°C           | - | -    | -1 | μA |
|                   |                                   |   | T <sub>J</sub> = 175°C (Note 4) | - | -    | -1 | mA |
| I <sub>GSS</sub>  | Gate to Source Leakage Current    | V <sub>GS</sub> = ±16 V                           | -                               | - | ±100 | nA |    |

### ON CHARACTERISTICS

|                     |                                  |   |                                 |     |     |      |    |
|---------------------|----------------------------------|---|---------------------------------|-----|-----|------|----|
| V <sub>GS(th)</sub> | Gate to Source Threshold Voltage | V <sub>GS</sub> = V <sub>DS</sub> , I <sub>D</sub> = 250 μA             | -1                              | -2  | -3  | V    |    |
| R <sub>DS(on)</sub> | Drain to Source On-Resistance    | V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -35 A, T <sub>J</sub> = 25°C | -                               | 8.7 | 15  | mΩ   |    |
|                     |                                  | V <sub>GS</sub> = -10 V,<br>I <sub>D</sub> = -70 A                      | T <sub>J</sub> = 25°C           | -   | 6.0 | 7.5  | mΩ |
|                     |                                  |   | T <sub>J</sub> = 175°C (Note 4) | -   | 10  | 12.6 | mΩ |

### DYNAMIC CHARACTERISTICS

|                      |                               |   |   |                                 |     |    |    |
|----------------------|-------------------------------|---|---|---------------------------------|-----|----|----|
| C <sub>iss</sub>     | Input Capacitance             | V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V, f = 1 MHz | - | 3350                            | -   | pF |    |
| C <sub>oss</sub>     | Output Capacitance            |   | - | 1250                            | -   | pF |    |
| C <sub>rss</sub>     | Reverse Transfer Capacitance  |   | - | 42                              | -   | pF |    |
| R <sub>g</sub>       | Gate Resistance               | V <sub>GS</sub> = -0.5 V, f = 1 MHz                       | - | 22                              | -   | Ω  |    |
| Q <sub>g(tot)</sub>  | Total Gate Charge             | V <sub>DD</sub> = -20 V,<br>I <sub>D</sub> = -70 A        | - | V <sub>GS</sub> = 0 V to -10 V  | 50  | 75 | nC |
| Q <sub>g(-4.5)</sub> | Total Gate Charge             |   |   | V <sub>GS</sub> = 0 V to -4.5 V | 23  | -  | nC |
| Q <sub>g(th)</sub>   | Threshold Gate Charge         |   |   | V <sub>GS</sub> = 0 V to -1 V   | 3.5 | -  | nC |
| Q <sub>gs</sub>      | Gate to Source Gate Charge    | V <sub>DD</sub> = -20 V, I <sub>D</sub> = -70 A           | - | -                               | 12  | -  | nC |
| Q <sub>gd</sub>      | Gate to Drain "Miller" Charge |   |   | -                               | 6   | -  | nC |

### SWITCHING CHARACTERISTICS

|                     |                     |   |   |     |     |    |
|---------------------|---------------------|---|---|-----|-----|----|
| t <sub>on</sub>     | Turn-On Time        | V <sub>DD</sub> = -20 V, I <sub>D</sub> = -80 A,<br>V <sub>GS</sub> = -10 V, R <sub>GEN</sub> = 6 Ω | - | -   | 16  | ns |
| t <sub>d(on)</sub>  | Turn-On Delay Time  |   | - | 8.0 | -   | ns |
| t <sub>r</sub>      | Turn-On Rise Time   |   | - | 4.0 | -   | ns |
| t <sub>d(off)</sub> | Turn-Off Delay Time |   | - | 190 | -   | ns |
| t <sub>f</sub>      | Turn-Off Fall Time  |   | - | 60  | -   | ns |
| t <sub>off</sub>    | Turn-Off Time       |   | - | -   | 375 | ns |

### DRAIN-SOURCE DIODE CHARACTERISTICS

|                 |                               |   |   |       |       |    |
|-----------------|-------------------------------|---|---|-------|-------|----|
| V <sub>SD</sub> | Source to Drain Diode Voltage | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = -70 A          | - | -0.96 | -1.25 | V  |
|                 |                               | V <sub>GS</sub> = 0 V, I <sub>SD</sub> = -35 A          | - | -0.88 | -1.2  | V  |
| T <sub>rr</sub> | Reverse Recovery Time         | I <sub>F</sub> = -70 A, dI <sub>SD</sub> /dt = 100 A/μs | - | 54    | 71    | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge       |   | - | 43    | 57    | nC |

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

4. The maximum value is specified by design at T<sub>J</sub> = 175°C. Product is not tested to this condition in production

TYPICAL CHARACTERISTICS

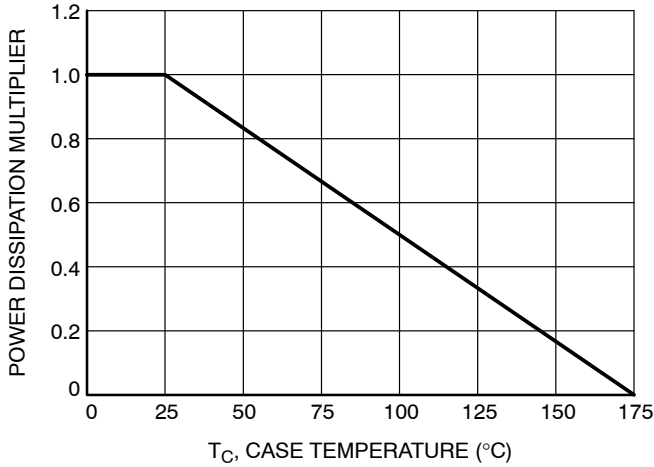


Figure 1. Normalized Power Dissipation vs. Case Temperature

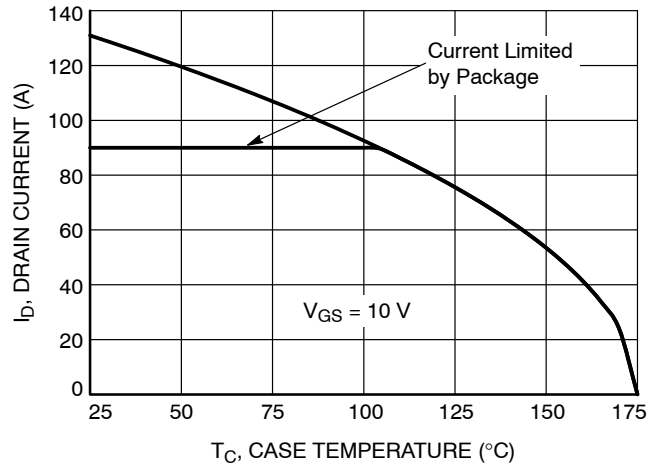


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

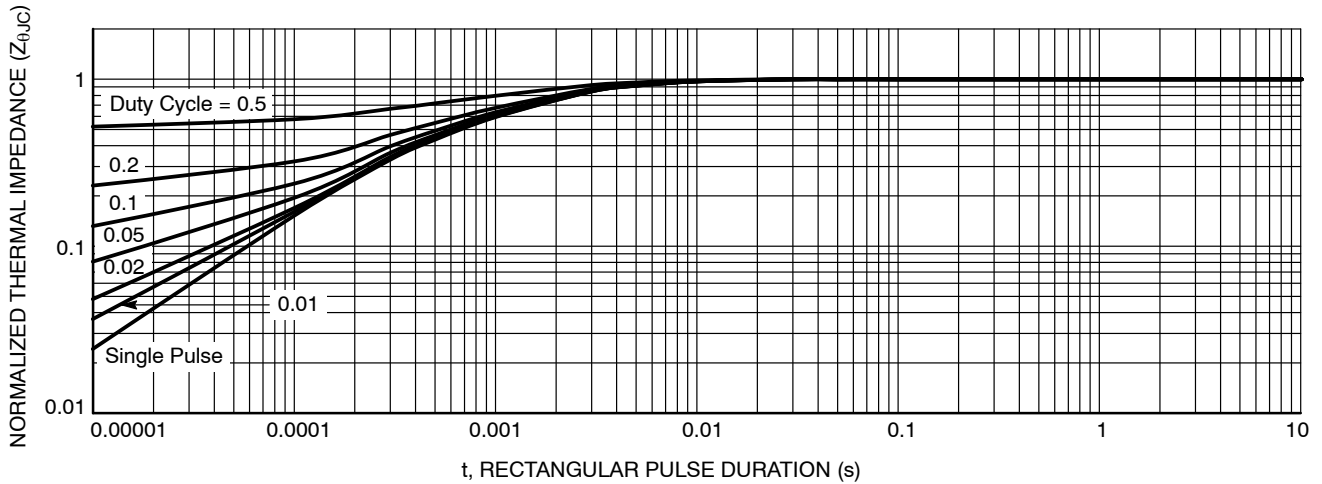


Figure 3. Normalized Maximum Transient Thermal Impedance

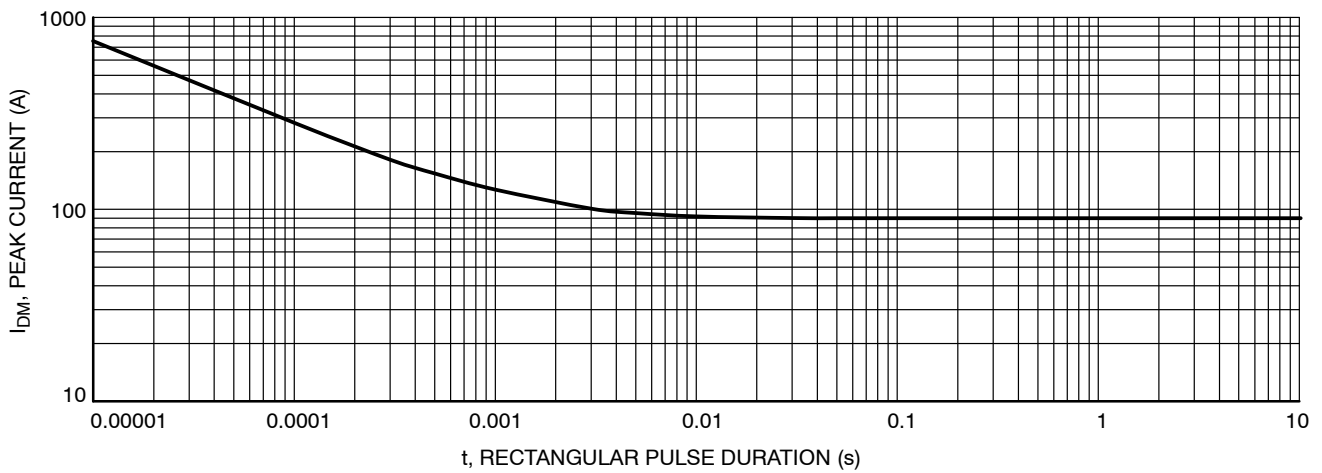


Figure 4. Peak Current Capability

TYPICAL CHARACTERISTICS

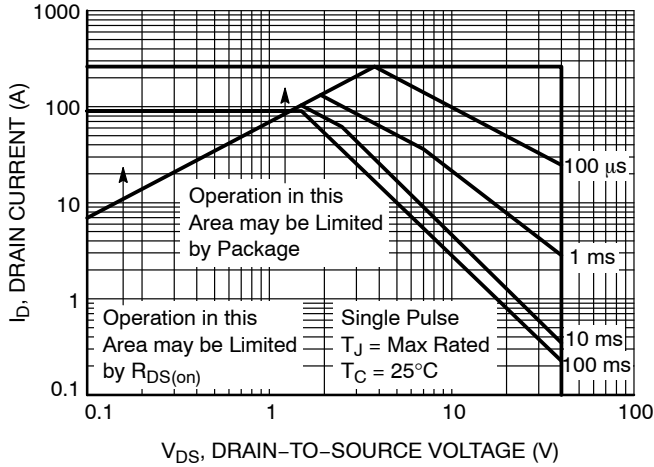


Figure 5. Forward Bias Safe Operating Area

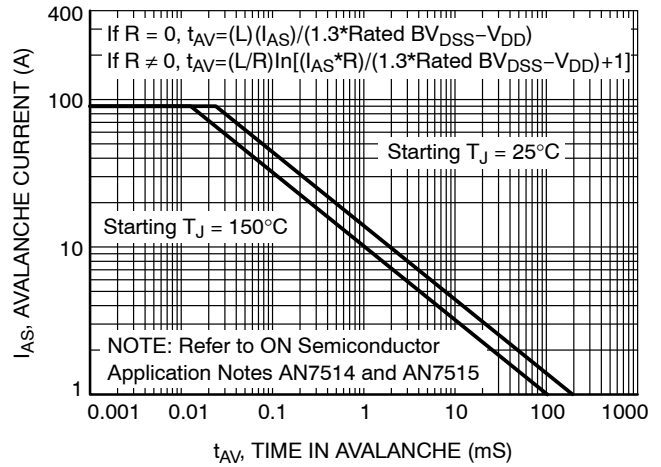


Figure 6. Unclamped Inductive Switching Capability

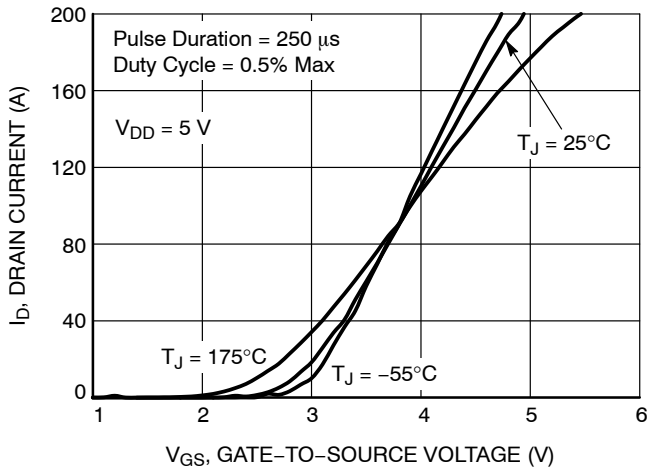


Figure 7. Transfer Characteristics

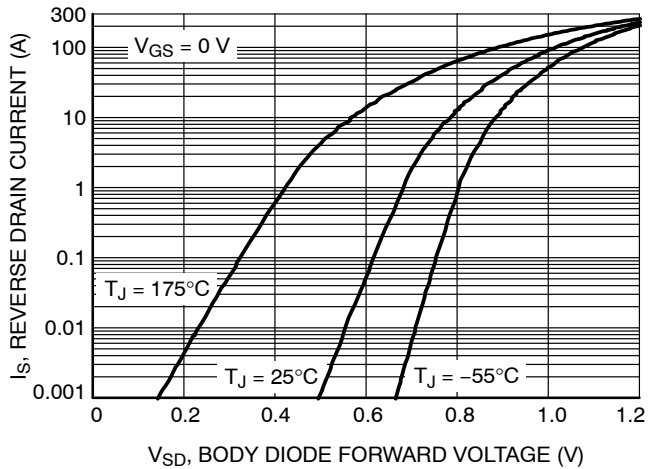


Figure 8. Forward Diode Characteristics

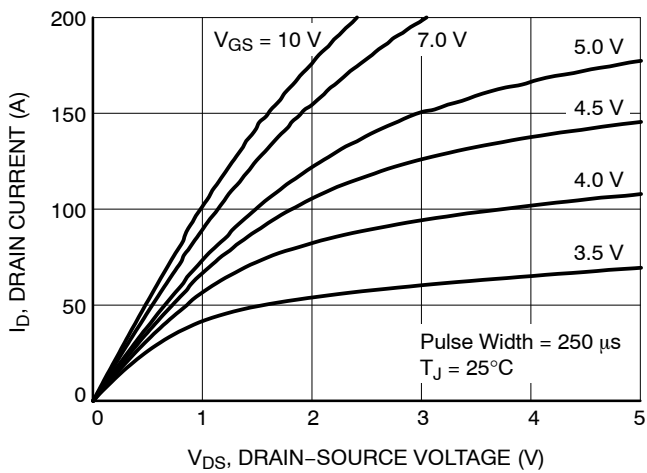


Figure 9. Saturation Characteristics

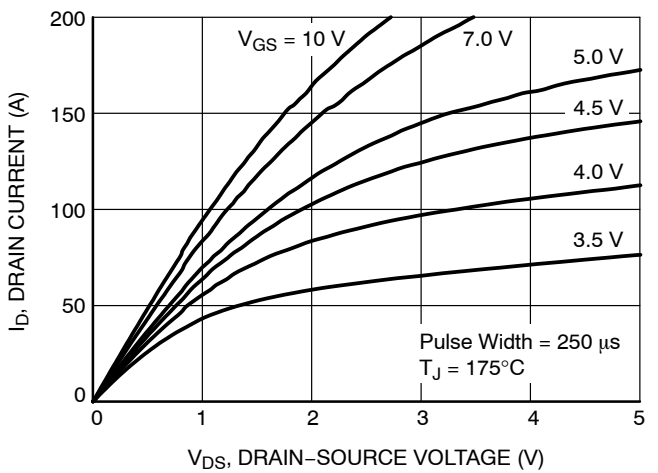


Figure 10. Saturation Characteristics

TYPICAL CHARACTERISTICS

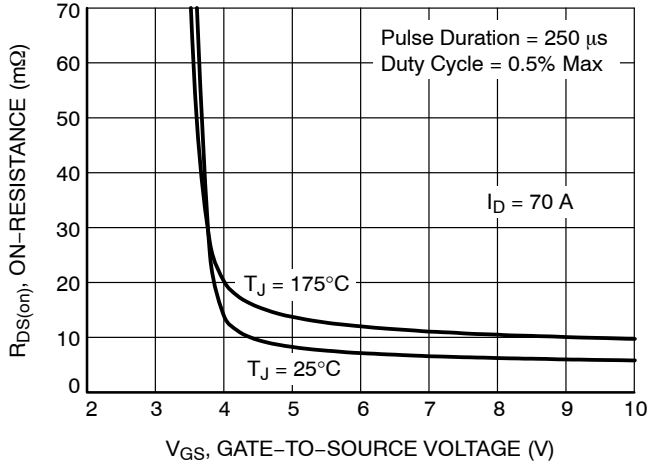


Figure 11.  $R_{DS(on)}$  vs. Gate Voltage

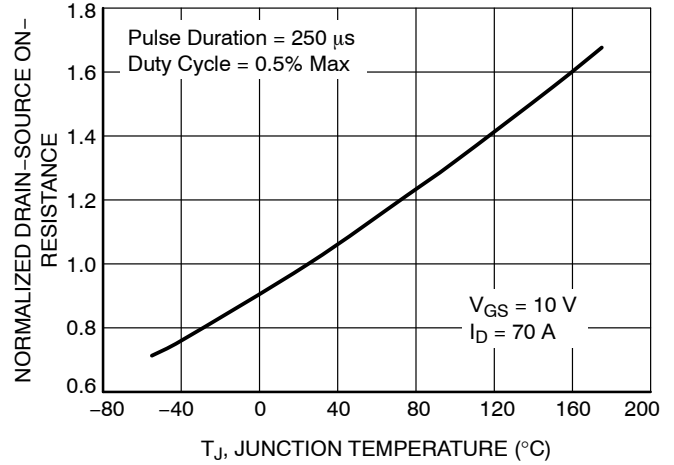


Figure 12. Normalized  $R_{DS(on)}$  vs. Junction Temperature

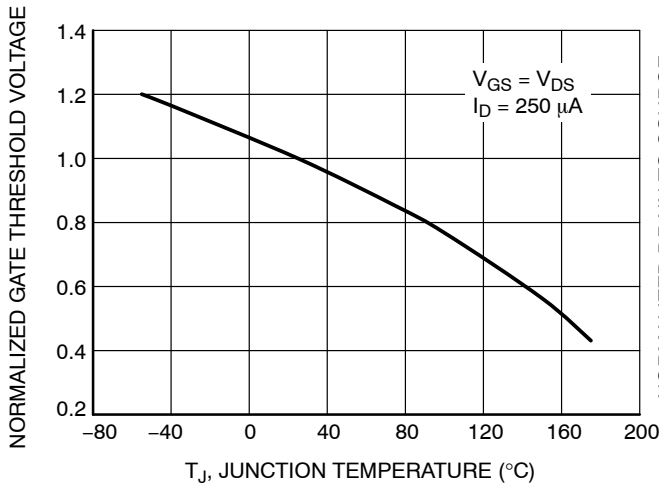


Figure 13. Normalized Gate Threshold Voltage vs. Temperature

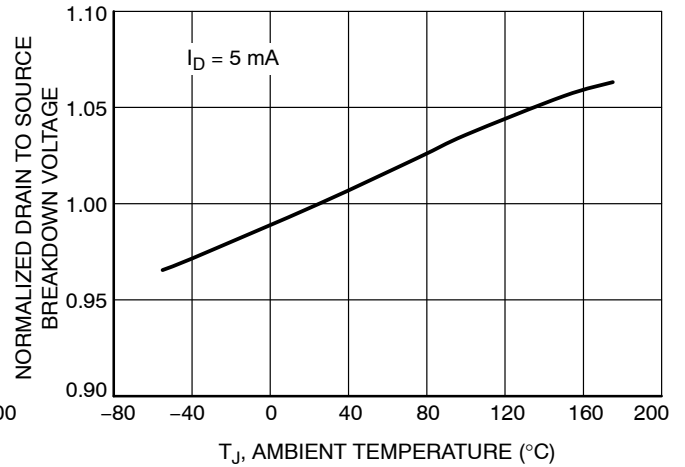


Figure 14. Normalized Drain to Source Breakdown Voltage vs. Junction Temperature

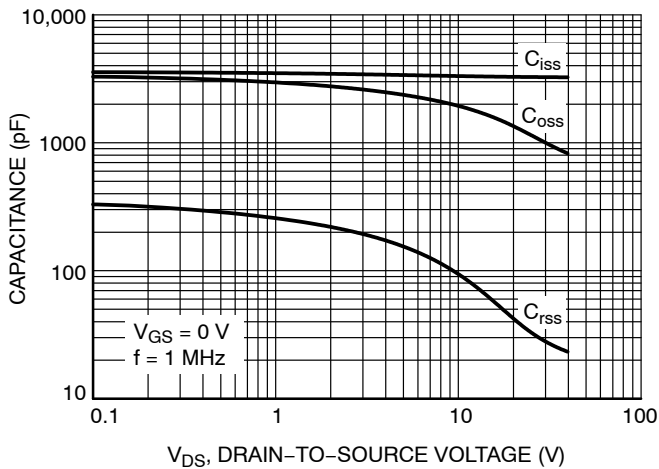


Figure 15. Capacitance vs. Drain to Source Voltage

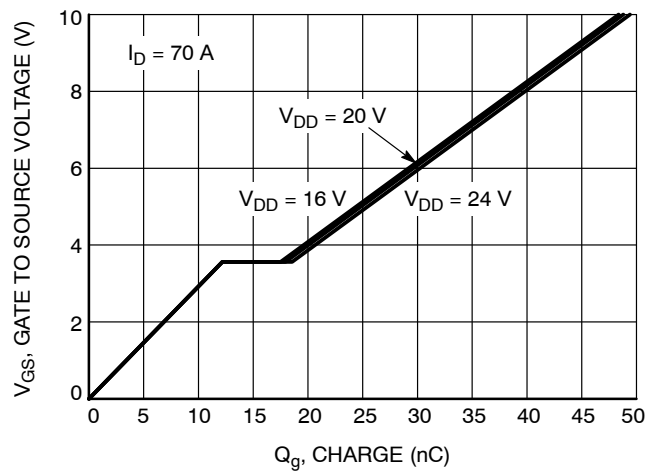
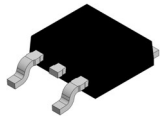


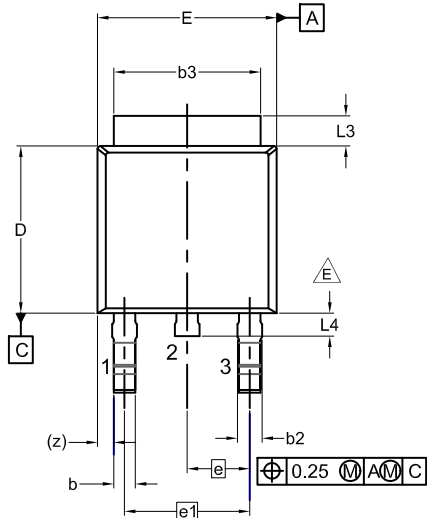
Figure 16. Gate Charge vs. Gate to Source Voltage

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

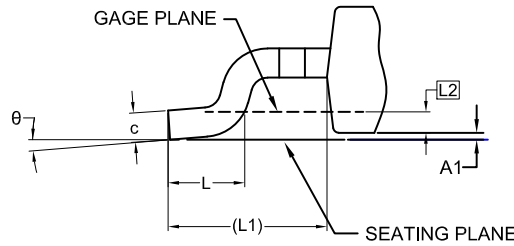


## DPAK3 (TO-252 3 LD) CASE 369AS ISSUE A

DATE 28 SEP 2022

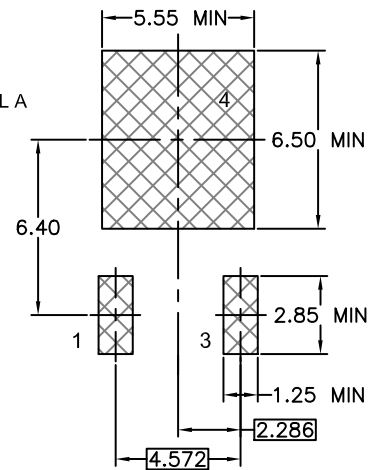
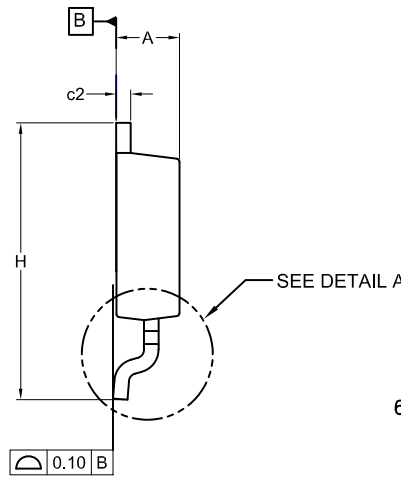
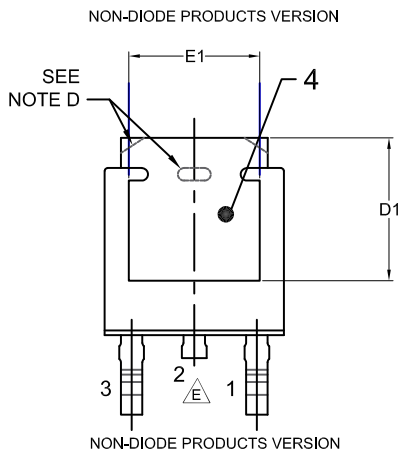


- NOTES: UNLESS OTHERWISE SPECIFIED  
 A) THIS PACKAGE CONFORMS TO JEDEC, TO-252, ISSUE C, VARIATION AA.  
 B) ALL DIMENSIONS ARE IN MILLIMETERS.  
 C) DIMENSIONING AND TOLERANCING PER ASME Y14.5M-2009.  
 D) SUPPLIER DEPENDENT MOLD LOCKING HOLES OR CHAMFERED CORNERS OR EDGE PROTRUSION.  
 E) FOR DIODE PRODUCTS, L4 IS 0.25 MM MAX.  
 F) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH AND TIE BAR EXTRUSIONS.  
 G) LAND PATTERN RECOMMENDATION IS BASED ON IPC7351A STD TO228P991X239-3N.



**DETAIL A**  
(ROTATED -90°)  
SCALE: 12X

| DIM | MILLIMETERS |      |       |
|-----|-------------|------|-------|
|     | MIN.        | NOM. | MAX.  |
| A   | 2.18        | 2.29 | 2.39  |
| A1  | 0.00        | -    | 0.127 |
| b   | 0.64        | 0.77 | 0.89  |
| b2  | 0.76        | 0.95 | 1.14  |
| b3  | 5.21        | 5.34 | 5.46  |
| c   | 0.45        | 0.53 | 0.61  |
| c2  | 0.45        | 0.52 | 0.58  |
| D   | 5.97        | 6.10 | 6.22  |
| D1  | 5.21        | -    | -     |
| E   | 6.35        | 6.54 | 6.73  |
| E1  | 4.32        | -    | -     |
| e   | 2.286 BSC   |      |       |
| e1  | 4.572 BSC   |      |       |
| H   | 9.40        | 9.91 | 10.41 |
| L   | 1.40        | 1.59 | 1.78  |
| L1  | 2.90 REF    |      |       |
| L2  | 0.51 BSC    |      |       |
| L3  | 0.89        | 1.08 | 1.27  |
| L4  | -           | -    | 1.02  |
| θ   | 0°          | --   | 10°   |



### GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code
- A = Assembly Location
- Y = Year
- WW = Work Week
- ZZ = Assembly Lot Code

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

### LAND PATTERN RECOMMENDATION

\*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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| <b>DESCRIPTION:</b>     | <b>DPAK3 (TO-252 3 LD)</b> | <b>PAGE 1 OF 1</b>   |

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