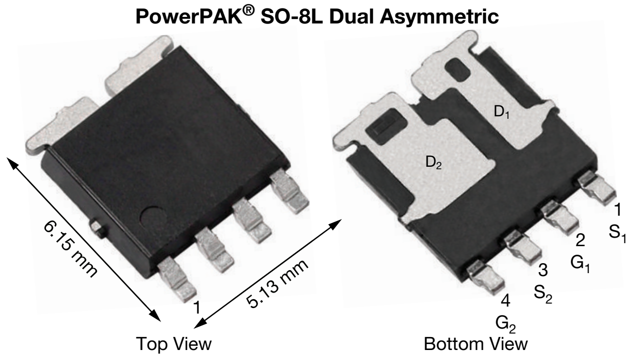
# Automotive Dual N-Channel 60 V (D-S) 175 °C MOSFETs

**PowerPAK® SO-8L Dual Asymmetric**

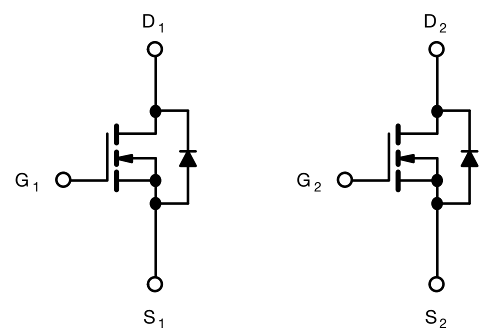



## FEATURESS

- TrenchFET® power MOSFET
- AEC-Q101 qualified
- 100 % $R_g$ and UIS tested
- Optimized for synchronous buck applications
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE
Pb-free
RoHS COMPLIANT
HALOGEN FREE

| PRODUCT SUMMARY | | |
|---|---|---|
| | N-CHANNEL 1 | N-CHANNEL 2 |
| $V_{DS}$ (V) | 60 | 60 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = 10 V | 0.0355 | 0.0155 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = 4.5 V | 0.0480 | 0.0200 |
| $I_D$ (A) | 15 | 40 |
| Configuration | Dual N | |
| Package | PowerPAK SO-8L Dual Asymmetric | |




N-Channel 1 MOSFET    N-Channel 2 MOSFET

**ABSOLUTE MAXIMUM RATINGS** ($T_C$ = 25 °C, unless otherwise noted)

| PARAMETER | | SYMBOL | N-CHANNEL 1 | N-CHANNEL 2 | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | $V_{DS}$ | 60 | 60 | V |
| Gate-source voltage | | $V_{GS}$ | ± 20 | | |
| Continuous drain current | $T_C$ = 25 °C | $I_D$ | 15 [a] | 40 | A |
| | $T_C$ = 125 °C | | 11 | 23 | |
| Continuous source current (diode conduction) | | $I_S$ | 15 [a] | 44 | |
| Pulsed drain current [b] | | $I_{DM}$ | 30 | 70 | |
| Single pulse avalanche current | L = 0.1 mH | $I_{AS}$ | 12 | 20 | |
| Single pulse avalanche energy | | $E_{AS}$ | 7.2 | 20 | mJ |
| Maximum power dissipation [b] | $T_C$ = 25 °C | $P_D$ | 27 | 48 | W |
| | $T_C$ = 125 °C | | 9 | 16 | |
| Operating junction and storage temperature range | | $T_J$, $T_{stg}$ | -55 to +175 | | °C |
| Soldering recommendations (peak temperature) [d, e] | | | 260 | | |

| THERMAL RESISTANCE RATINGS | | | | | |
|---|---|---|---|---|---|
| PARAMETER | | SYMBOL | N-CHANNEL 1 | N-CHANNEL 2 | UNIT |
| Junction-to-ambient | PCB mount [c] | $R_{thJA}$ | 85 | 85 | °C/W |
| Junction-to-case (drain) | | $R_{thJC}$ | 5.5 | 3.1 | |

**Notes**

a. Package limited
b. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %
c. When mounted on 1" square PCB (FR4 material)
d. See solder profile (www.vishay.com/doc?73257). The PowerPAK SO-8L is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper tip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection
e. Rework conditions: manual soldering with a soldering iron is not recommended for leadless components

| SPECIFICATIONS ($T_C$ = 25 °C, unless otherwise noted) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | TEST CONDITIONS | | | MIN. | TYP. | MAX. | UNIT |
| **Static** | | | | | | | | |
| Drain-source breakdown voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = 250 μA | | N-Ch 1 | 60 | - | - | V |
| | | $V_{GS}$ = 0 V, $I_D$ = 250 μA | | N-Ch 2 | 60 | - | - | |
| Gate-source threshold voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | | N-Ch 1 | 1.5 | 2.0 | 2.5 | |
| | | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 μA | | N-Ch 2 | 1.5 | 2.0 | 2.5 | |
| Gate-source leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ± 20 V | | N-Ch 1 | - | - | ± 100 | nA |
| | | | | N-Ch 2 | - | - | ± 100 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V | N-Ch 1 | - | - | 1 | μA |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V | N-Ch 2 | - | - | 1 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V, $T_J$ = 125 °C | N-Ch 1 | - | - | 50 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V, $T_J$ = 125 °C | N-Ch 2 | - | - | 50 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V, $T_J$ = 175 °C | N-Ch 1 | - | - | 250 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 60 V, $T_J$ = 175 °C | N-Ch 2 | - | - | 250 | |
| On-state drain current [a] | $I_{D(on)}$ | $V_{GS}$ = 10 V | $V_{DS}$ ≥ 5 V | N-Ch 1 | 10 | - | - | A |
| | | $V_{GS}$ = 10 V | $V_{DS}$ ≥ 5 V | N-Ch 2 | 20 | - | - | |
| Drain-source on-state resistance [a] | $R_{DS(on)}$ | $V_{GS}$ = 10 V | $I_D$ = 2 A | N-Ch 1 | - | 0.0295 | 0.0355 | Ω |
| | | $V_{GS}$ = 10 V | $I_D$ = 5 A | N-Ch 2 | - | 0.0126 | 0.0155 | |
| | | $V_{GS}$ = 10 V | $I_D$ = 2 A, $T_J$ = 125 °C | N-Ch 1 | - | - | 0.0563 | |
| | | $V_{GS}$ = 10 V | $I_D$ = 5 A, $T_J$ = 125 °C | N-Ch 2 | - | - | 0.0253 | |
| | | $V_{GS}$ = 10 V | $I_D$ = 2 A, $T_J$ = 175 °C | N-Ch 1 | - | - | 0.0700 | |
| | | $V_{GS}$ = 10 V | $I_D$ = 5 A, $T_J$ = 175 °C | N-Ch 2 | - | - | 0.0311 | |
| | | $V_{GS}$ = 4.5 V | $I_D$ = 1 A | N-Ch 1 | - | 0.0400 | 0.0480 | |
| | | $V_{GS}$ = 4.5 V | $I_D$ = 3 A | N-Ch 2 | - | 0.0165 | 0.0200 | |
| **Dynamic [b]** | | | | | | | | |
| Input capacitance | $C_{iss}$ | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 1 | - | 410 | 550 | pF |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 2 | - | 967 | 1260 | |
| Output capacitance | $C_{oss}$ | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 1 | - | 212 | 280 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 2 | - | 436 | 570 | |
| Reverse transfer capacitance | $C_{rss}$ | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 1 | - | 15 | 20 | |
| | | $V_{GS}$ = 0 V | $V_{DS}$ = 25 V, f = 1 MHz | N-Ch 2 | - | 18 | 25 | |
| Total gate charge [c] | $Q_g$ | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 1 A | N-Ch 1 | - | 6.5 | 10 | nC |
| | | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 2 A | N-Ch 2 | - | 14.5 | 23 | |
| Gate-source charge [c] | $Q_{gs}$ | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 1 A | N-Ch 1 | - | 1.4 | - | |
| | | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 2 A | N-Ch 2 | - | 2.7 | - | |
| Gate-drain charge [c] | $Q_{gd}$ | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 1 A | N-Ch 1 | - | 0.9 | - | |
| | | $V_{GS}$ = 10 V | $V_{DS}$ = 30 V, $I_D$ = 2 A | N-Ch 2 | - | 2.1 | - | |
| Gate resistance | $R_g$ | f = 1 MHz | | N-Ch 1 | 0.7 | 1.47 | 2.2 | Ω |
| | | | | N-Ch 2 | 0.3 | 0.62 | 0.95 | |

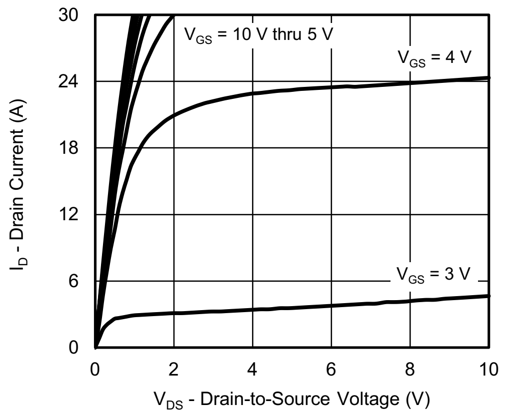
| **SPECIFICATIONS** ($T_C$ = 25 °C, unless otherwise noted) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Dynamic** [b] | | | | | | | |
| Turn-on delay time [c] | $t_{d(on)}$ | $V_{DD}$ = 30 V, $R_L$ = 30 Ω, $I_D$ ≅ 1 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 1 | - | 9 | 15 | ns |
| | | $V_{DD}$ = 30 V, $R_L$ = 15 Ω, $I_D$ ≅ 2 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 2 | - | 13 | 20 | |
| Rise time [c] | $t_r$ | $V_{DD}$ = 30 V, $R_L$ = 30 Ω, $I_D$ ≅ 1 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 1 | - | 3 | 5 | |
| | | $V_{DD}$ = 30 V, $R_L$ = 15 Ω, $I_D$ ≅ 2 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 2 | - | 3 | 5 | |
| Turn-off delay time [c] | $t_{d(off)}$ | $V_{DD}$ = 30 V, $R_L$ = 30 Ω, $I_D$ ≅ 1 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 1 | - | 15 | 25 | |
| | | $V_{DD}$ = 30 V, $R_L$ = 15 Ω, $I_D$ ≅ 2 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 2 | - | 23 | 35 | |
| Fall time [c] | $t_f$ | $V_{DD}$ = 30 V, $R_L$ = 30 Ω, $I_D$ ≅ 1 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 1 | - | 10 | 15 | |
| | | $V_{DD}$ = 30 V, $R_L$ = 15 Ω, $I_D$ ≅ 2 A, $V_{GEN}$ = 10 V, $R_g$ = 1 Ω | N-Ch 2 | - | 10 | 15 | |
| **Source-Drain Diode Ratings and Characteristics** [b] | | | | | | | |
| Pulsed current [a] | $I_{SM}$ | | N-Ch 1 | - | - | 30 | A |
| | | | N-Ch 2 | - | - | 70 | |
| Forward voltage | $V_{SD}$ | $I_F$ = 2 A, $V_{GS}$ = 0 V | N-Ch 1 | - | 0.81 | 1.2 | V |
| | | $I_F$ = 5 A, $V_{GS}$ = 0 V | N-Ch 2 | - | 0.80 | 1.2 | |
| Body diode reverse recovery time | $t_{rr}$ | $I_F$ = 2 A, di/dt = 100 A/µs | N-Ch 1 | - | 24 | 50 | ns |
| | | $I_F$ = 3 A, di/dt = 100 A/µs | N-Ch 2 | - | 36 | 75 | |
| Body diode reverse recovery charge | $Q_{rr}$ | $I_F$ = 2 A, di/dt = 100 A/µs | N-Ch 1 | - | 17 | 35 | nC |
| | | $I_F$ = 3 A, di/dt = 100 A/µs | N-Ch 2 | - | 30 | 60 | |
| Reverse recovery fall time | $t_a$ | $I_F$ = 2 A, di/dt = 100 A/µs | N-Ch 1 | - | 12 | - | ns |
| | | $I_F$ = 3 A, di/dt = 100 A/µs | N-Ch 2 | - | 19 | - | |
| Reverse recovery rise time | $t_b$ | $I_F$ = 2 A, di/dt = 100 A/µs | N-Ch 1 | - | 12 | - | |
| | | $I_F$ = 3 A, di/dt = 100 A/µs | N-Ch 2 | - | 17 | - | |
| Body diode peak reverse recovery current | $I_{RM(REC)}$ | $I_F$ = 2 A, di/dt = 100 A/µs | N-Ch 1 | - | -1.3 | - | A |
| | | $I_F$ = 3 A, di/dt = 100 A/µs | N-Ch 2 | - | -1.6 | - | |

**Notes**

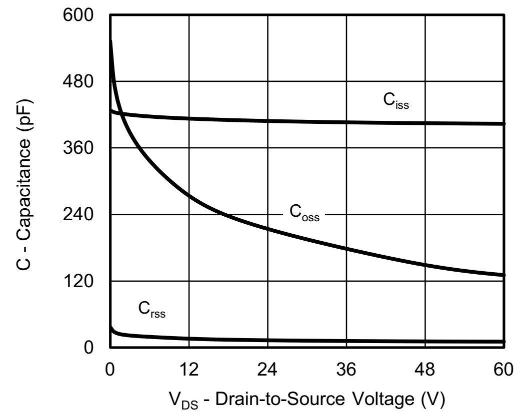
a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %
b. Guaranteed by design, not subject to production testing
c. Independent of operating temperature

*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.*

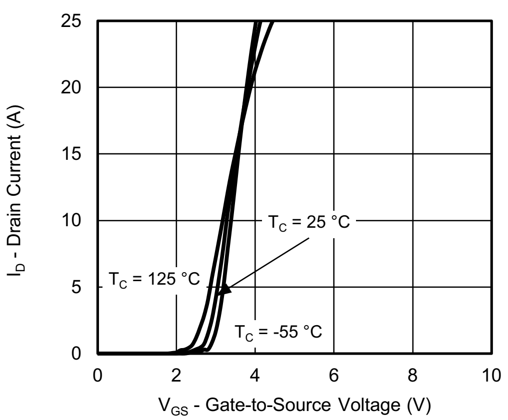
**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)



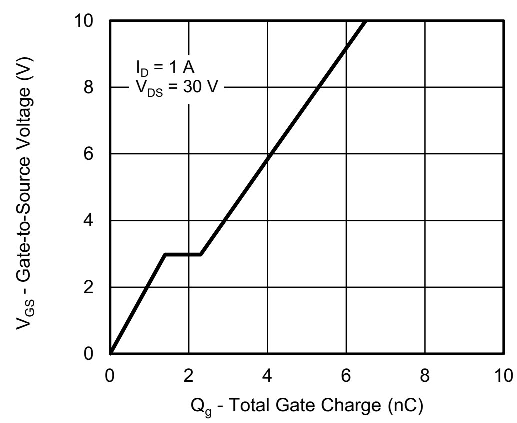

**Output Characteristics**



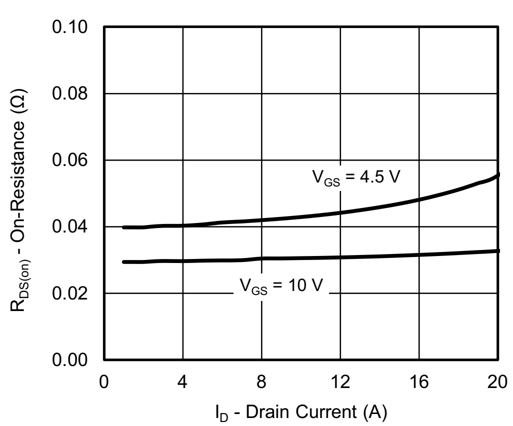

**Capacitance**



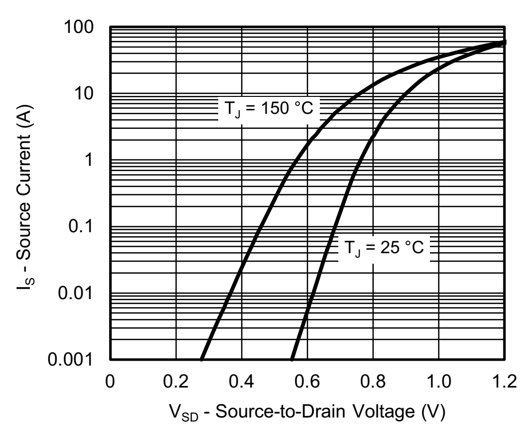

**Transfer Characteristics**




**Gate Charge**

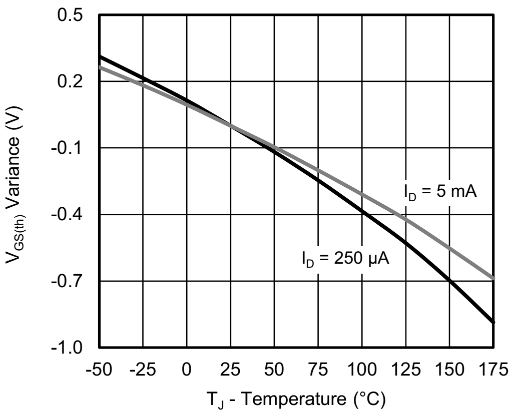



**On-Resistance vs. Drain Current**

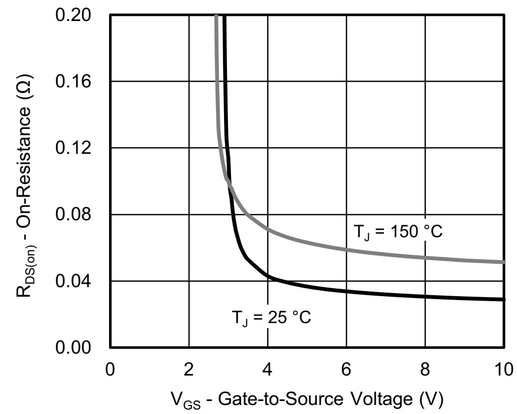



**Source Drain Diode Forward Voltage**

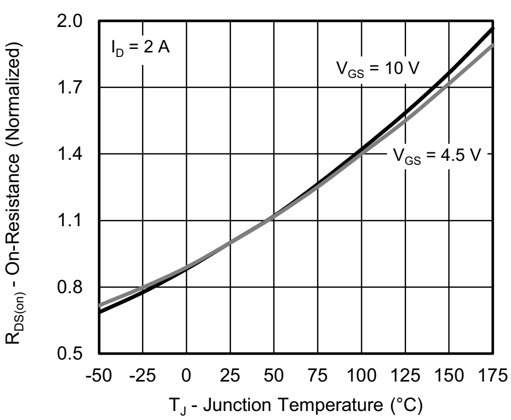
**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)



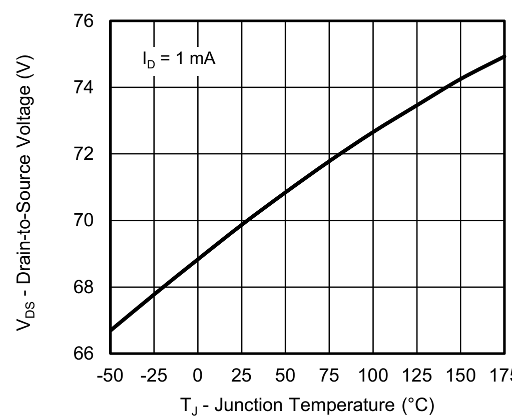

**Threshold Voltage**



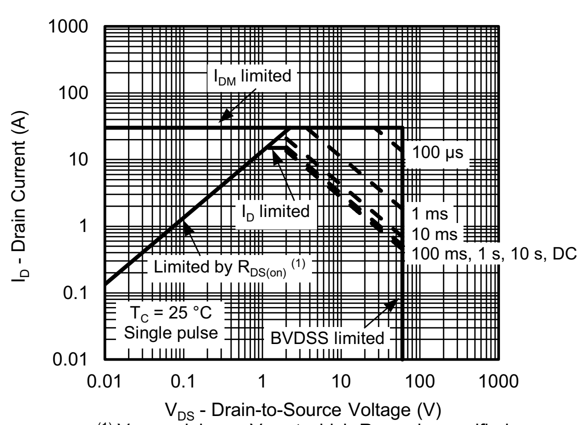

**On-Resistance vs. Gate-to-Source Voltage**




**On-Resistance vs. Junction Temperature**



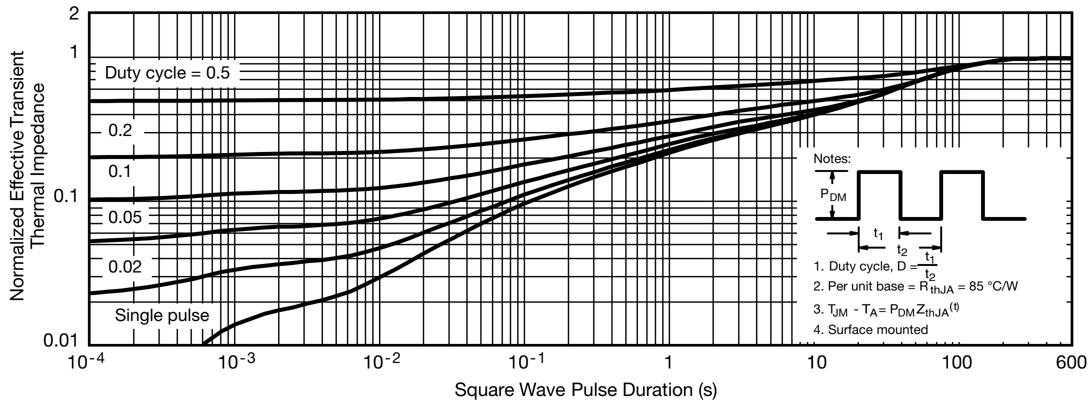

**Drain Source Breakdown vs. Junction Temperature**



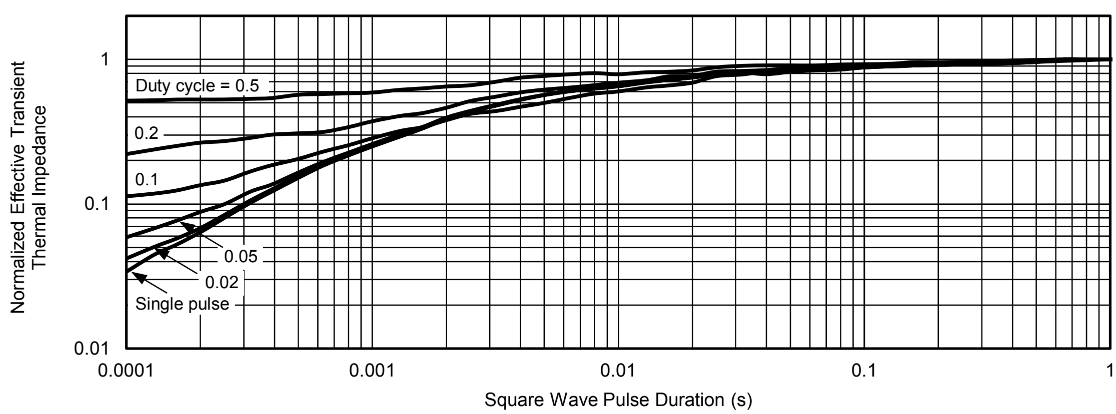

(1) $V_{GS}$ > minimum $V_{GS}$ at which $R_{DS(on)}$ is specified

**Safe Operating Area**

**N-CHANNEL 1 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)




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

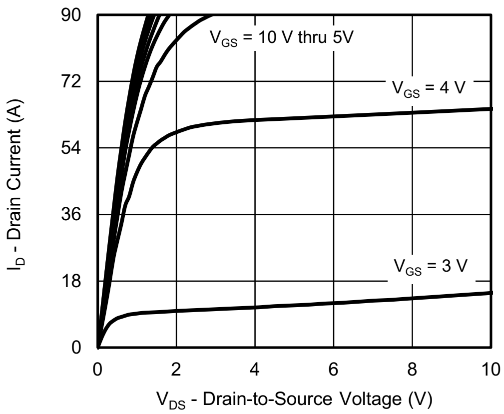



**Normalized Thermal Transient Impedance, Junction-to-Case**

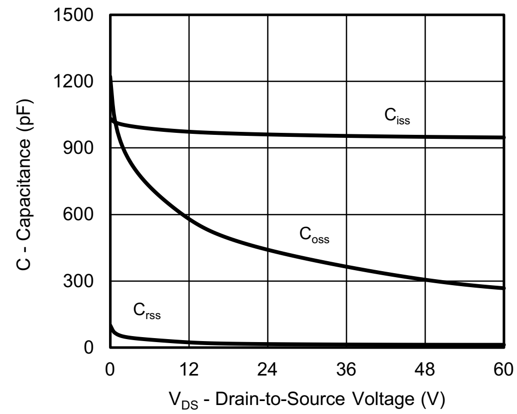
**Note**

- The characteristics shown in the graph:
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  is 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

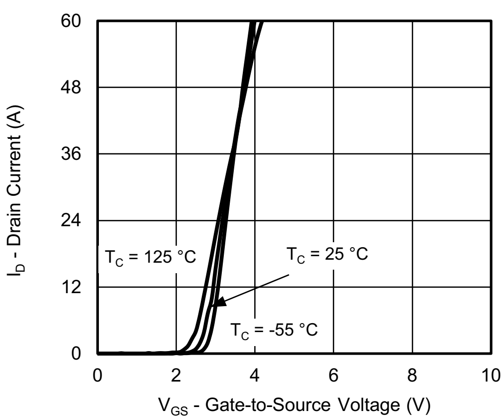
**N-CHANNEL 2 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)



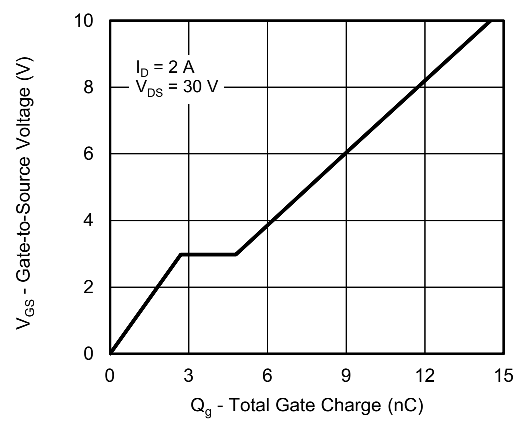

**Output Characteristics**



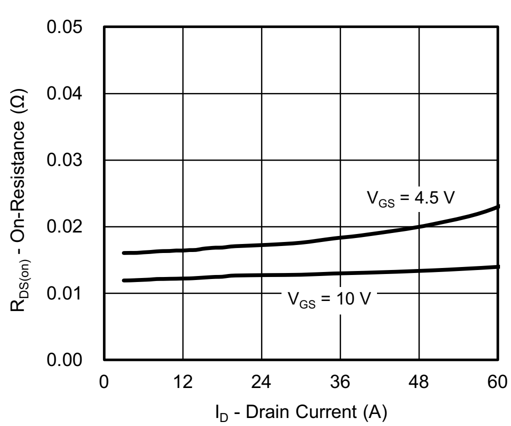

**Capacitance**



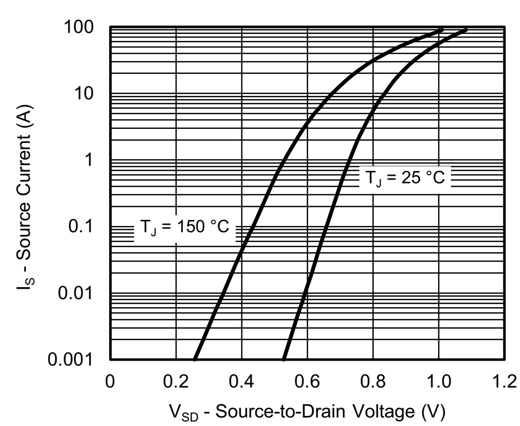

**Transfer Characteristics**




**Gate Charge**

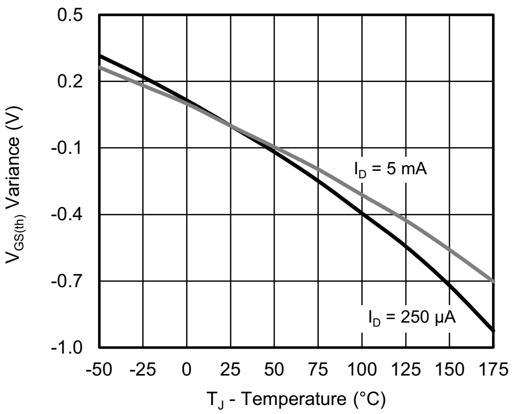



**On-Resistance vs. Drain Current**

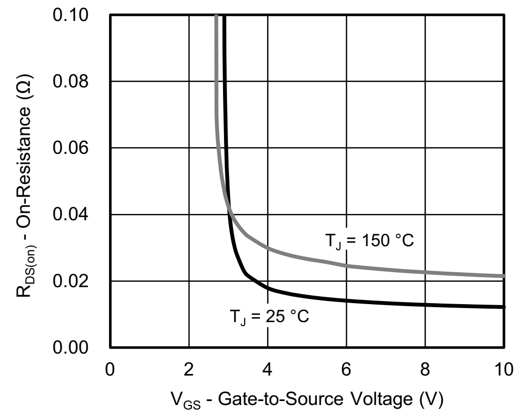



**Source Drain Diode Forward Voltage**

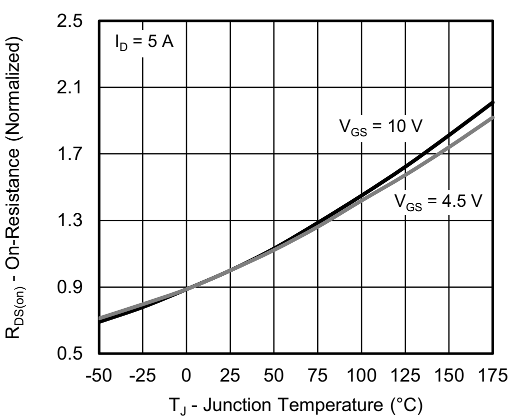
**N-CHANNEL 2 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)



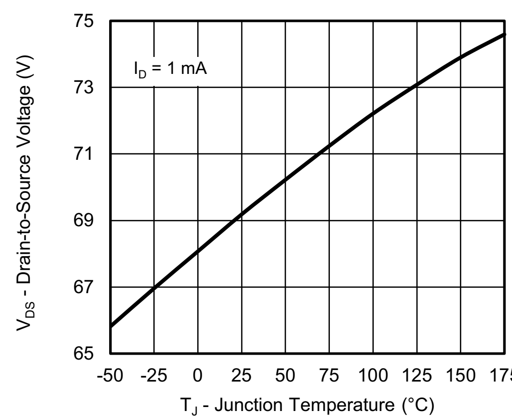

**Threshold Voltage**



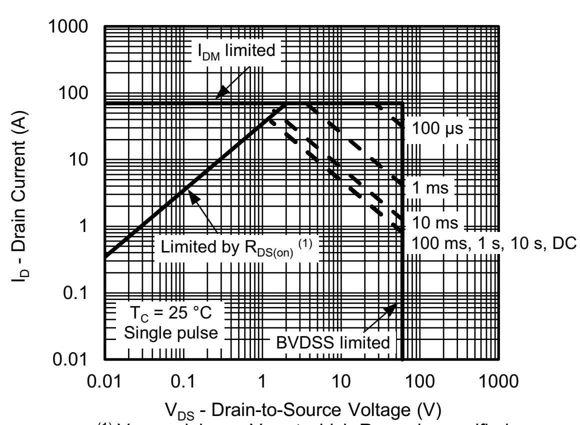

**On-Resistance vs. Gate-to-Source Voltage**




**On-Resistance vs. Junction Temperature**



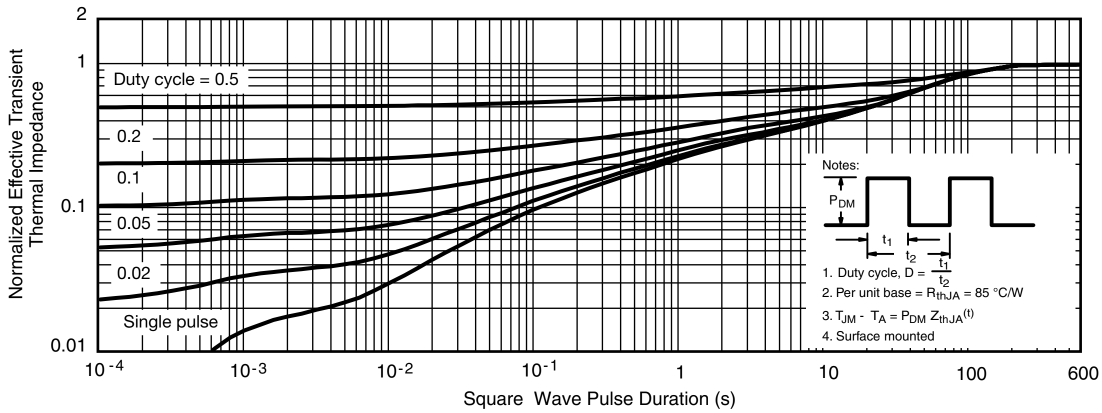

**Drain Source Breakdown vs. Junction Temperature**



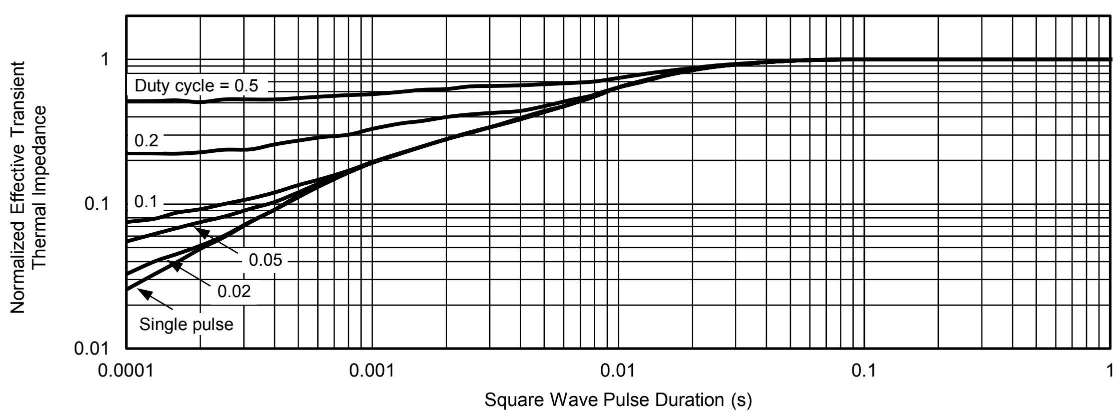

(1) $V_{GS}$ > minimum $V_{GS}$ at which $R_{DS(on)}$ is specified

**Safe Operating Area**

**N-CHANNEL 2 TYPICAL CHARACTERISTICS** ($T_A$ = 25 °C, unless otherwise noted)




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




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

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*Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package / tape drawings, part marking, and reliability data, see www.vishay.com/ppg?75504.*

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