

# FDB9509L-F085

## Power MOSFET, Single P-Channel

-40 V, -83 A, 8.0 mΩ

### Features

- Low  $R_{DS(on)}$  to Minimize Conduction Losses
- Low QG and Capacitance to Minimize Driver Losses
- AEC-Q101 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

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

| Parameter   | Symbol         | Value                     | Unit             |
|---|----------------|---------------------------|------------------|
| Drain-to-Source Voltage   | $V_{DS}$       | -40                       | V                |
| Gate-to-Source Voltage  | $V_{GS}$       | $\pm 16$                  | V                |
| Continuous Drain Current $R_{\theta JC}$ (Notes 1, 3)             | $I_D$          | $T_C = 25^\circ\text{C}$  | -83              |
|   |                | $T_C = 100^\circ\text{C}$ | -59              |
| Power Dissipation $R_{\theta JC}$ (Note 1)                        | $P_D$          | $T_C = 25^\circ\text{C}$  | 93.8             |
|   |                | $T_C = 100^\circ\text{C}$ | 46.9             |
| Continuous Drain Current $R_{\theta JA}$ (Notes 1, 2, 3)          | $I_D$          | $T_C = 25^\circ\text{C}$  | -16.1            |
|   |                | $T_C = 100^\circ\text{C}$ | -11.4            |
| Power Dissipation $R_{\theta JA}$ (Notes 1 & 2)                   | $P_D$          | $T_C = 25^\circ\text{C}$  | 3.5              |
|   |                | $T_C = 100^\circ\text{C}$ | 1.7              |
| Pulsed Drain Current  | $I_{DM}$       | -669                      | A                |
| Operating Junction and Storage Temperature                        | $T_J, T_{stg}$ | -55 to +175               | $^\circ\text{C}$ |
| Source Current (Body Diode)                                       | $I_S$          | -80                       | A                |
| Single Pulse Drain-to-Source Avalanche Energy ( $I_L(pk) = -64$ ) | $E_{AS}$       | 82                        | mJ               |
| Lead Temperature for Soldering Purposes (1/83 from case for 10 s) | $T_L$          | 260                       | $^\circ\text{C}$ |

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.

### THERMAL RESISTANCE MAXIMUM RATINGS

| Parameter                                   | Symbol          | Value | Unit                      |
|---|-----------------|-------|---------------------------|
| Junction-to-Case - Steady State             | $R_{\theta JC}$ | 1.6   | $^\circ\text{C}/\text{W}$ |
| Junction-to-Ambient - Steady State (Note 2) | $R_{\theta JA}$ | 43    | $^\circ\text{C}/\text{W}$ |

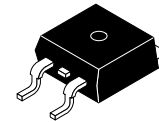
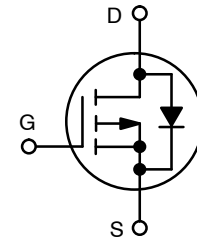
1. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
2. Surface-mounted on FR4 board using a 650 mm<sup>2</sup>, 2 oz. Cu pad.
3. Maximum current for pulses as long as 1 second is higher but is dependent on pulse duration and duty cycle.



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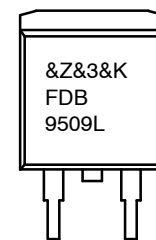
[www.onsemi.com](http://www.onsemi.com)

| $V_{(BR)DSS}$ | $R_{DS(ON)} \text{ MAX}$ | $I_D \text{ MAX}$ |
|---------------|--------------------------|-------------------|
| -40 V         | 8.0 mΩ @ -10 V           | -83 A             |
|               | 12.5 mΩ @ -4.5 V         |                   |



D<sup>2</sup>PAK-3 (TO-163AB)  
CASE 418AJ

### MARKING DIAGRAM



&Z = Assembly Plant Code  
 &3 = Numeric Date Code  
 &K = Lot Code  
 FDB9509L = Specific Device Code

### ORDERING INFORMATION

See detailed ordering, marking and shipping information on page 6 of this data sheet.

# FDB9509L-F085

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

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

### Off Characteristics

|   |                   |   |                           |    |  |                            |               |
|---|-------------------|---|---------------------------|----|--|----------------------------|---------------|
| Drain to Source Breakdown Voltage                         | $V_{(BR)DSS}$     | $V_{GS} = 0\text{ V}, I_D = -250\ \mu\text{A}$  | -40                       |    |  | V                          |               |
| Drain-to-Source Breakdown Voltage Temperature Coefficient | $V_{(BR)DSS}/T_J$ |   |                           | 20 |  | $\text{mV}/^\circ\text{C}$ |               |
| Zero Gate Voltage Drain Current                           | $I_{DSS}$         | $V_{GS} = 0\text{ V}, V_{DS} = -40\text{ V}$    | $T_J = 25^\circ\text{C}$  |    |  | -1                         | $\mu\text{A}$ |
|   |                   |   | $T_J = 175^\circ\text{C}$ |    |  | -1                         | $\text{mA}$   |
| Zero Gate Voltage Drain Current                           | $I_{GSS}$         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 16\text{ V}$ |                           |    |  | $\pm 100$                  | $\text{nA}$   |

### On Characteristics (Note 4)

|                                   |                  |  |                      |      |      |                            |
|-----------------------------------|------------------|--|----------------------|------|------|----------------------------|
| Gate Threshold Voltage            | $V_{GS(TH)}$     | $V_{GS} = V_{DS}, I_D = -250\ \mu\text{A}$ | -1                   | -1.7 | -3   | V                          |
| Threshold Temperature Coefficient | $V_{GS(TH)}/T_J$ |  |                      | -5   |      | $\text{mV}/^\circ\text{C}$ |
| Drain-to-Source On Resistance     | $R_{DS(on)}$     | $V_{GS} = -10\text{ V}$                    | $I_D = -80\text{ A}$ | 6.4  | 8.0  | $\text{m}\Omega$           |
|                                   |                  | $V_{GS} = -4.5\text{ V}$                   | $I_D = -40\text{ A}$ | 9.6  | 12.5 |                            |

### Charges, Capacitances & Gate Resistance

|                               |              |   |  |      |  |             |
|-------------------------------|--------------|---|--|------|--|-------------|
| Input Capacitance             | $C_{iss}$    | $V_{GS} = 0\text{ V}, f = 1\text{ MHz}, V_{DS} = -20\text{ V}$      |  | 3400 |  | $\text{pF}$ |
| Output Capacitance            | $C_{oss}$    |   |  | 1250 |  | $\text{pF}$ |
| Reverse Transfer Capacitance  | $C_{rss}$    |   |  | 39   |  | $\text{pF}$ |
| Gate Resistance               | $R_g$        | $V_{GS} = 0.5\text{ V}, f = 100\text{ kHz}$                         |  | 21   |  | $\Omega$    |
| Total Gate Charge             | $Q_{G(TOT)}$ | $V_{GS} = -10\text{ V}, V_{DS} = -32\text{ V}; I_D = -80\text{ A}$  |  | 48   |  | $\text{nC}$ |
|                               |              | $V_{GS} = -4.5\text{ V}, V_{DS} = -32\text{ V}; I_D = -80\text{ A}$ |  | 22   |  |             |
| Threshold Gate Charge         | $Q_{g(th)}$  | $V_{GS} = 0\text{ to }-1\text{ V}$                                  |  | 6    |  |             |
| Gate to Source Gate Charge    | $Q_{gs}$     | $V_{DD} = -32\text{ V}, I_D = -80\text{ A}$                         |  | 12   |  |             |
| Gate to Drain "Miller" Charge | $Q_{gd}$     |   |  | 5    |  |             |
| Plateau Voltage               | $V_{GP}$     |   |  | -3.5 |  | V           |

### Switching Characteristics

|                     |              |   |  |     |  |             |
|---------------------|--------------|---|--|-----|--|-------------|
| Turn-On Delay Time  | $t_{d(ON)}$  | $V_{DD} = -20\text{ V}, I_D = -80\text{ A}, V_{GS} = -10\text{ V}, R_{GEN} = 6\ \Omega$ |  | 9   |  | $\text{ns}$ |
| Turn-On Rise Time   | $t_r$        |   |  | 4   |  | $\text{ns}$ |
| Turn-Off Delay Time | $t_{d(OFF)}$ |   |  | 200 |  | $\text{ns}$ |
| Turn-Off Fall Time  | $t_f$        |   |  | 57  |  | $\text{ns}$ |

### Drain-Source Diode Characteristics

|                               |          |  |  |       |       |             |
|-------------------------------|----------|--|--|-------|-------|-------------|
| Source to Drain Diode Voltage | $V_{SD}$ | $I_{SD} = -80\text{ A}, V_{GS} = 0\text{ V}$                                     |  | -0.98 | -1.25 | V           |
|                               |          | $I_{SD} = -40\text{ A}, V_{GS} = 0\text{ V}$                                     |  | -0.9  | -1.2  | V           |
| Reverse Recovery Time         | $T_{RR}$ | $V_{GS} = 0\text{ V}, dI_{SD}/dt = 100\text{ A}/\mu\text{s}, I_S = -80\text{ A}$ |  | 78    |       | $\text{ns}$ |
| Charge Time                   | $t_a$    |  |  | 33    |       |             |
| Discharge Time                | $t_b$    |  |  | 46    |       |             |
| Reverse Recovery Charge       | $Q_{RR}$ |  |  | 95    |       |             |

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. Pulse Test: pulse width  $\leq 300\ \mu\text{s}$ , duty cycle  $\leq 2\%$

5. Switching characteristics are independent of operating junction temperatures.

TYPICAL CHARACTERISTICS

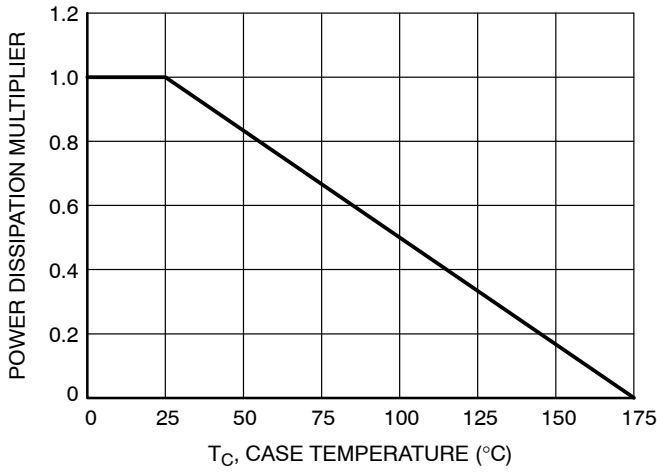


Figure 1. Normalized Power Dissipation vs. Case Temperature

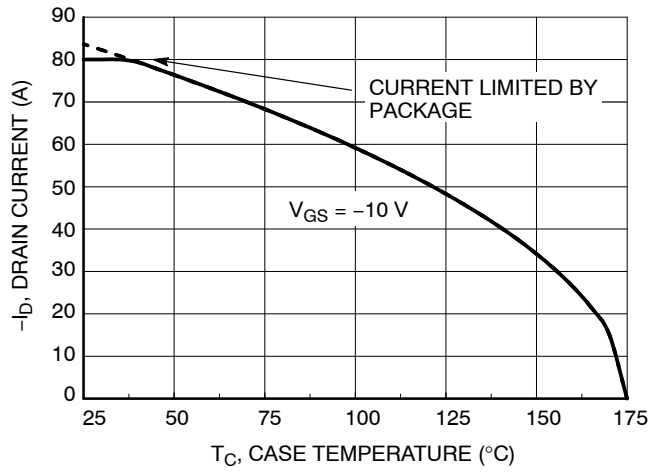


Figure 2. Maximum Continuous Drain Current vs. Case Temperature

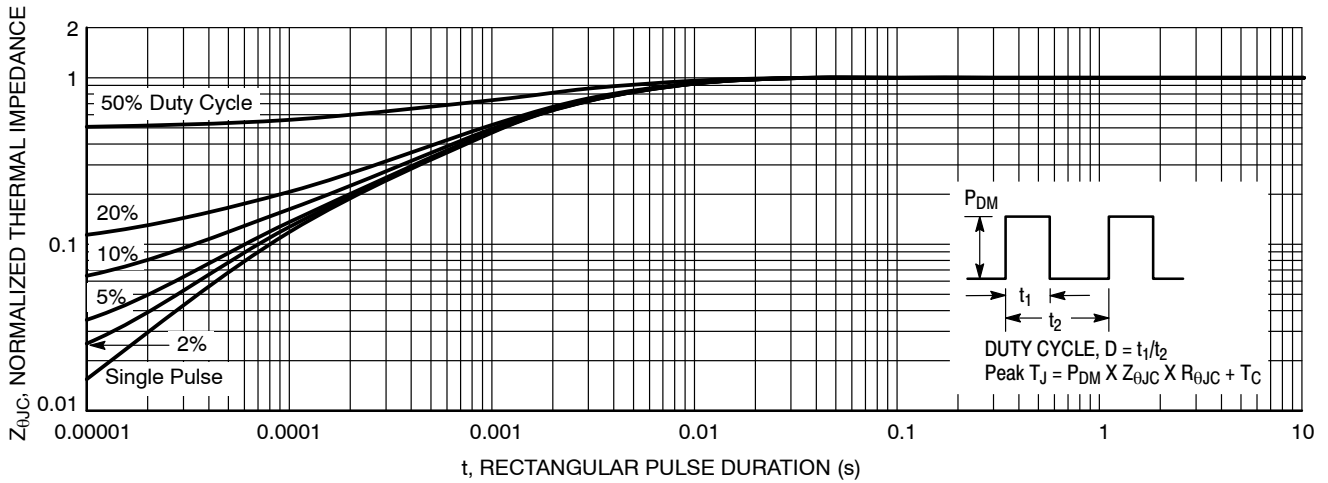


Figure 3. Normalized Maximum Transient Thermal Impedance

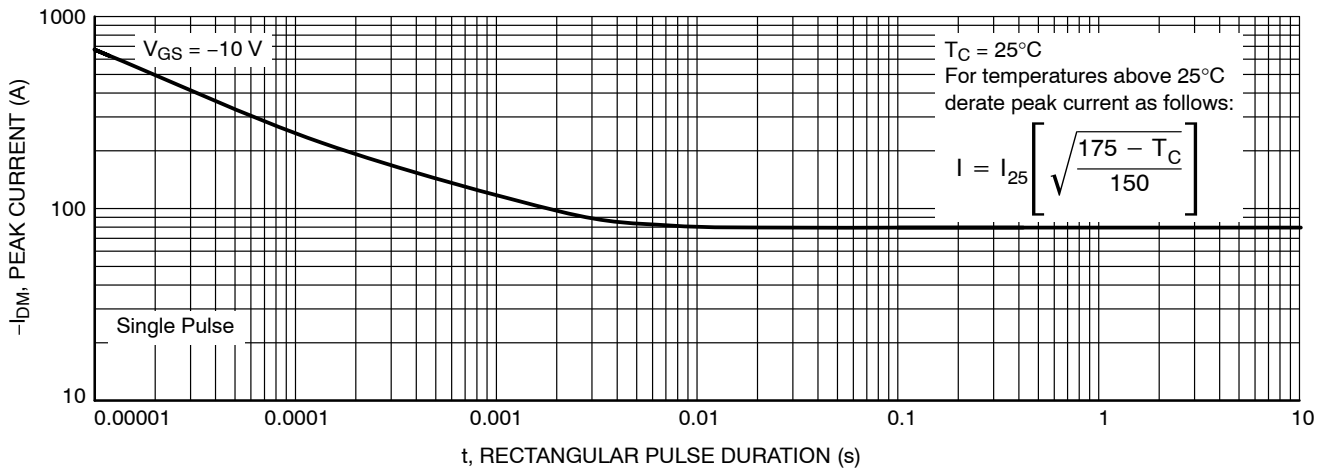


Figure 4. Peak Current Capability

TYPICAL CHARACTERISTICS

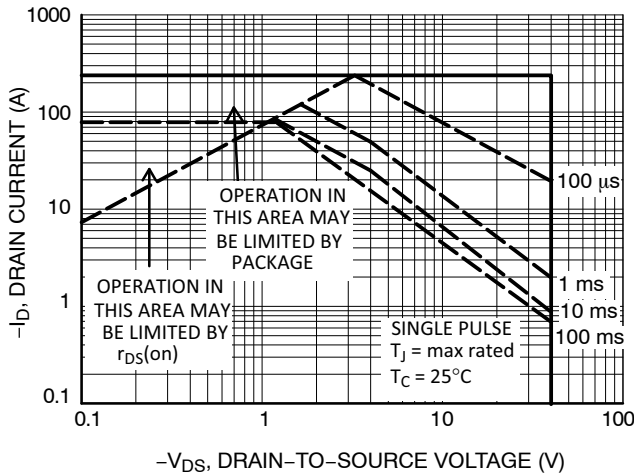
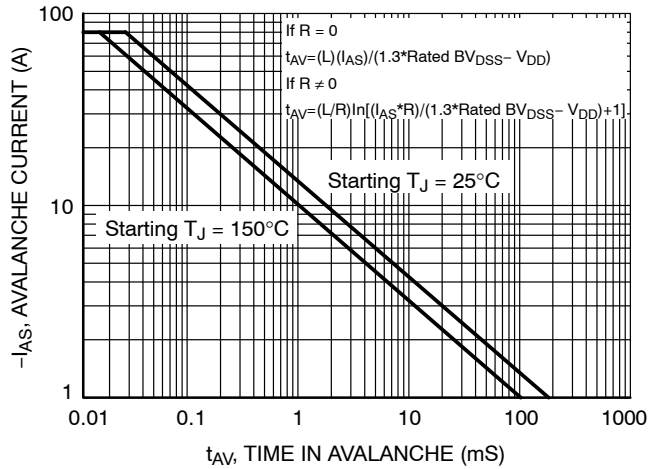


Figure 5. Forward Bias Safe Operating Area



Note: Refer to ON Semiconductor Application Notes AN7514 and AN7515

Figure 6. Unclamped Inductive Switching Capability

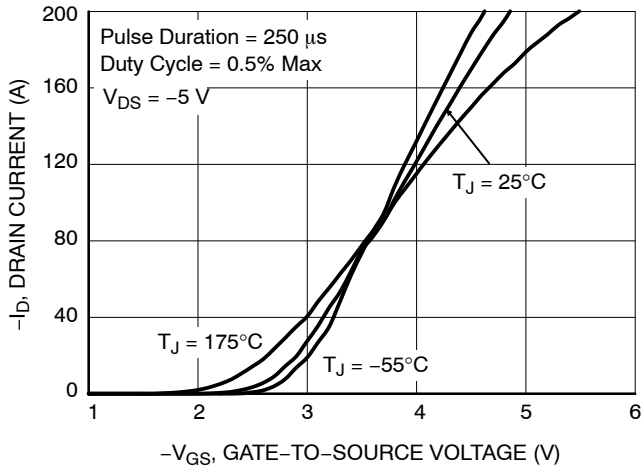


Figure 7. Transfer Characteristics

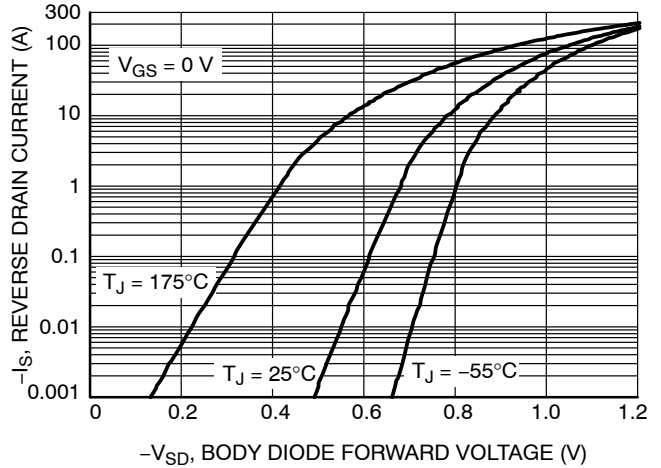


Figure 8. Forward Diode Characteristics

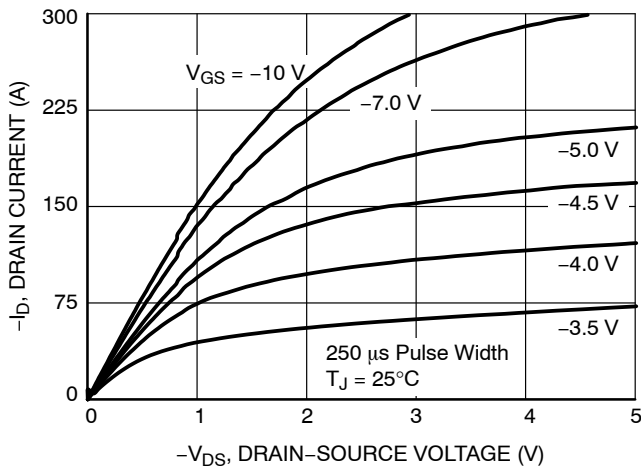


Figure 9. Saturation Characteristics

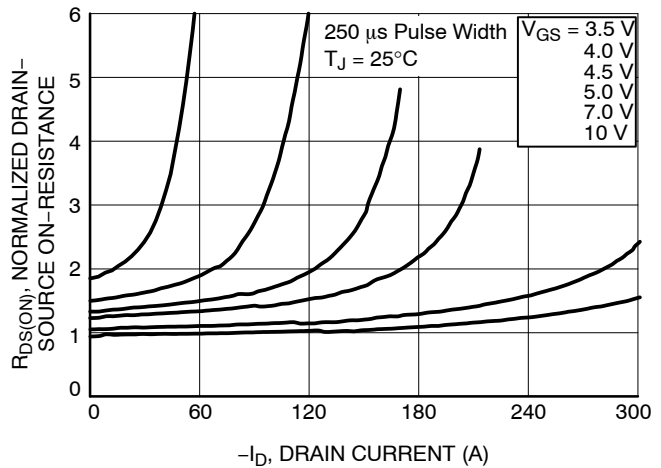


Figure 10. Normalized  $R_{DS(ON)}$  vs. Drain Current

TYPICAL CHARACTERISTICS

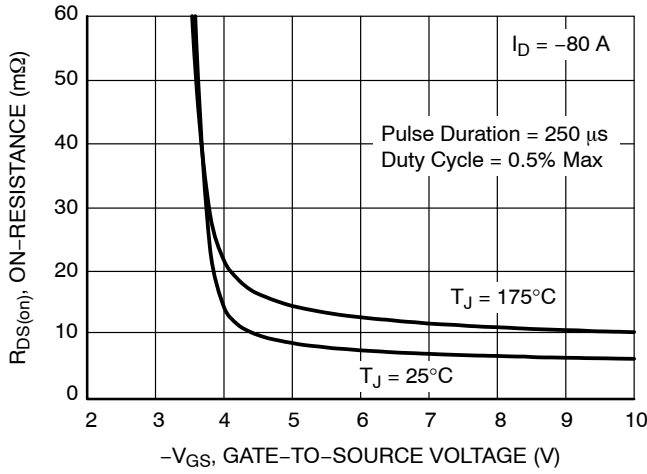


Figure 11.  $R_{DS(on)}$  vs. Gate Voltage

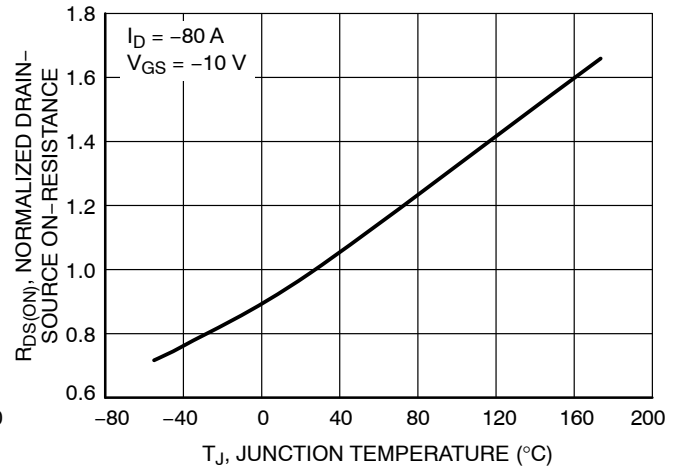


Figure 12. Normalized  $R_{DS(on)}$  vs. Junction Temperature

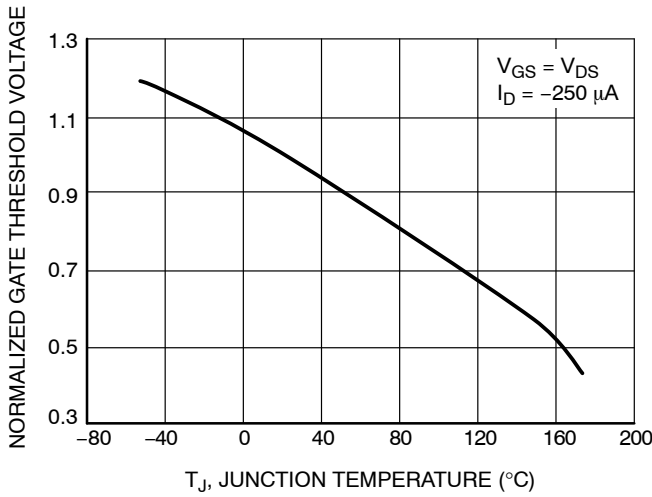


Figure 13. Normalized Gate Threshold Voltage vs. Temperature

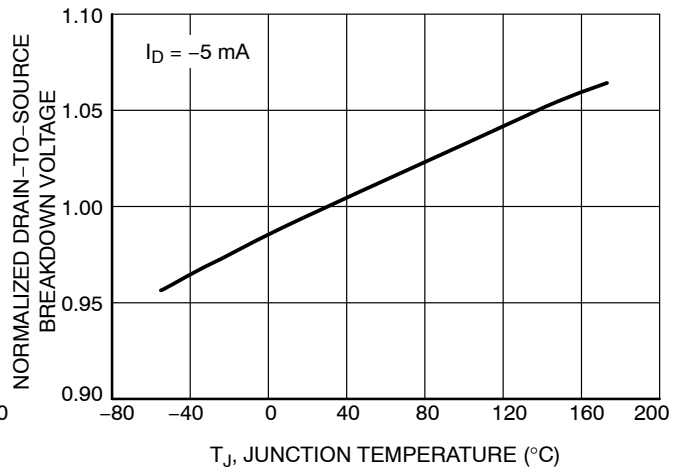


Figure 14. Normalized Drain-to-Source Breakdown Voltage vs. Junction Temperature

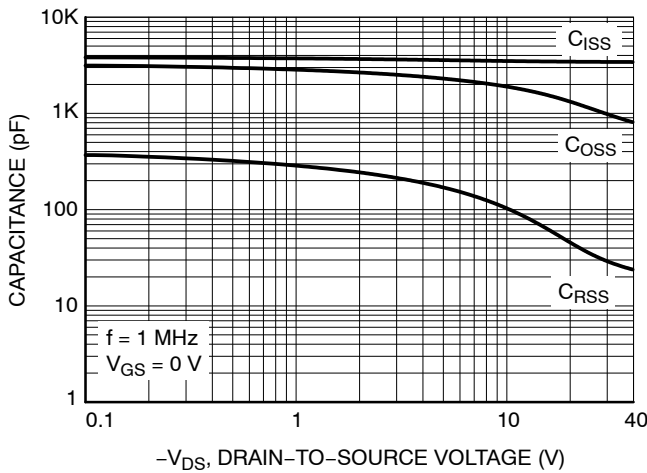


Figure 15. Capacitance vs. Drain-to-Source Voltage

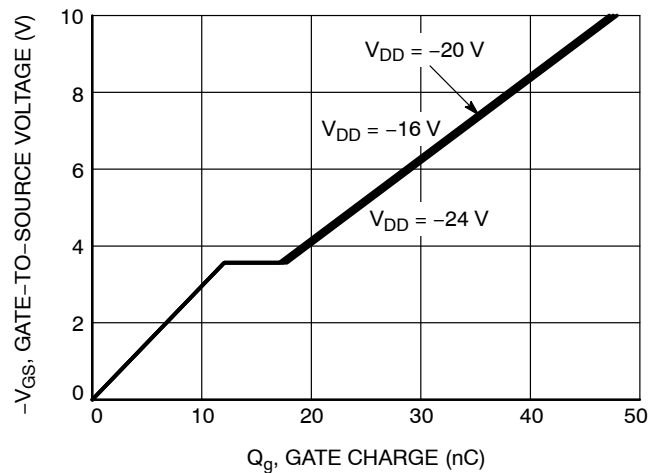


Figure 16. Gate Charge vs. Gate-to-Source Voltage

# FDB9509L-F085

## ORDERING INFORMATION

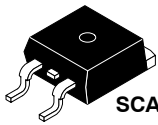
| Device        | Device Marking | Package   | Shipping†           |
|---------------|----------------|---|---------------------|
| FDB9509L-F085 | FDB9509L       | D <sup>2</sup> PAK-3<br>(Pb-Free, Halogen Free) | 3,000 / Tape & Reel |

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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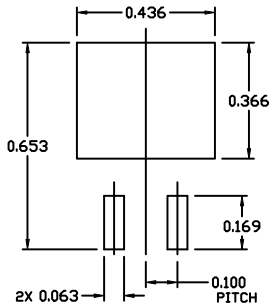
SCALE 1:1

### D<sup>2</sup>PAK-3 (TO-263, 3-LEAD)

#### CASE 418AJ

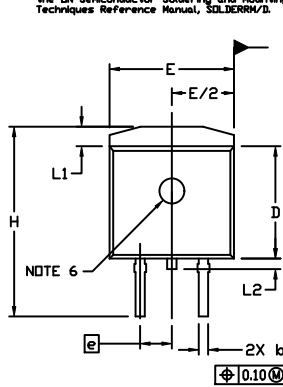
#### ISSUE F

DATE 11 MAR 2021



#### RECOMMENDED MOUNTING FOOTPRINT

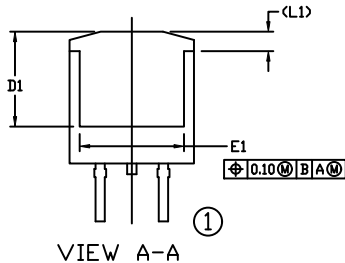
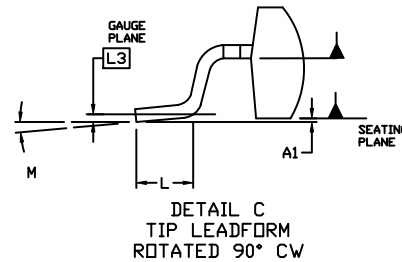
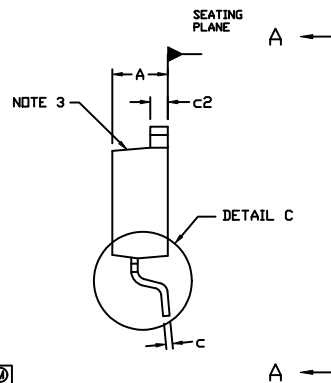
■ For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



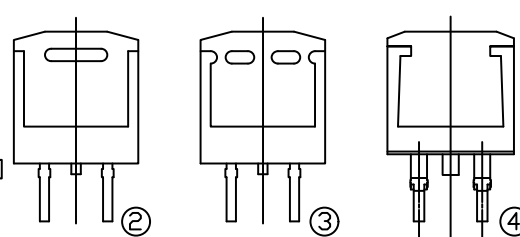
#### NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: INCHES
3. CHAMFER OPTIONAL.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.005 PER SIDE. THESE DIMENSIONS ARE MEASURED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY AT DATUM H.
5. THERMAL PAD CONTOUR IS OPTIONAL WITHIN DIMENSIONS E, L1, D1, AND E1.
6. OPTIONAL MOLD FEATURE.
7.  $\text{①}$ ,  $\text{②}$  ... OPTIONAL CONSTRUCTION FEATURE CALL OUTS.

| DIM | INCHES |       | MILLIMETERS |       |
|-----|--------|-------|-------------|-------|
|     | MIN.   | MAX.  | MIN.        | MAX.  |
| A   | 0.160  | 0.190 | 4.06        | 4.83  |
| A1  | 0.000  | 0.010 | 0.00        | 0.25  |
| b   | 0.020  | 0.039 | 0.51        | 0.99  |
| c   | 0.012  | 0.029 | 0.30        | 0.74  |
| c2  | 0.045  | 0.065 | 1.14        | 1.65  |
| D   | 0.330  | 0.380 | 8.38        | 9.65  |
| D1  | 0.260  | ---   | 6.60        | ---   |
| E   | 0.380  | 0.420 | 9.65        | 10.67 |
| E1  | 0.245  | ---   | 6.22        | ---   |
| e   | 0.100  | BSC   | 2.54        | BSC   |
| H   | 0.575  | 0.625 | 14.60       | 15.88 |
| L   | 0.070  | 0.110 | 1.78        | 2.79  |
| L1  | ---    | 0.066 | ---         | 1.68  |
| L2  | ---    | 0.070 | ---         | 1.78  |
| L3  | 0.010  | BSC   | 0.25        | BSC   |
| M   | 0*     | 8*    | 0*          | 8*    |

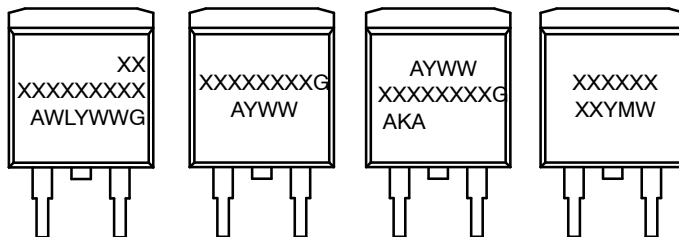


VIEW A-A



VIEW A-A  
OPTIONAL CONSTRUCTIONS

#### GENERIC MARKING DIAGRAMS\*



IC

Standard

Rectifier

SSG

- XXXXXX = Specific Device Code
- A = Assembly Location
- WL = Wafer Lot
- Y = Year
- WW = Work Week
- W = Week Code (SSG)
- M = Month Code (SSG)
- G = Pb-Free Package
- AKA = Polarity Indicator

\*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.

|                  |                                       |  |
|------------------|---------------------------------------|--|
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| DESCRIPTION:     | D <sup>2</sup> PAK-3 (TO-263, 3-LEAD) | PAGE 1 OF 1  |

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