# **Power MOSFET**

# 60 V, 8.9 m $\Omega$ , 49 A, Single N-Channel

#### **Features**

- Low R<sub>DS(on)</sub> to Minimize Conduction Losses
- Low Q<sub>G</sub> 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<sub>J</sub> = 25°C unless otherwise noted)

| Parameter   |  |                                 | Symbol                            | Value         | Unit |
|---|--|---------------------------------|-----------------------------------|---------------|------|
| Drain-to-Source Voltage   |  |                                 | V <sub>DSS</sub>                  | 60            | V    |
| Gate-to-Source Voltage  |  |                                 | $V_{GS}$                          | ±20           | V    |
| Continuous Drain Cur-   | Steady                                 | T <sub>C</sub> = 25°C           | I <sub>D</sub>                    | 49            | Α    |
| rent R <sub>θJC</sub> (Notes 1 & 3)   |  | T <sub>C</sub> = 100°C          |                                   | 34            |      |
| Power Dissipation R <sub>θJC</sub>  | State                                  | $T_C = 25^{\circ}C$             | $P_{D}$                           | 44            | W    |
| (Note 1)  |  | T <sub>C</sub> = 100°C          |                                   | 22            |      |
| Continuous Drain  |  | T <sub>A</sub> = 25°C           | I <sub>D</sub>                    | 13            | Α    |
| Current R <sub>θJA</sub> (Notes 1, 2 & 3)   | Steady                                 | T <sub>A</sub> = 100°C          |                                   | 9.0           |      |
| Power Dissipation R <sub>θJA</sub>  | State                                  | State $T_A = 25^{\circ}C$ $P_D$ | 3.1                               | W             |      |
| (Notes 1 & 2)   |  | T <sub>A</sub> = 100°C          |                                   | 1.5           |      |
| Pulsed Drain Current  | $T_A = 25^{\circ}C$ , $t_p = 10 \mu s$ |                                 | I <sub>DM</sub>                   | 250           | Α    |
| Operating Junction and Storage Temperature  |  |                                 | T <sub>J</sub> , T <sub>stg</sub> | -55 to<br>175 | °C   |
| Source Current (Body Diode)   |  |                                 | Is                                | 25            | Α    |
| Single Pulse Drain-to-Source Avalanche Energy (T <sub>J</sub> = 25°C, I <sub>L(pk)</sub> = 3 A) |  |                                 | E <sub>AS</sub>                   | 104           | mJ   |
| Lead Temperature for Soldering Purposes (1/8" from case for 10 s)                               |  | TL                              | 260                               | °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 (Drain) (Note 1)           | $R_{\theta JC}$ | 3.4   | °C/W |
| Junction-to-Ambient - Steady State (Note 2) | $R_{\theta JA}$ | 48.7  |      |

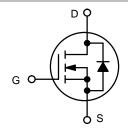
- 1. The entire application environment impacts the thermal resistance values shown, they are not constants and are only valid for the particular conditions noted.
- 2. Surface–mounted on FR4 board using a 650 mm<sup>2</sup>, 2 oz. Cu pad.
- 3. Maximum current for pulses as long as 1 second is higher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



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| V <sub>(BR)DSS</sub> | R <sub>DS(on)</sub> | I <sub>D</sub> |  |
|----------------------|---------------------|----------------|--|
| 60 V                 | 8.9 mΩ @ 10 V       | 49 A           |  |
|                      | 12.8 mΩ @ 4.5 V     | 497            |  |

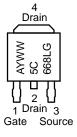


**N-CHANNEL MOSFET** 



**CASE 369C** STYLE 2

### **MARKING DIAGRAM & PIN ASSIGNMENT**



= Assembly Location

= Year WW = Work Week 5C668L = Device Code = Pb-Free Package

#### ORDERING INFORMATION

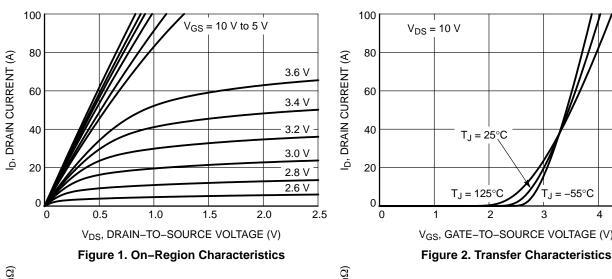
See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

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

| Parameter  | Symbol   | Test Condition  |  | Min | Тур  | Max  | Unit  |
|--|--|---|--|-----|------|------|-------|
| OFF CHARACTERISTICS  | •  |   |  |     | •    |      | •     |
| Drain-to-Source Breakdown Voltage                            | $V_{(BR)DSS}$  | $V_{GS} = 0 \text{ V}, I_D = 250 \mu\text{A}$                             |  | 60  |      |      | V     |
| Drain-to-Source Breakdown Voltage<br>Temperature Coefficient | V <sub>(BR)DSS</sub> /T <sub>J</sub>                         |   |  |     | 27   |      | mV/°C |
| Zero Gate Voltage Drain Current                              | I <sub>DSS</sub>   | V <sub>GS</sub> = 0 V,  | T <sub>J</sub> = 25°C                                |     |      | 10   | μΑ    |
|  |  | $V_{DS} = 60 \text{ V}$   | T <sub>J</sub> = 125°C                               |     |      | 250  | 1     |
| Gate-to-Source Leakage Current                               | I <sub>GSS</sub>   | $V_{DS} = 0 V, V_{G}$   | S = 20 V   |     |      | 100  | nA    |
| ON CHARACTERISTICS (Note 4)                                  |  |   |  |     |      |      |       |
| Gate Threshold Voltage                                       | $V_{GS(TH)}$   | $V_{GS} = V_{DS}, I_{D}$  | = 250 μΑ   | 1.2 |      | 2.1  | V     |
| Negative Threshold Temperature Coefficient                   | V <sub>GS(TH)</sub> /T <sub>J</sub>                          |   |  |     | 4.8  |      | mV/°C |
| Drain-to-Source On Resistance                                | R <sub>DS(on)</sub>  | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 25 A                             |  |     | 7.4  | 8.9  | mΩ    |
|  |  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 25 A                            |  |     | 10.2 | 12.8 | 1     |
| Forward Transconductance                                     | 9FS  | V <sub>DS</sub> = 15 V, I <sub>E</sub>                                    | <sub>O</sub> = 25 A                                  |     | 60   |      | S     |
| CHARGES, CAPACITANCES AND GATE RE                            | SISTANCES  |   |  |     |      |      |       |
| Input Capacitance  | C <sub>iss</sub>   | $V_{GS} = 0 \text{ V, f} = 1.0 \text{ MHz,}$<br>$V_{DS} = 25 \text{ V}$   |  |     | 1300 |      | pF    |
| Output Capacitance   | C <sub>oss</sub>   |   |  |     | 580  |      | 1     |
| Reverse Transfer Capacitance                                 | C <sub>rss</sub>   |   |  |     | 18   |      |       |
| Total Gate Charge  | $Q_{G(TOT)}$ $V_{DS} = 48 \text{ V},$ $I_{D} = 25 \text{ A}$ | Vps = 48 V  | V <sub>GS</sub> = 4.5 V                              |     | 8.7  |      | nC    |
|  |  |   | V <sub>GS</sub> = 10 V                               |     | 18.7 |      |       |
| Threshold Gate Charge  | Q <sub>G(TH)</sub>   | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 48 V,<br>I <sub>D</sub> = 25 A |  |     | 2.4  |      | nC    |
| Gate-to-Source Charge  | Q <sub>GS</sub>  |   |  |     | 4.1  |      |       |
| Gate-to-Drain Charge   | $Q_{GD}$   |   |  |     | 2.0  |      | 1     |
| Plateau Voltage  | V <sub>GP</sub>  |   |  |     | 3.1  |      | V     |
| SWITCHING CHARACTERISTICS (Note 5)                           | •  |   |  |     | •    |      | •     |
| Turn-On Delay Time   | t <sub>d(on)</sub>   |   |  |     | 12   |      | ns    |
| Rise Time  | t <sub>r</sub>   | $V_{GS} = 4.5 \text{ V}, V_{I}$   | ne = 48 V.   |     | 74   |      | 1     |
| Turn-Off Delay Time  | t <sub>d(off)</sub>  | $I_D = 25 \text{ A}, R_G$   | $= 2.5 \Omega$                                       |     | 26   |      |       |
| Fall Time  | t <sub>f</sub>   |   |  |     | 62   |      |       |
| DRAIN-SOURCE DIODE CHARACTERISTIC                            | S  |   |  |     |      |      |       |
| Forward Diode Voltage  | V <sub>SD</sub>  | Vcs = 0 V   | $V_{GS} = 0 \text{ V},$ $T_{J} = 25^{\circ}\text{C}$ |     | 0.87 | 1.2  | V     |
|  |  | $I_{S} = 20 \text{ A}$  | T <sub>J</sub> = 125°C                               |     | 0.76 |      | 7     |
| Reverse Recovery Time  | t <sub>RR</sub>  | $V_{GS} = 0$ V, dls/dt = 100 A/ $\mu$ s, $I_S = 25$ A                     |  |     | 32   |      | ns    |
| Charge Time  | ta   |   |  |     | 15   |      | 1     |
| Discharge Time   | tb   |   |  |     | 16   |      | 1     |
| Reverse Recovery Charge                                      | Q <sub>RR</sub>  |   |  |     | 20   |      | nC    |

Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2%.
 Switching characteristics are independent of operating junction temperatures.

#### **TYPICAL CHARACTERISTICS**



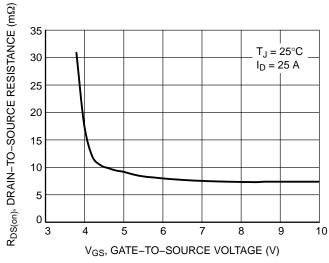


Figure 3. On-Resistance vs. Gate-to-Source Voltage

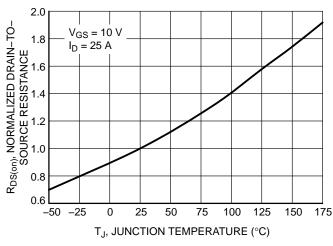
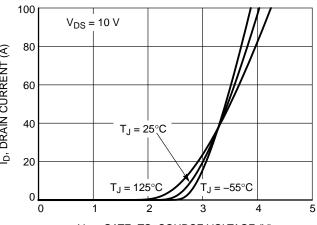


Figure 5. On-Resistance Variation with **Temperature** 



V<sub>GS</sub>, GATE-TO-SOURCE VOLTAGE (V)

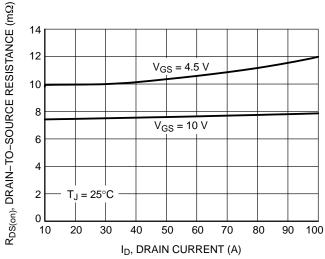


Figure 4. On-Resistance vs. Drain Current and **Gate Voltage** 

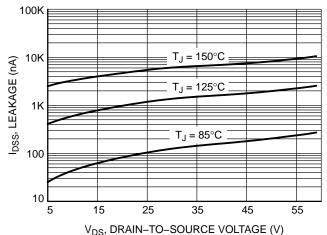
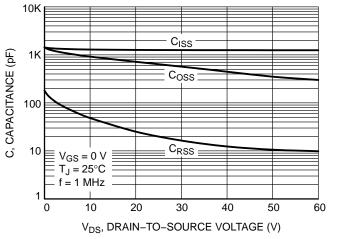


Figure 6. Drain-to-Source Leakage Current vs. Voltage

#### **TYPICAL CHARACTERISTICS**

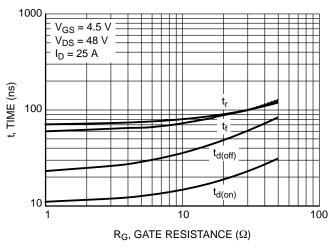


V<sub>GS</sub>, GATE-TO-SOURCE VOLTAGE (V)  $I_D = 25 A$ 8  $T_J = 25^{\circ}C$ 6 5  $\mathsf{Q}_{\mathsf{GS}}$ 4  $Q_{GD}$ 2 0 10 12 16 18 0 Q<sub>G</sub>, TOTAL GATE CHARGE (nC)

 $V_{DS} = 48 V$ 

Figure 7. Capacitance Variation

Figure 8. Gate-to-Source vs. Total Charge



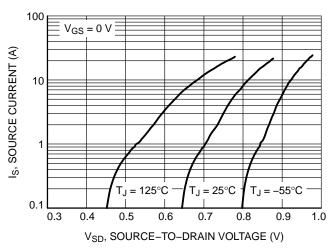
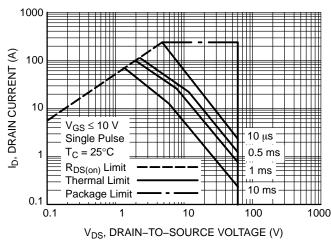


Figure 9. Resistive Switching Time Variation vs. Gate Resistance

Figure 10. Diode Forward Voltage vs. Current



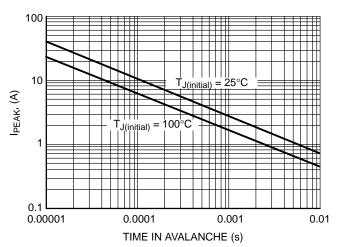


Figure 11. Maximum Rated Forward Biased Safe Operating Area

Figure 12. Maximum Drain Current vs. Time in **Avalanche** 

### **TYPICAL CHARACTERISTICS**

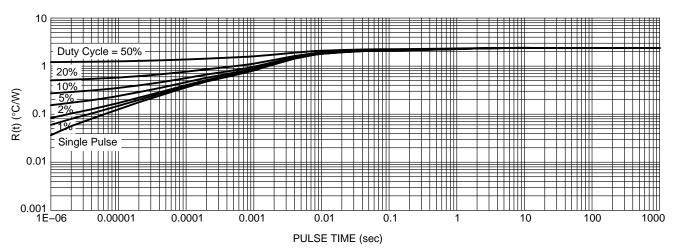


Figure 13. Thermal Response

#### **ORDERING INFORMATION**

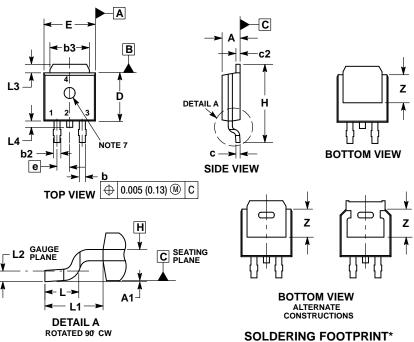
| Order Number  | Package           | Shipping <sup>†</sup> |
|---------------|-------------------|-----------------------|
| NVD5C668NLT4G | DPAK<br>(Pb-Free) | 2500 / Tape & Reel    |

<sup>†</sup>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.

#### PACKAGE DIMENSIONS

## **DPAK (SINGLE GAUGE)**

CASE 369C ISSUE F



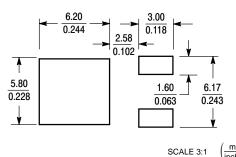
#### NOTES:

- 1. DIMENSIONING AND TOLERANCING PER ASME
- Y14.5M, 1994. CONTROLLING DIMENSION: INCHES.
- THERMAL PAD CONTOUR OPTIONAL WITHIN DI-MENSIONS b3, L3 and Z.
- MENSIONS DS, LS AND E DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.006 INCHES PER SIDE.
- DIMENSIONS D AND E ARE DETERMINED AT THE OUTERMOST EXTREMES OF THE PLASTIC BODY.
- 6. DATUMS A AND B ARE DETERMINED AT DATUM PLANE H.
- 7. OPTIONAL MOLD FEATURE.

|     | INC       | HES   | MILLIN   | IETERS   |  |  |
|-----|-----------|-------|----------|----------|--|--|
| DIM | MIN       | MAX   | MIN      | MAX      |  |  |
| Α   | 0.086     | 0.094 | 2.18     | 2.38     |  |  |
| A1  | 0.000     | 0.005 | 0.00     | 0.13     |  |  |
| b   | 0.025     | 0.035 | 0.63     | 0.89     |  |  |
| b2  | 0.028     | 0.045 | 0.72     | 1.14     |  |  |
| b3  | 0.180     | 0.215 | 4.57     | 5.46     |  |  |
| С   | 0.018     | 0.024 | 0.46     | 0.61     |  |  |
| c2  | 0.018     | 0.024 | 0.46     | 0.61     |  |  |
| D   | 0.235     | 0.245 | 5.97     | 6.22     |  |  |
| E   | 0.250     | 0.265 | 6.35     | 6.73     |  |  |
| е   | 0.090 BSC |       | 2.29 BSC |          |  |  |
| Н   | 0.370     | 0.410 | 9.40     | 10.41    |  |  |
| L   | 0.055     | 0.070 | 1.40     | 1.78     |  |  |
| L1  | 0.114 REF |       | 2.90     | REF      |  |  |
| L2  | 0.020 BSC |       | 0.51     | 0.51 BSC |  |  |
| L3  | 0.035     | 0.050 | 0.89     | 1.27     |  |  |
| L4  |           | 0.040 |          | 1.01     |  |  |
| Z   | 0.155     |       | 3.93     |          |  |  |

STYLE 2:

- PIN 1. GATE 2. DRAIN
- 3. SOURCE 4. DRAIN



\*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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