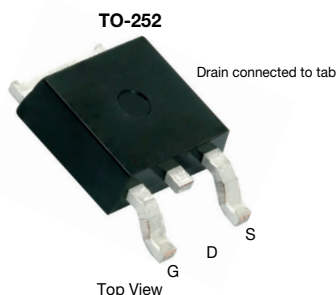


# Automotive N-Channel 60 V (D-S) 175 °C MOSFET

| PRODUCT SUMMARY                               |        |
|---|--------|
| $V_{DS}$ (V)                                  | 60     |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 10$ V  | 0.031  |
| $R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = 4.5$ V | 0.045  |
| $I_D$ (A)                                     | 23     |
| Configuration                                 | Single |
| Package                                       | TO-252 |

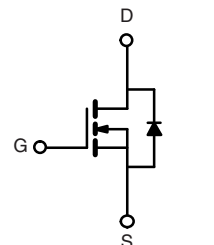


## FEATURES

- TrenchFET® power MOSFET
- 100 %  $R_g$  and UIS tested
- AEC-Q101 qualified <sup>d</sup>
- Material categorization:  
for definitions of compliance please see  
[www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**



N-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted) |                |                |             |      |
|---|----------------|----------------|-------------|------|
| PARAMETER   |                | SYMBOL         | LIMIT       | UNIT |
| Drain-Source Voltage  |                | $V_{DS}$       | 60          | V    |
| Gate-Source Voltage   |                | $V_{GS}$       | $\pm 20$    |      |
| Continuous Drain Current  | $T_C = 25$ °C  | $I_D$          | 23          | A    |
|   | $T_C = 125$ °C |                | 13          |      |
| Continuous Source Current (Diode Conduction) <sup>a</sup>         |                | $I_S$          | 30          |      |
| Pulsed Drain Current <sup>b</sup>                                 |                | $I_{DM}$       | 90          |      |
| Single Pulse Avalanche Current                                    | $L = 0.1$ mH   | $I_{AS}$       | 20          |      |
|   |                | $E_{AS}$       | 20          | mJ   |
| Maximum Power Dissipation <sup>b</sup>                            | $T_C = 25$ °C  | $P_D$          | 37          | W    |
|   | $T_C = 125$ °C |                | 12          |      |
| Operating Junction and Storage Temperature Range                  |                | $T_J, T_{stg}$ | -55 to +175 | °C   |

| THERMAL RESISTANCE RATINGS |                        |            |       |      |
|----------------------------|------------------------|------------|-------|------|
| PARAMETER                  |                        | SYMBOL     | LIMIT | UNIT |
| Junction-to-Ambient        | PCB Mount <sup>c</sup> | $R_{thJA}$ | 50    | °C/W |
| Junction-to-Case (Drain)   |                        | $R_{thJC}$ | 4     |      |

## Notes

- Package limited.
- Pulse test; pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2$  %.
- When mounted on 1" square PCB (FR4 material).
- Parametric verification ongoing.



| SPECIFICATIONS (T <sub>C</sub> = 25 °C, unless otherwise noted) |                     |   |   |      |       |       |      |
|---|---------------------|---|---|------|-------|-------|------|
| PARAMETER   | SYMBOL              | TEST CONDITIONS   |   | MIN. | TYP.  | MAX.  | UNIT |
| Static  |                     |   |   |      |       |       |      |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA  |   | 60   | -     | -     | V    |
| Gate-Source Threshold Voltage                                   | V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA   |   | 1.5  | 2.0   | 2.5   |      |
| Gate-Source Leakage   | I <sub>GSS</sub>    | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V   |   | -    | -     | ± 100 | nA   |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>    | V <sub>GS</sub> = 0 V   | V <sub>DS</sub> = 60 V                          | -    | -     | 1.0   | μA   |
|   |                     | V <sub>GS</sub> = 0 V   | V <sub>DS</sub> = 60 V, T <sub>J</sub> = 125 °C | -    | -     | 50    |      |
|   |                     | V <sub>GS</sub> = 0 V   | V <sub>DS</sub> = 60 V, T <sub>J</sub> = 175 °C | -    | -     | 250   |      |
| On-State Drain Current <sup>a</sup>                             | I <sub>D(on)</sub>  | V <sub>GS</sub> = 10 V  | V <sub>DS</sub> ≥ 5 V                           | 30   | -     | -     | A    |
| Drain-Source On-State Resistance <sup>a</sup>                   | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V  | I <sub>D</sub> = 15 A                           | -    | 0.024 | 0.031 | Ω    |
|   |                     | V <sub>GS</sub> = 10 V  | I <sub>D</sub> = 15 A, T <sub>J</sub> = 125 °C  | -    | -     | 0.055 |      |
|   |                     | V <sub>GS</sub> = 10 V  | I <sub>D</sub> = 15 A, T <sub>J</sub> = 175 °C  | -    | -     | 0.070 |      |
|   |                     | V <sub>GS</sub> = 4.5 V   | I <sub>D</sub> = 10 A                           | -    | -     | 0.045 |      |
| Forward Transconductance <sup>b</sup>                           | g <sub>fs</sub>     | V <sub>DS</sub> = 15 V, I <sub>D</sub> = 15 A   |   | -    | 25    | -     | S    |
| Dynamic <sup>b</sup>  |                     |   |   |      |       |       |      |
| Input Capacitance   | C <sub>iss</sub>    | V <sub>GS</sub> = 0 V   | V <sub>DS</sub> = 25 V, f = 1 MHz               | -    | 674   | 845   | pF   |
| Output Capacitance  | C <sub>oss</sub>    |   |   | -    | 144   | 180   |      |
| Reverse Transfer Capacitance                                    | C <sub>rss</sub>    |   |   | -    | 55    | 70    |      |
| Total Gate Charge <sup>c</sup>                                  | Q <sub>g</sub>      | V <sub>GS</sub> = 10 V  | V <sub>DS</sub> = 30 V, I <sub>D</sub> = 23 A   | -    | 16    | 24    | nC   |
| Gate-Source Charge <sup>c</sup>                                 | Q <sub>gs</sub>     |   |   | -    | 4     | -     |      |
| Gate-Drain Charge <sup>c</sup>                                  | Q <sub>gd</sub>     |   |   | -    | 3     | -     |      |
| Gate Resistance   | R <sub>g</sub>      | f = 1 MHz   |   | 0.5  | 1.4   | 3.3   | Ω    |
| Turn-On Delay Time <sup>c</sup>                                 | t <sub>d(on)</sub>  | V <sub>DD</sub> = 30 V, R <sub>L</sub> = 1.3 Ω,<br>I <sub>D</sub> ≅ 23 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 1 Ω |   | -    | 6     | 9     | ns   |
| Rise Time <sup>c</sup>  | t <sub>r</sub>      |   |   | -    | 8     | 12    |      |
| Turn-Off Delay Time <sup>c</sup>                                | t <sub>d(off)</sub> |   |   | -    | 14    | 21    |      |
| Fall Time <sup>c</sup>  | t <sub>f</sub>      |   |   | -    | 3     | 5     |      |
| Source-Drain Diode Ratings and Characteristics <sup>b</sup>     |                     |   |   |      |       |       |      |
| Pulsed Current <sup>a</sup>                                     | I <sub>SM</sub>     |   |   | -    | -     | 90    | A    |
| Forward Voltage   | V <sub>SD</sub>     | I <sub>F</sub> = 15 A, V <sub>GS</sub> = 0 V  |   | -    | 0.9   | 1.5   | V    |

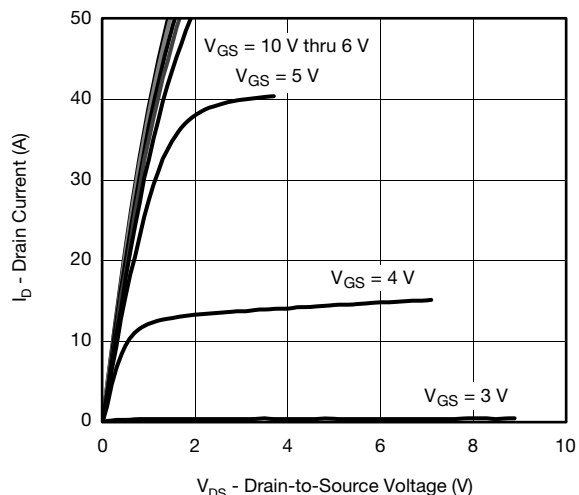
**Notes**

- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
b. Guaranteed by design, not subject to production testing.  
c. Independent of operating temperature.

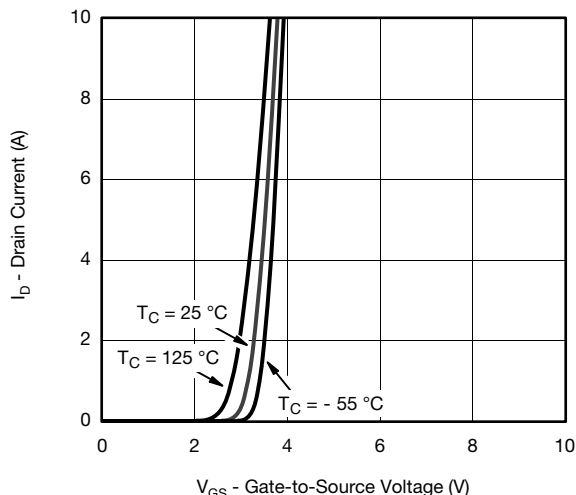
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.



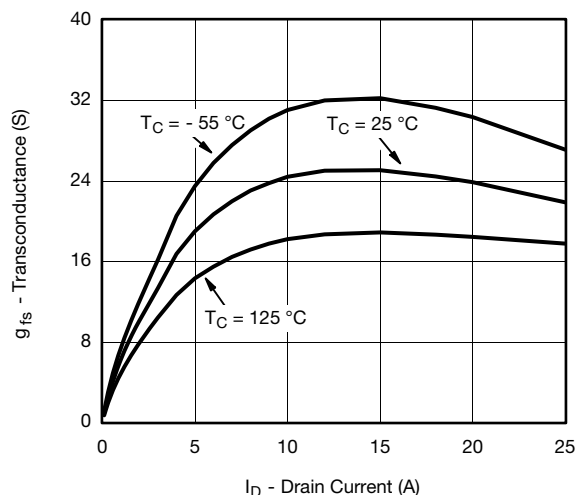
**TYPICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



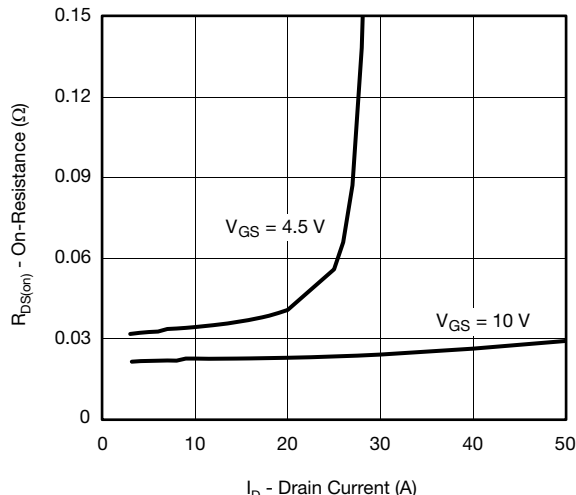
**Output Characteristics**



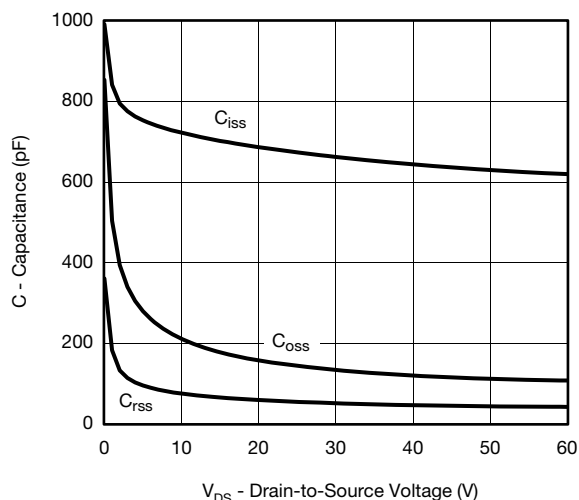
**Transfer Characteristics**



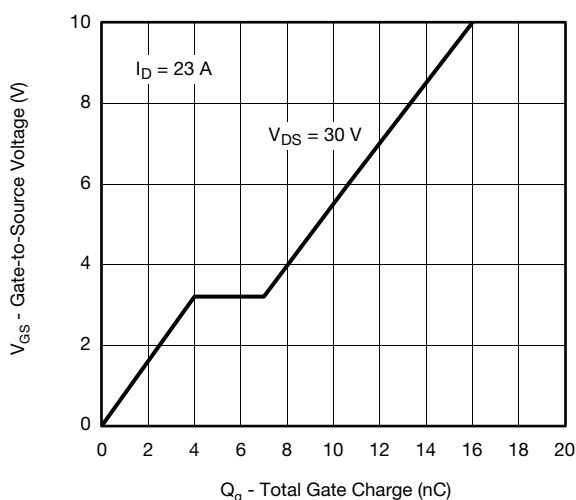
**Transconductance**



**On-Resistance vs. Drain Current**



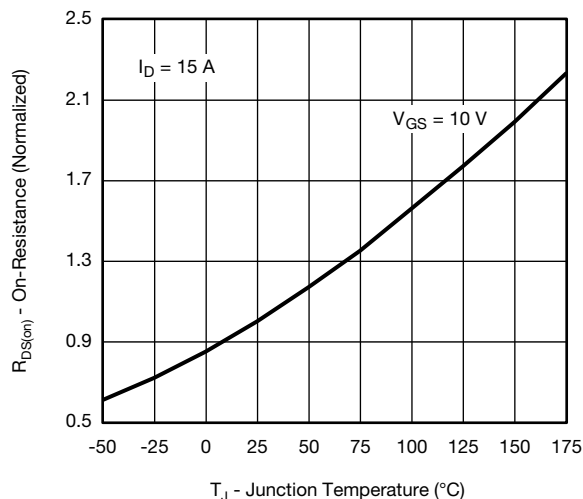
**Capacitance**



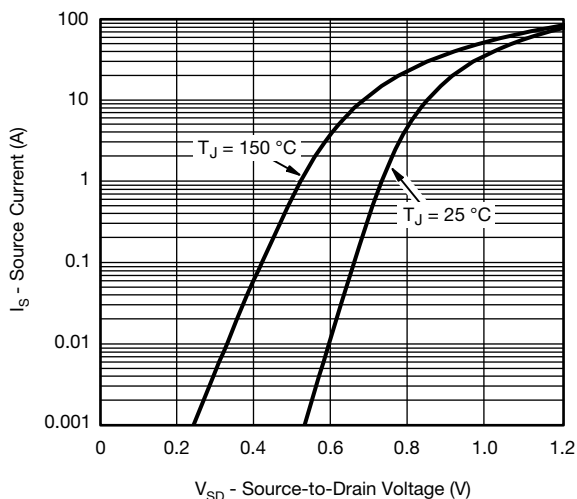
**Gate Charge**



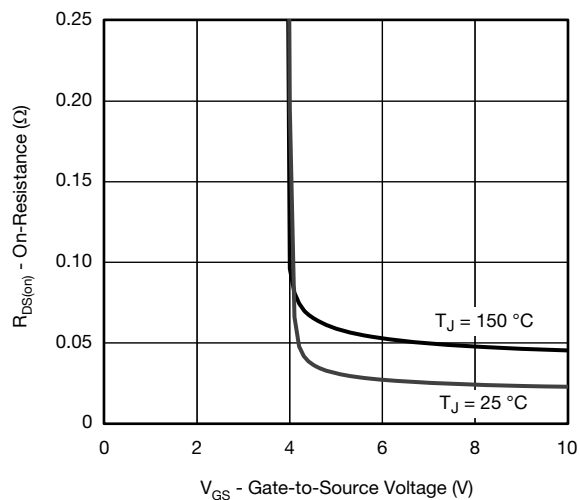
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



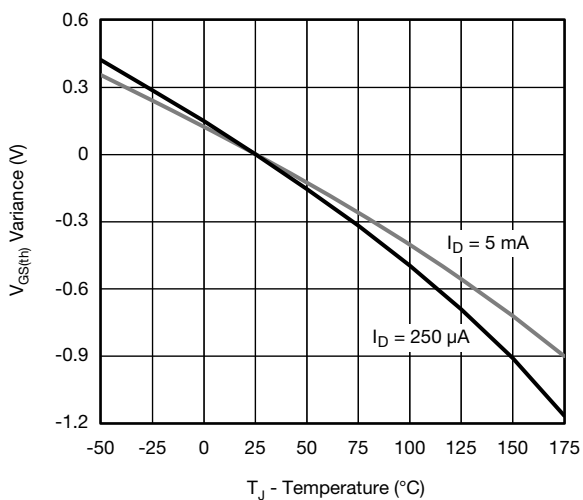
**On-Resistance vs. Junction Temperature**



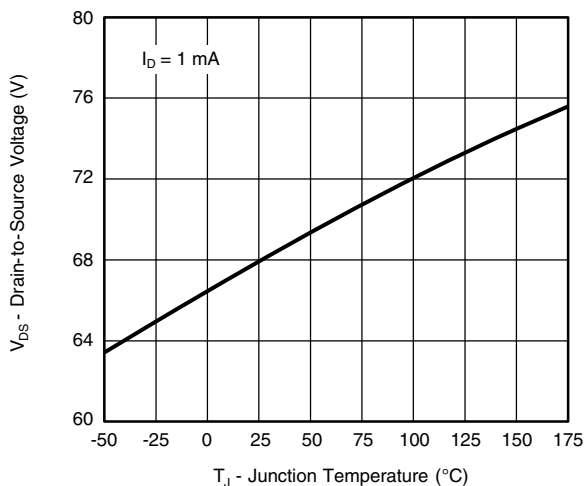
**Source Drain Diode Forward Voltage**



**On-Resistance vs. Gate-to-Source Voltage**



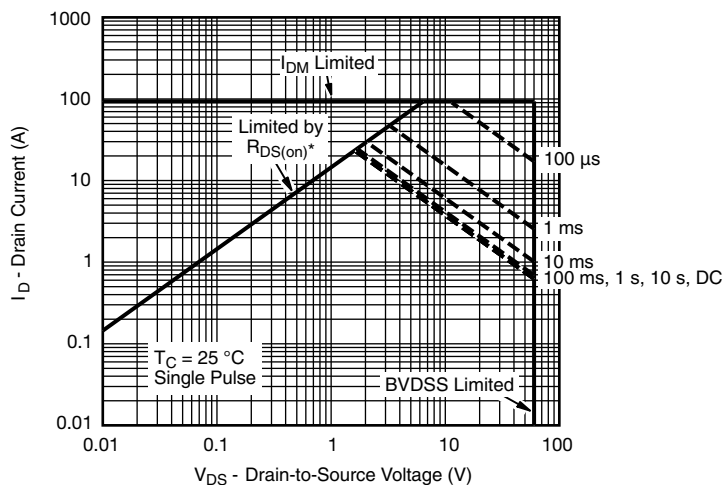
**Threshold Voltage**



**On-Resistance vs. Junction Temperature**

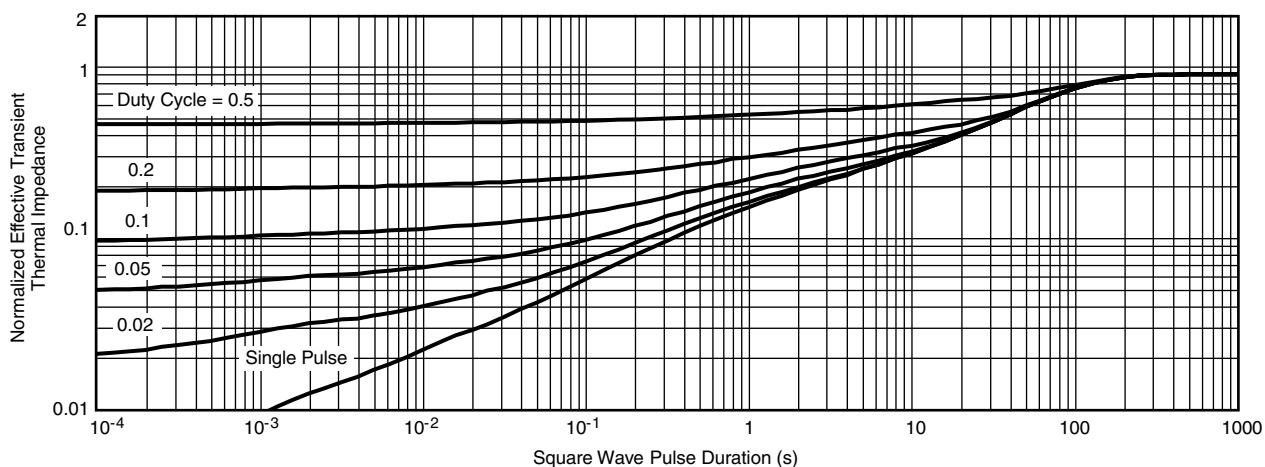


**THERMAL RATINGS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

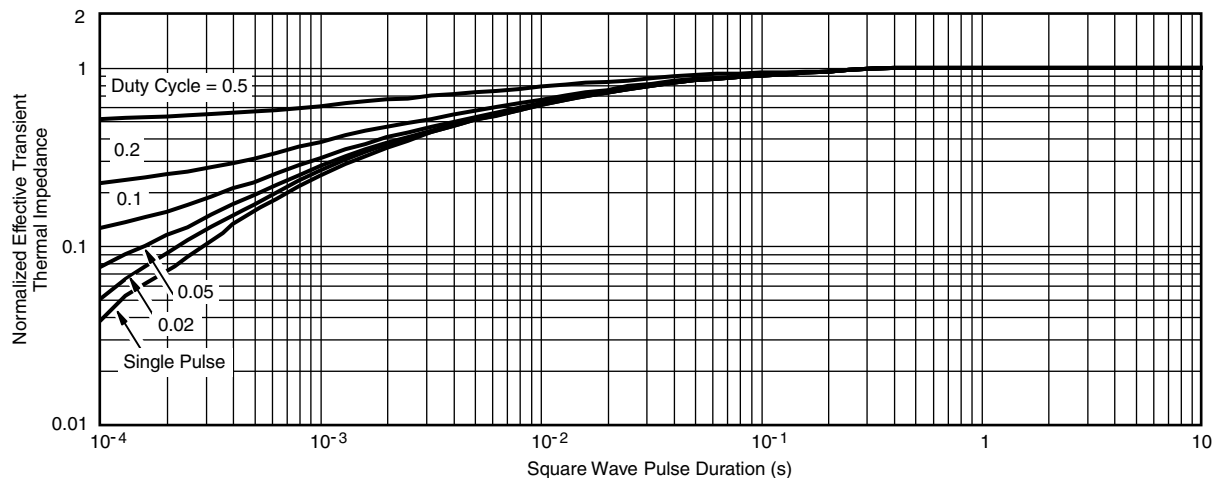
**Safe Operating Area**



**Normalized Thermal Transient Impedance, Junction-to-Ambient**



**THERMAL RATINGS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



**Normalized Thermal Transient Impedance, Junction-to-Case**

**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient ( $25\text{ }^{\circ}\text{C}$ )
  - Normalized Transient Thermal Impedance Junction-to-Case ( $25\text{ }^{\circ}\text{C}$ )are given for general guidelines only to enable the user to get a “ball park” indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

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| REVISION HISTORY <sup>a</sup> |           |  |
|-------------------------------|-----------|--|
| REVISION                      | DATE      | DESCRIPTION OF CHANGE                  |
| C                             | 04-Aug-15 | • Revised R <sub>g</sub> minimum limit |

**Note**

a. As of April 2014

**DPAK / TO-252 and Reverse DPAK**

Ordering codes for the SQ rugged series power MOSFETs in the DPAK / TO-252 and Reverse DPAK packages:

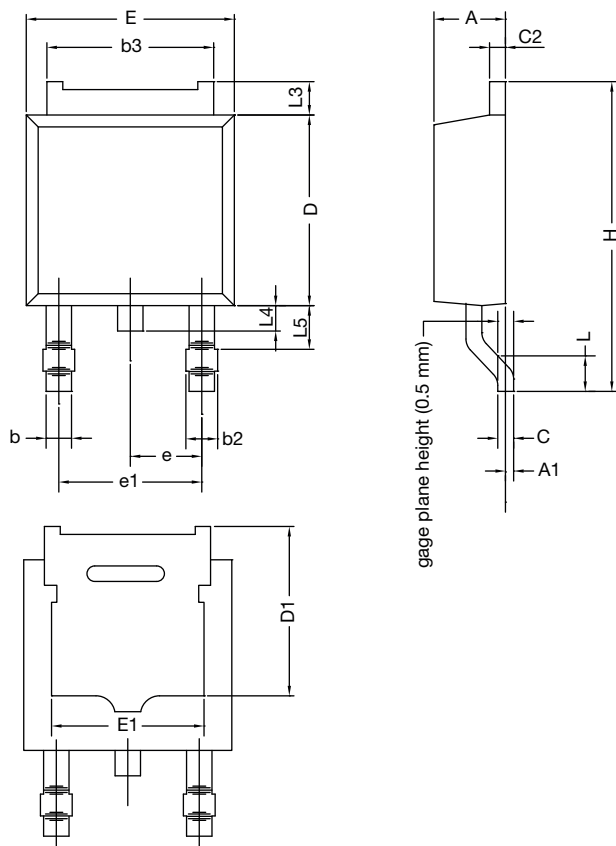
| DATASHEET PART NUMBER | OLD ORDERING CODE <sup>a</sup> | NEW ORDERING CODE  |
|-----------------------|--------------------------------|--------------------|
| SQD07N25-350H         | SQD07N25-350H-GE3              | SQD07N25-350H_GE3  |
| SQD100N03-3m2L        | SQD100N03-3M2L-GE3             | SQD100N03-3M2L_GE3 |
| SQD100N03-3m4         | SQD100N03-3M4-GE3              | SQD100N03-3M4_GE3  |
| SQD100N04-3m6         | SQD100N04-3M6-GE3              | SQD100N04-3M6_GE3  |
| SQD100N04-3m6L        | SQD100N04-3M6L-GE3             | SQD100N04-3M6L_GE3 |
| SQD10N30-330H         | SQD10N30-330H-GE3              | SQD10N30-330H_GE3  |
| SQD15N06-42L          | SQD15N06-42L-GE3               | SQD15N06-42L_GE3   |
| SQD19P06-60L          | SQD19P06-60L-GE3               | SQD19P06-60L_GE3   |
| SQD23N06-31L          | SQD23N06-31L-GE3               | SQD23N06-31L_GE3   |
| SQD25N06-22L          | SQD25N06-22L-GE3               | SQD25N06-22L_GE3   |
| SQD25N15-52           | SQD25N15-52-GE3                | SQD25N15-52_GE3    |
| SQD30N05-20L          | SQD30N05-20L-GE3               | SQD30N05-20L_GE3   |
| SQD40N06-14L          | SQD40N06-14L-GE3               | SQD40N06-14L_GE3   |
| SQD40N10-25           | SQD40N10-25-GE3                | SQD40N10-25_GE3    |
| SQD40P10-40L          | SQD40P10-40L-GE3               | SQD40P10-40L_GE3   |
| SQD45P03-12           | SQD45P03-12-GE3                | SQD45P03-12_GE3    |
| SQD50N04-5m6          | SQD50N04-5M6-GE3               | SQD50N04-5M6_GE3   |
| SQD50N05-11L          | SQD50N05-11L-GE3               | SQD50N05-11L_GE3   |
| SQD50N06-09L          | SQD50N06-09L-GE3               | SQD50N06-09L_GE3   |
| SQD50N10-8m9L         | SQD50N10-8M9L-GE3              | SQD50N10-8M9L_GE3  |
| SQD50P03-07           | SQD50P03-07-GE3                | SQD50P03-07_GE3    |
| SQD50P04-13L          | SQD50P04-13L-GE3               | SQD50P04-13L_GE3   |
| SQD50P04-09L          | SQD50P04-09L-GE3               | SQD50P04-09L_GE3   |
| SQD50P06-15L          | SQD50P06-15L-GE3               | SQD50P06-15L_GE3   |
| SQD50P08-25L          | SQD50P08-25L-GE3               | SQD50P08-25L_GE3   |
| SQD50P08-28           | SQD50P08-28-GE3                | SQD50P08-28_GE3    |
| SQD90P04-9m4L         | SQD90P04-9M4L-GE3              | SQD90P04-9M4L_GE3  |
| SQD97N06-6m3L         | SQD97N06-6M3L-GE3              | SQD97N06-6M3L_GE3  |
| SQR40N10-25           | SQR40N10-25-GE3                | SQR40N10-25_GE3    |
| SQR50N04-3m8          | SQR50N04-3M8-GE3               | SQR50N04-3M8_GE3   |

**Note**

a. Old ordering code is obsolete and no longer valid for new orders



## TO-252AA Case Outline

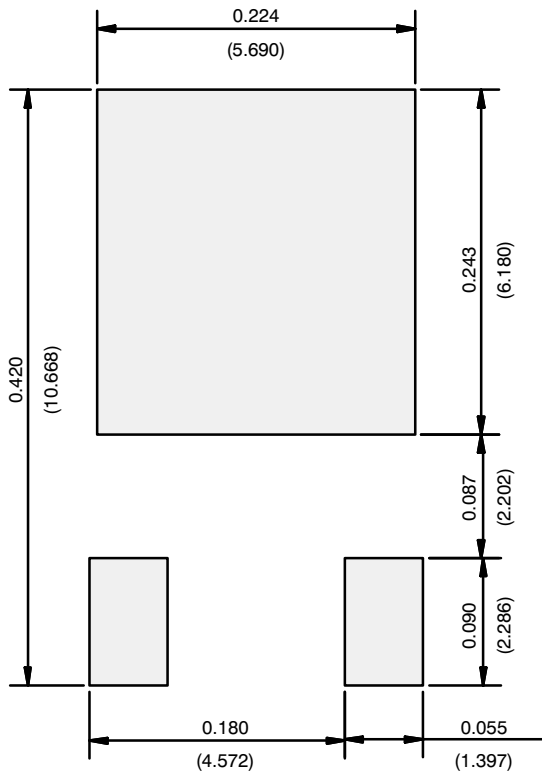


| DIM.   | MILLIMETERS |       | INCHES    |       |
|--|-------------|-------|-----------|-------|
|  | MIN.        | MAX.  | MIN.      | MAX.  |
| A  | 2.18        | 2.38  | 0.086     | 0.094 |
| A1   | -           | 0.127 | -         | 0.005 |
| b  | 0.64        | 0.88  | 0.025     | 0.035 |
| b2   | 0.76        | 1.14  | 0.030     | 0.045 |
| b3   | 4.95        | 5.46  | 0.195     | 0.215 |
| C  | 0.46        | 0.61  | 0.018     | 0.024 |
| C2   | 0.46        | 0.89  | 0.018     | 0.035 |
| D  | 5.97        | 6.22  | 0.235     | 0.245 |
| D1   | 4.10        | -     | 0.161     | -     |
| E  | 6.35        | 6.73  | 0.250     | 0.265 |
| E1   | 4.32        | -     | 0.170     | -     |
| H  | 9.40        | 10.41 | 0.370     | 0.410 |
| e  | 2.28 BSC    |       | 0.090 BSC |       |
| e1   | 4.56 BSC    |       | 0.180 BSC |       |
| L  | 1.40        | 1.78  | 0.055     | 0.070 |
| L3   | 0.89        | 1.27  | 0.035     | 0.050 |
| L4   | -           | 1.02  | -         | 0.040 |
| L5   | 1.01        | 1.52  | 0.040     | 0.060 |
| ECN: T13-0592-Rev. A, 02-Sep-13<br>DWG: 6019 |             |       |           |       |

### Note

- Dimension L3 is for reference only.

## RECOMMENDED MINIMUM PADS FOR DPAK (TO-252)



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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