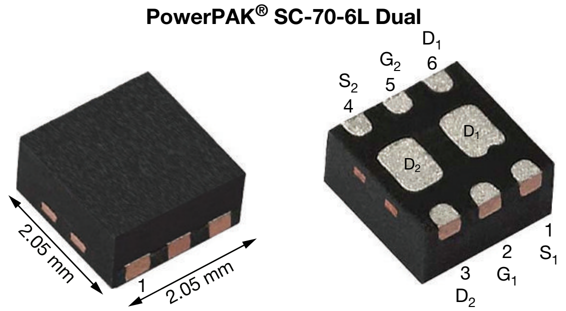
# N- and P-Channel 12 V (D-S) MOSFET

**PowerPAK® SC-70-6L Dual**




**Marking code:** EH

## FEATURES

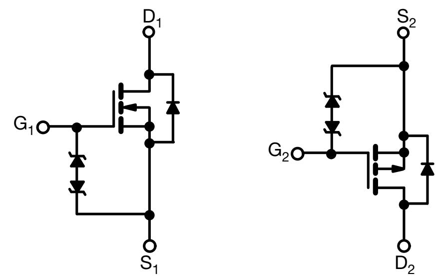
- TrenchFET® power MOSFETs
- Typical ESD protection: n-channel 1500 V, p-channel 1000 V
- 100 % $R_g$ tested
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT
HALOGEN FREE

## APPLICATIONS

- Load switch for portable devices
- DC/DC converters

| PRODUCT SUMMARY | | |
|---|---|---|
| | N-CHANNEL | P-CHANNEL |
| $V_{DS}$ (V) | 12 | -12 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = ± 4.5 V | 0.034 | 0.059 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = ± 2.5 V | 0.040 | 0.081 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = ± 1.8 V | 0.050 | 0.115 |
| $R_{DS(on)}$ (Ω) at $V_{GS}$ = ± 1.5 V | 0.070 | 0.215 |
| $Q_g$ typ. (nC) | 5.6 | 7.8 |
| $I_D$ (A) [a] | 4.5 | -4.5 |
| Configuration | N- and p-pair | |




N-Channel MOSFET    P-Channel MOSFET

| ORDERING INFORMATION | |
|---|---|
| Package | PowerPAK SC-70 |
| Lead (Pb)-free and halogen-free | SiA533EDJ-T1-GE3 |

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

| PARAMETER | | SYMBOL | N-CHANNEL | P-CHANNEL | UNIT |
|---|---|---|---|---|---|
| Drain-source voltage | | $V_{DS}$ | 12 | -12 | V |
| Gate-source voltage | | $V_{GS}$ | ± 8 | ± 8 | |
| Continuous drain current ($T_J$ = 150 °C) | $T_C$ = 25 °C | $I_D$ | 4.5 [a] | -4.5 [a] | A |
| | $T_C$ = 70 °C | | 4.5 [a] | -4.5 [a] | |
| | $T_A$ = 25 °C | | 4.5 [a, b, c] | -4.5 [a, b, c] | |
| | $T_A$ = 70 °C | | 4.5 [a, b, c] | -3.7 [b, c] | |
| Pulsed drain current | | $I_{DM}$ | 20 | -15 | |
| Source-drain current diode current | $T_C$ = 25 °C | $I_S$ | 4.5 [a] | -4.5 [a] | |
| | $T_A$ = 25 °C | | 1.6 [b, c] | -1.6 [b, c] | |
| Maximum power dissipation | $T_C$ = 25 °C | $P_D$ | 7.8 | 7.8 | W |
| | $T_C$ = 70 °C | | 5 | 5 | |
| | $T_A$ = 25 °C | | 1.9 [b, c] | 1.9 [b, c] | |
| | $T_A$ = 70 °C | | 1.2 [b, c] | 1.2 [b, c] | |
| Operating junction and storage temperature range | | $T_J$, $T_{stg}$ | -55 to +150 | | °C |
| Soldering recommendations (peak temperature) [d, e] | | | 260 | | |

| THERMAL RESISTANCE RATINGS | | | | | | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | | SYMBOL | N-CHANNEL | | P-CHANNEL | | UNIT |
| | | | TYP. | MAX. | TYP. | MAX. | |
| Maximum junction-to-ambient [b, f] | $t \leq 5$ s | $R_{thJA}$ | 52 | 65 | 52 | 65 | °C/W |
| Maximum junction-to-case (drain) | Steady state | $R_{thJC}$ | 12.5 | 16 | 12.5 | 16 | |

**Notes**

a. Package limited
b. Surface mounted on 1" x 1" FR4 board
c. t = 5 s
d. See solder profile (www.vishay.com/doc?73257). The PowerPAK SC-70 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
f. Maximum under steady state conditions is 110 °C/W

| **SPECIFICATIONS** ($T_J$ = 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 | 12 | - | - | V |
| | | $V_{GS}$ = 0 V, $I_D$ = -250 µA | P-Ch | -12 | - | - | |
| $V_{DS}$ temperature coefficient | $\Delta V_{DS}/T_J$ | $I_D$ = 250 µA | N-Ch | - | 19 | - | mV/°C |
| | | $I_D$ = -250 µA | P-Ch | - | -5.7 | - | |
| $V_{GS(th)}$ temperature coefficient | $\Delta V_{GS(th)}/T_J$ | $I_D$ = 250 µA | N-Ch | - | -2.7 | - | |
| | | $I_D$ = -250 µA | P-Ch | - | 1.7 | - | |
| Gate threshold voltage | $V_{GS(th)}$ | $V_{DS} = V_{GS}$, $I_D$ = 250 µA | N-Ch | 0.4 | - | 1 | V |
| | | $V_{DS} = V_{GS}$, $I_D$ = -250 µA | P-Ch | -0.4 | - | -1 | |
| Gate-body leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ± 4.5 V | N-Ch | - | - | ± 0.5 | µA |
| | | | P-Ch | - | - | ± 0.5 | |
| | | $V_{DS}$ = 0 V, $V_{GS}$ = ± 8 V | N-Ch | - | - | ± 5 | |
| | | | P-Ch | - | - | ± 5 | |
| Zero gate voltage drain current | $I_{DSS}$ | $V_{DS}$ = 12 V, $V_{GS}$ = 0 V | N-Ch | - | - | 1 | |
| | | $V_{DS}$ = -12 V, $V_{GS}$ = 0 V | P-Ch | - | - | -1 | |
| | | $V_{DS}$ = 12 V, $V_{GS}$ = 0 V, $T_J$ = 55 °C | N-Ch | - | - | 10 | |
| | | $V_{DS}$ = -12 V, $V_{GS}$ = 0 V, $T_J$ = 55 °C | P-Ch | - | - | -10 | |
| On-state drain current [b] | $I_{D(on)}$ | $V_{DS} \geq 5$ V, $V_{GS}$ = 4.5 V | N-Ch | 10 | - | - | A |
| | | $V_{DS} \leq -5$ V, $V_{GS}$ = -4.5 V | P-Ch | -10 | - | - | |
| Drain-source on-state resistance [b] | $R_{DS(on)}$ | $V_{GS}$ = 4.5 V, $I_D$ = 4.6 A | N-Ch | - | 0.028 | 0.034 | Ω |
| | | $V_{GS}$ = -4.5 V, $I_D$ = -3.6 A | P-Ch | - | 0.048 | 0.059 | |
| | | $V_{GS}$ = 2.5 V, $I_D$ = 4.2 A | N-Ch | - | 0.032 | 0.040 | |
| | | $V_{GS}$ = -2.5 V, $I_D$ = -3.1 A | P-Ch | - | 0.066 | 0.081 | |
| | | $V_{GS}$ = 1.8 V, $I_D$ = 3.8 A | N-Ch | - | 0.038 | 0.050 | |
| | | $V_{GS}$ = -1.8 V, $I_D$ = -2.6 A | P-Ch | - | 0.093 | 0.115 | |
| | | $V_{GS}$ = 1.5 V, $I_D$ = 1.5 A | N-Ch | - | 0.045 | 0.070 | |
| | | $V_{GS}$ = -1.5 V, $I_D$ = -0.5 A | P-Ch | - | 0.120 | 0.215 | |
| Forward transconductance [b] | $g_{fs}$ | $V_{DS}$ = 6 V, $I_D$ = 4.6 A | N-Ch | - | 21 | - | S |
| | | $V_{DS}$ = -6 V, $I_D$ = -3.6 A | P-Ch | - | 11 | - | |

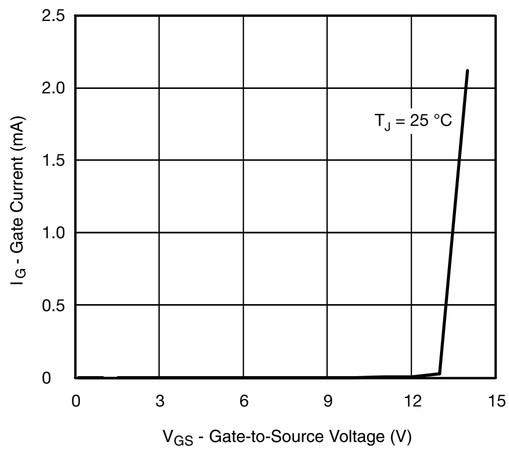
| SPECIFICATIONS ($T_J$ = 25 °C, unless otherwise noted) | | | | | | | |
|---|---|---|---|---|---|---|---|
| **PARAMETER** | **SYMBOL** | **TEST CONDITIONS** | | **MIN.** | **TYP.** | **MAX.** | **UNIT** |
| **Dynamic** [a] | | | | | | | |
| Input capacitance | $C_{iss}$ | N-channel $V_{DS}$ = 6 V, $V_{GS}$ = 0 V, f = 1 MHz<br>P-channel $V_{DS}$ = -6 V, $V_{GS}$ = 0 V, f = 1 MHz | N-Ch | - | 420 | - | pF |
| | | | P-Ch | - | 545 | - | |
| Output capacitance | $C_{oss}$ | | N-Ch | - | 100 | - | |
| | | | P-Ch | - | 192 | - | |
| Reverse transfer capacitance | $C_{rss}$ | | N-Ch | - | 62 | - | |
| | | | P-Ch | - | 175 | - | |
| Total gate charge | $Q_g$ | $V_{DS}$ = 10 V, $V_{GS}$ = 10 V, $I_D$ = 5.9 A | N-Ch | - | 10 | 15 | nC |
| | | $V_{DS}$ = -10 V, $V_{GS}$ = -10 V, $I_D$ = -4.7 A | P-Ch | - | 13 | 20 | |
| | | $V_{DS}$ = 10 V, $V_{GS}$ = 4.5 V, $I_D$ = 5.9 A | N-Ch | - | 5.6 | 8.5 | |
| | | $V_{DS}$ = -10 V, $V_{GS}$ = -4.5 V, $I_D$ = -4.7 A | P-Ch | - | 7.8 | 12 | |
| Gate-source charge | $Q_{gs}$ | N-channel $V_{DS}$ = 10 V, $V_{GS}$ = 4.5 V, $I_D$ = 5.9 A<br>P-channel $V_{DS}$ = -10 V, $V_{GS}$ = -4.5 V, $I_D$ = -4.7 A | N-Ch | - | 0.7 | - | |
| | | | P-Ch | - | 1.3 | - | |
| Gate-drain charge | $Q_{gd}$ | | N-Ch | - | 0.85 | - | |
| | | | P-Ch | - | 2.3 | - | |
| Gate resistance | $R_g$ | f = 1 MHz | N-Ch | 0.7 | 3.5 | 7 | Ω |
| | | | P-Ch | 1.4 | 7 | 14 | |
| Turn-on delay time | $t_{d(on)}$ | N-channel $V_{DD}$ = 6 V, $R_L$ = 1.3 Ω, $I_D \cong$ 4.8 A, $V_{GEN}$ = 4.5 V, $R_g$ = 1 Ω<br>P-channel $V_{DD}$ = -6 V, $R_L$ = 1.6 Ω, $I_D \cong$ -3.7 A, $V_{GEN}$ = -4.5 V, $R_g$ = 1 Ω | N-Ch | - | 10 | 15 | ns |
| | | | P-Ch | - | 15 | 25 | |
| Rise time | $t_r$ | | N-Ch | - | 10 | 15 | |
| | | | P-Ch | - | 15 | 25 | |
| Turn-off delay time | $t_{d(off)}$ | | N-Ch | - | 20 | 30 | |
| | | | P-Ch | - | 25 | 40 | |
| Fall time | $t_f$ | | N-Ch | - | 10 | 15 | |
| | | | P-Ch | - | 10 | 15 | |
| Turn-on delay time | $t_{d(on)}$ | N-channel $V_{DD}$ = 6 V, $R_L$ = 1.3 Ω, $I_D \cong$ 4.8 A, $V_{GEN}$ = 8 V, $R_g$ = 1 Ω<br>P-channel $V_{DD}$ = -6 V, $R_L$ = 1.6 Ω, $I_D \cong$ -3.7 A, $V_{GEN}$ = -8 V, $R_g$ = 1 Ω | N-Ch | - | 5 | 10 | |
| | | | P-Ch | - | 5 | 10 | |
| Rise time | $t_r$ | | N-Ch | - | 10 | 15 | |
| | | | P-Ch | - | 10 | 15 | |
| Turn-off delay time | $t_{d(off)}$ | | N-Ch | - | 20 | 30 | |
| | | | P-Ch | - | 25 | 40 | |
| Fall Time | $t_f$ | | N-Ch | - | 10 | 15 | |
| | | | P-Ch | - | 10 | 15 | |
| **Drain-Source Body Diode Characteristics** | | | | | | | |
| Continuous source-drain diode current | $I_S$ | $T_C$ = 25 °C | N-Ch | - | - | 4.5 | A |
| | | | P-Ch | - | - | -4.5 | |
| Pulse diode forward current [a] | $I_{SM}$ | | N-Ch | - | - | 20 | |
| | | | P-Ch | - | - | -15 | |
| Body diode voltage | $V_{SD}$ | $I_S$ = 4.8 A, $V_{GS}$ = 0 V | N-Ch | - | 0.85 | 1.2 | V |
| | | $I_S$ = -3.7 A, $V_{GS}$ = 0 V | P-Ch | - | -0.87 | -1.2 | |
| Body diode reverse recovery time | $t_{rr}$ | N-channel $I_F$ = 4.4 A, di/dt = 100 A/µs, $T_J$ = 25 °C<br>P-channel $I_F$ = -3.7 A, di/dt = -100 A/µs, $T_J$ = 25 °C | N-Ch | - | 10 | 20 | ns |
| | | | P-Ch | - | 25 | 50 | |
| Body diode reverse recovery charge | $Q_{rr}$ | | N-Ch | - | 5 | 10 | nC |
| | | | P-Ch | - | 10 | 20 | |
| Reverse recovery fall time | $t_a$ | | N-Ch | - | 5.5 | - | ns |
| | | | P-Ch | - | 17 | - | |
| Reverse recovery rise time | $t_b$ | | N-Ch | - | 4.5 | - | |
| | | | P-Ch | - | 8 | - | |

**Notes**

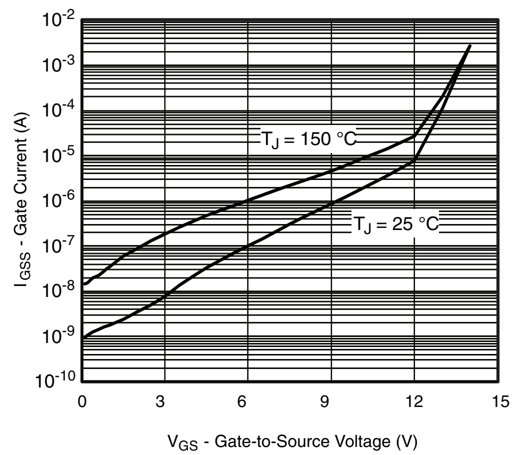
a. Guaranteed by design, not subject to production testing
b. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %

*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 TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)




**Gate Current vs. Gate-Source Voltage**

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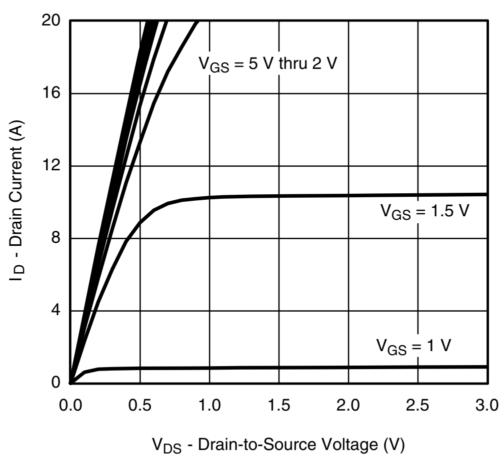
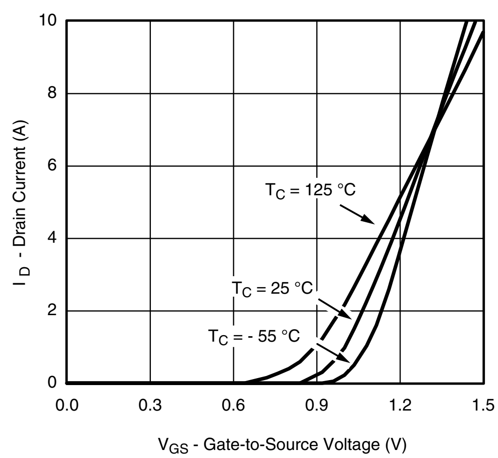
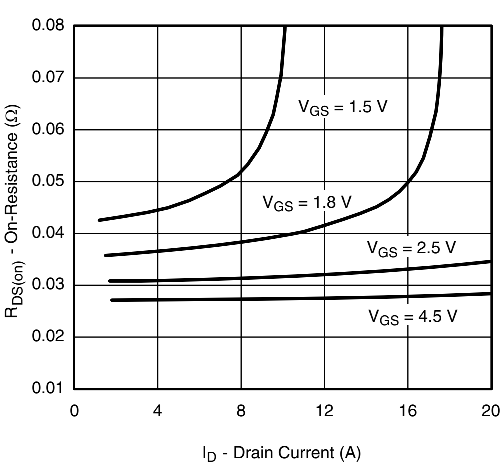


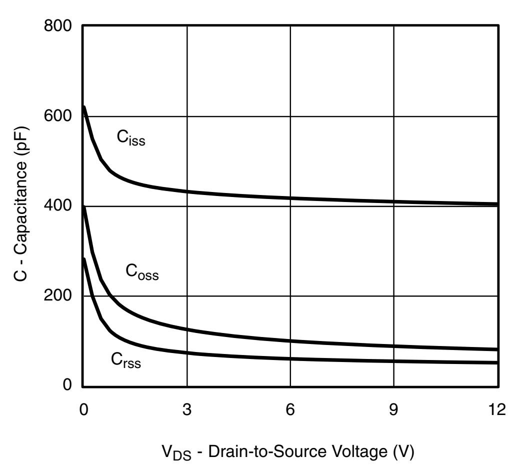

**Output Characteristics**




**Transfer Characteristics**

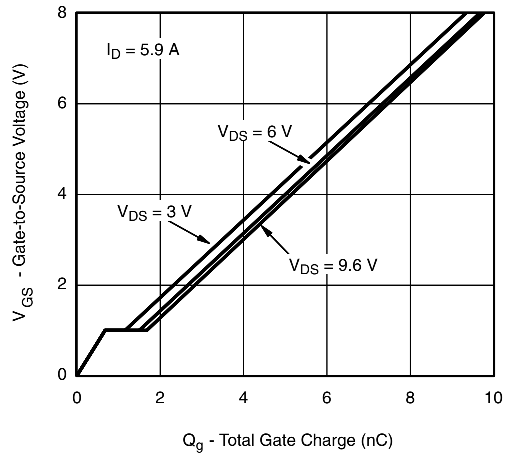



**On-Resistance vs. Drain Current and Gate Voltage**

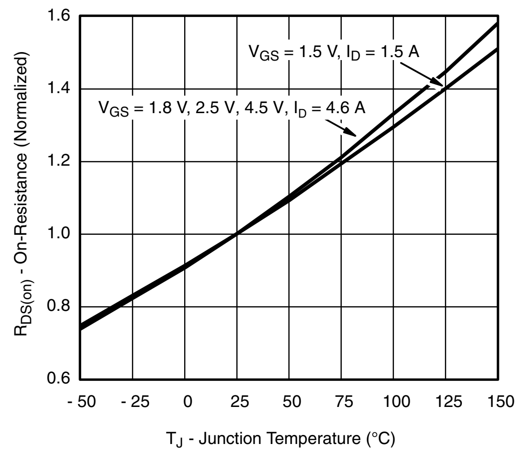



**Capacitance**

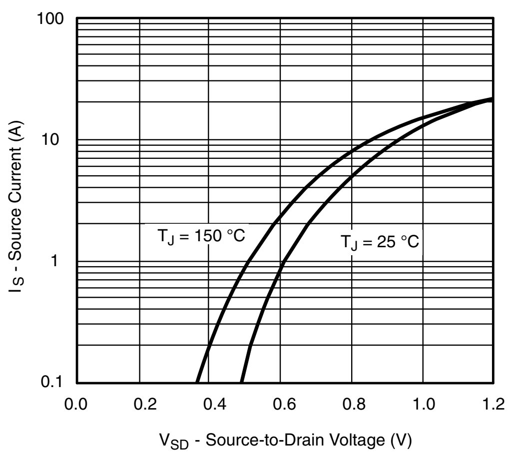
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



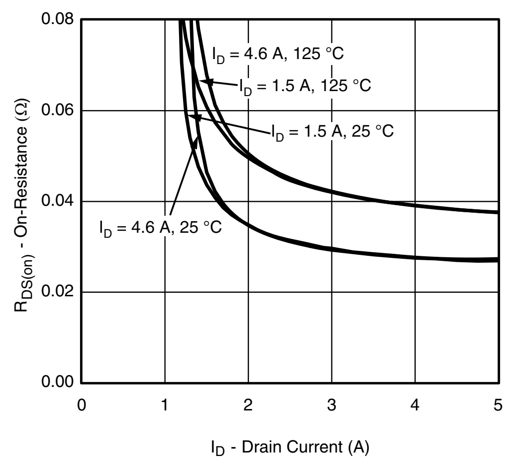

**Gate Charge**



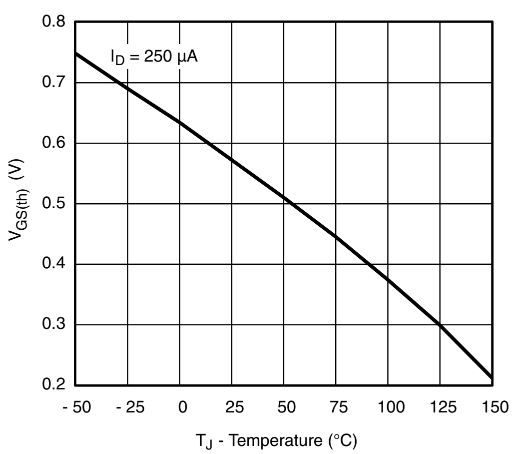

**On-Resistance vs. Junction Temperature**



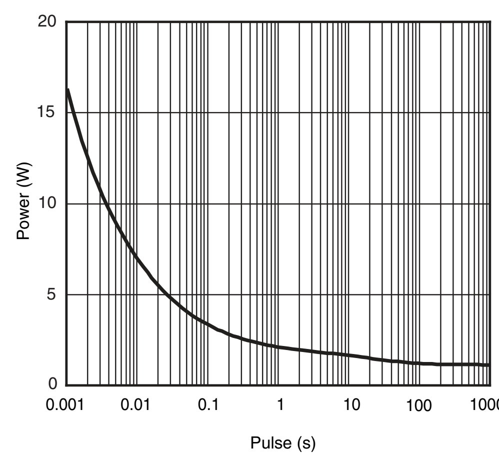

**Source-Drain Diode Forward Voltage**




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

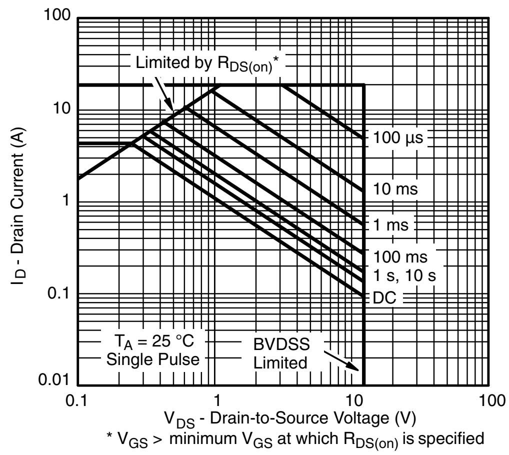



**Threshold Voltage**

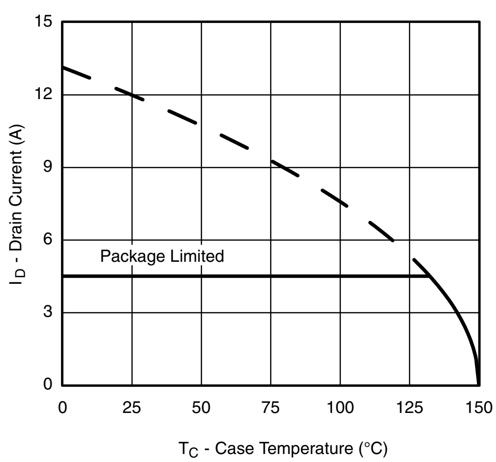



**Single Pulse Power (Junction-to-Ambient)**

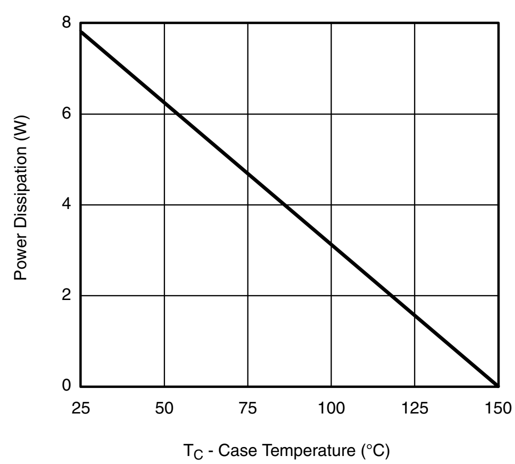
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)




**Safe Operating Area, Junction-to-Ambient**




**Current Derating** [a]

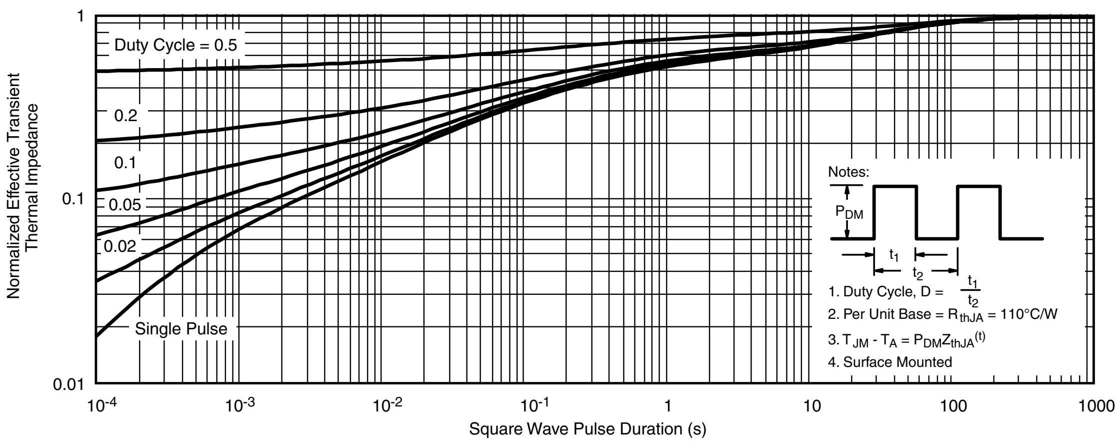



**Power Derating**

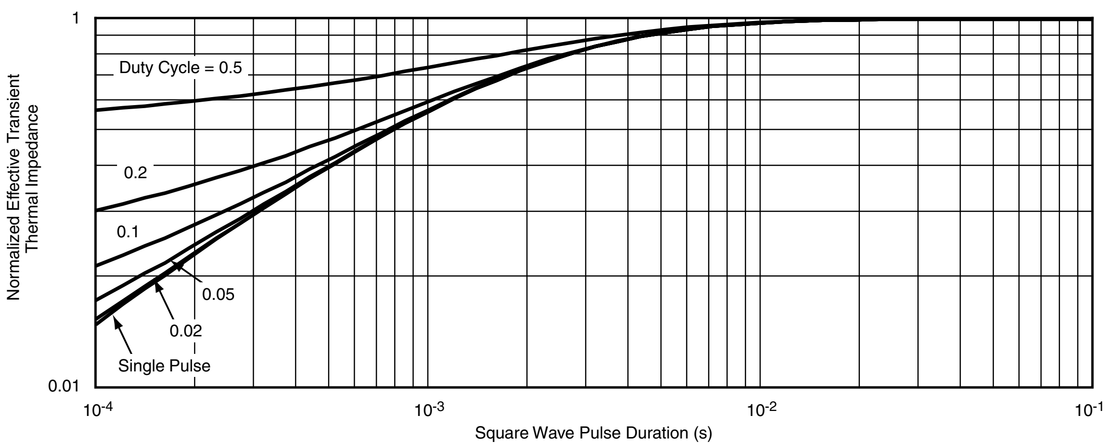
**Note**

a. The power dissipation $P_D$ is based on $T_J$ max. = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit

**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

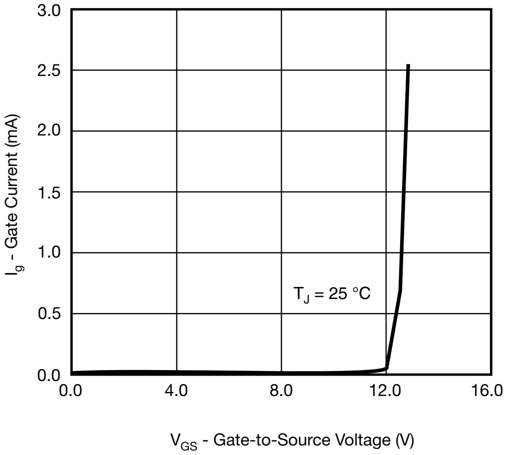



**Normalized Thermal Transient Impedance, Junction-to-Ambient**

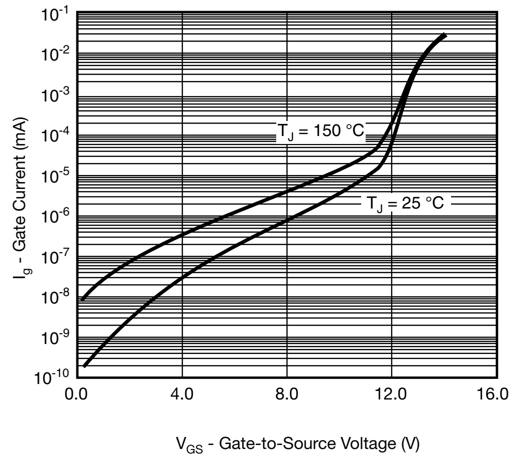



**Normalized Thermal Transient Impedance, Junction-to-Case**

## P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)




**Gate Current vs. Gate-Source Voltage**

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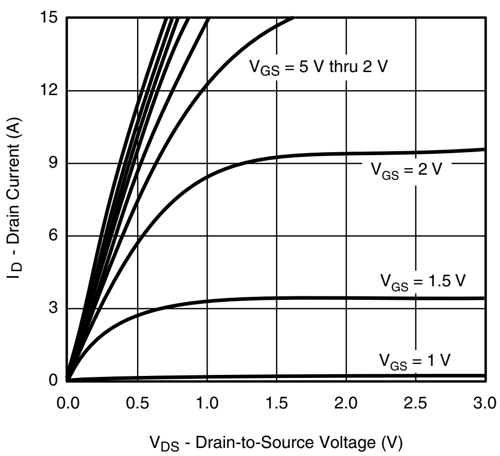
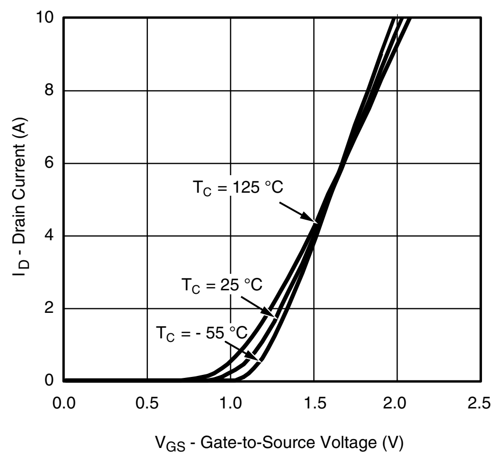
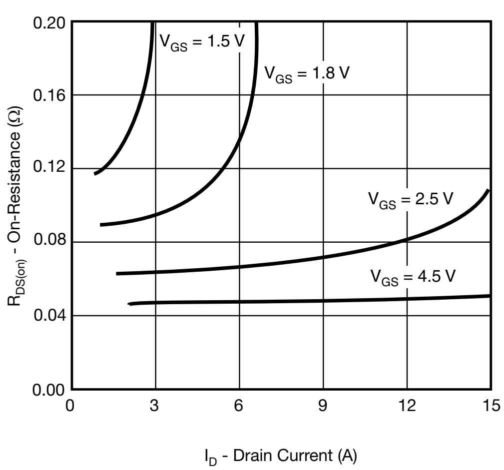


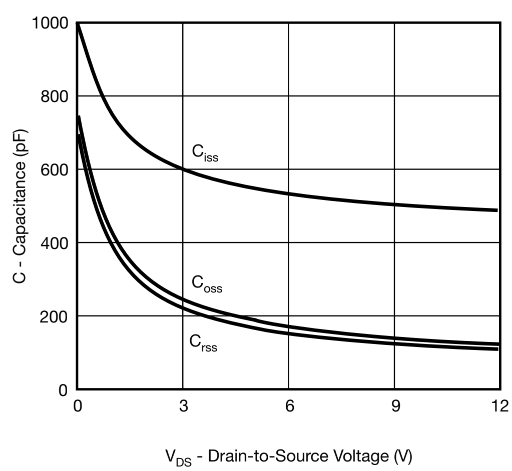

**Output Characteristics**




**Transfer Characteristics**

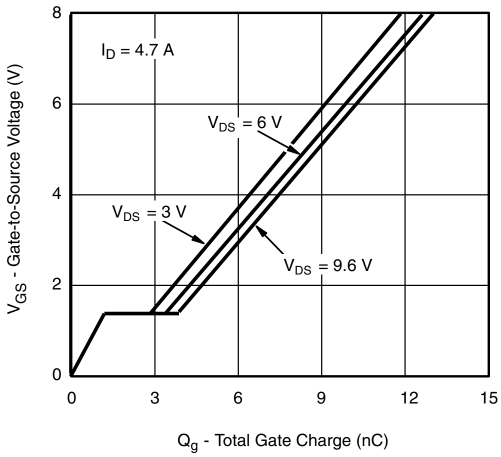



**On-Resistance vs. Drain Current and Gate Voltage**

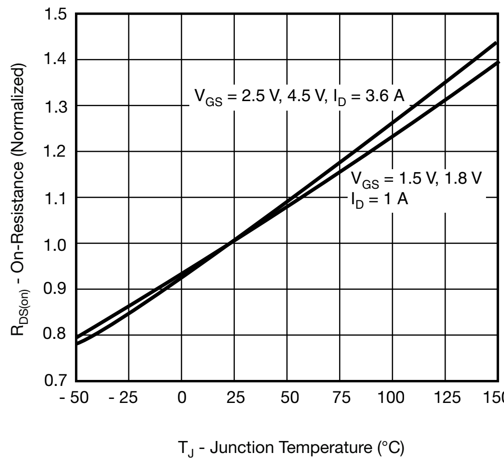



**Capacitance**

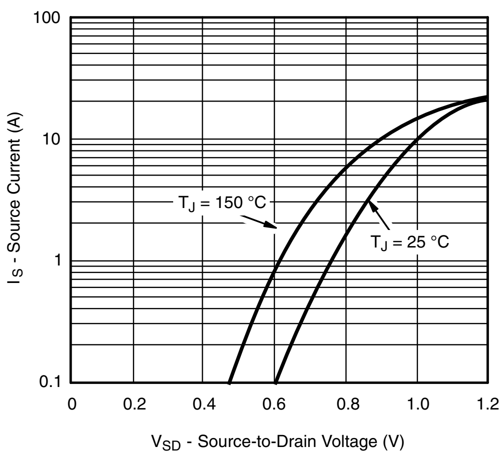
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



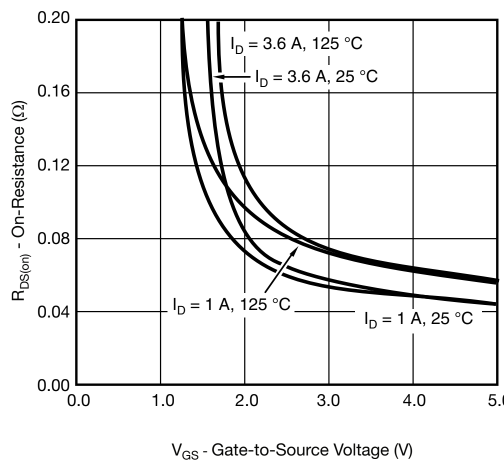

**Gate Charge**



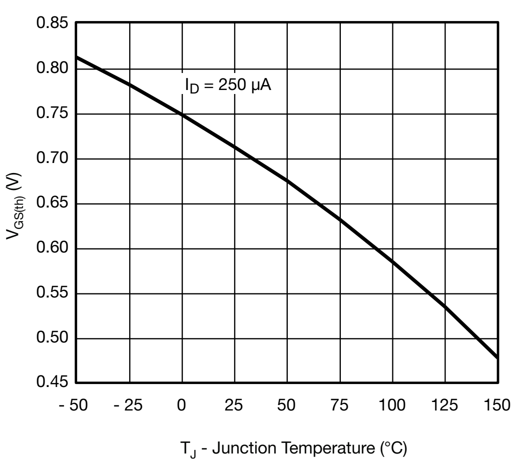

**On-Resistance vs. Junction Temperature**



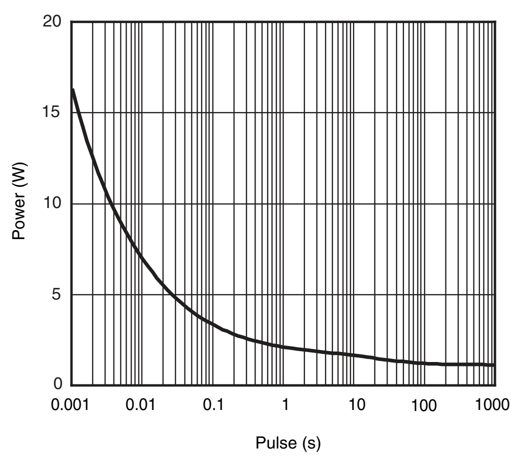

**Source-Drain Diode Forward Voltage**




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

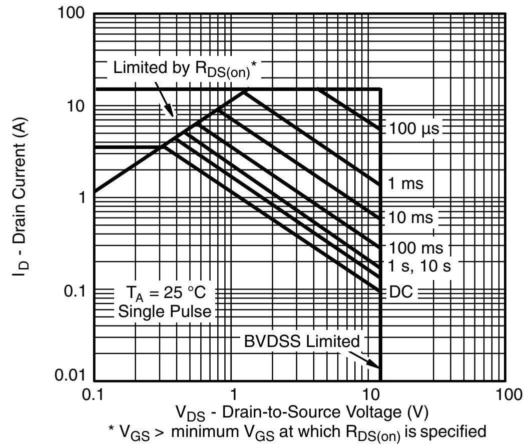



**Threshold Voltage**

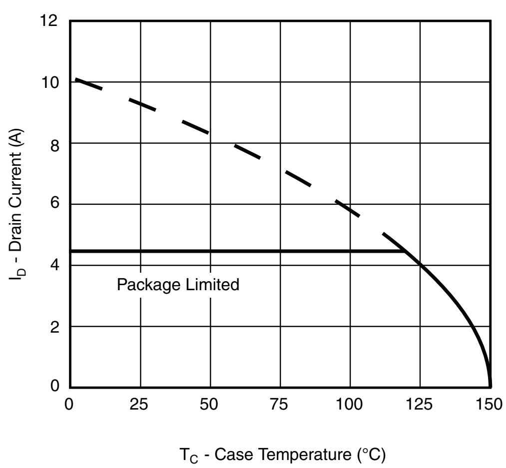



**Single Pulse Power (Junction-to-Ambient)**

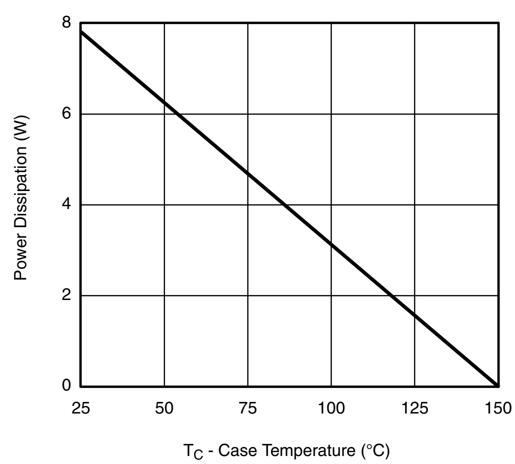
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)




**Safe Operating Area, Junction-to-Ambient**




**Current Derating** [a]

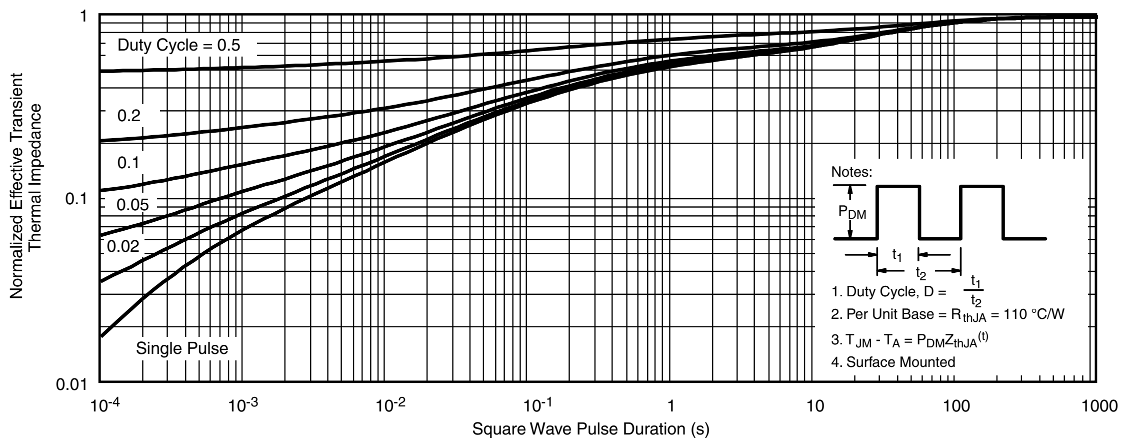



**Power Derating**

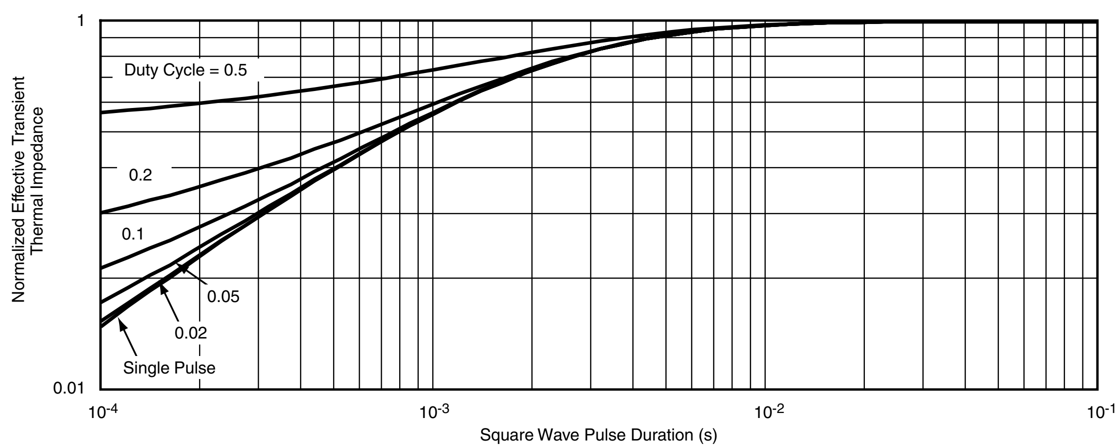
**Note**

a. The power dissipation $P_D$ is based on $T_J$ max. = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit

**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



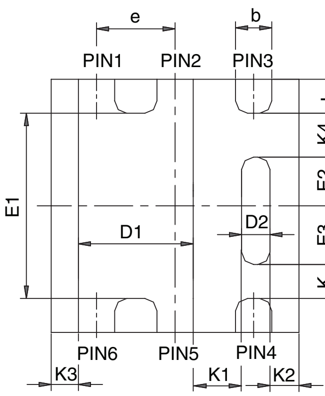

**Normalized Thermal Transient Impedance, Junction-to-Ambient**



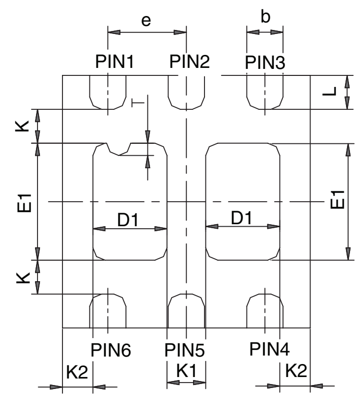

**Normalized Thermal Transient Impedance, Junction-to-Case**

*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?65706.*

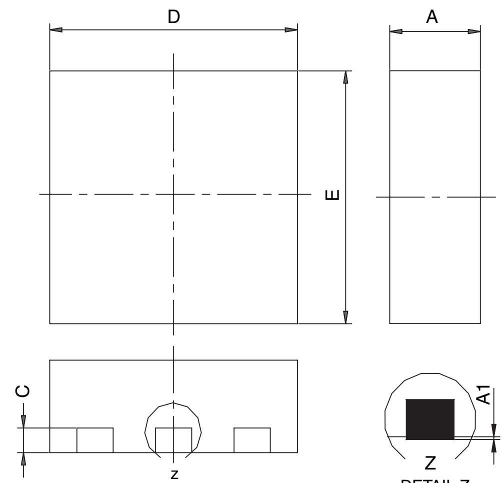
## PowerPAK® SC70-6L




BACKSIDE VIEW OF SINGLE




BACKSIDE VIEW OF DUAL



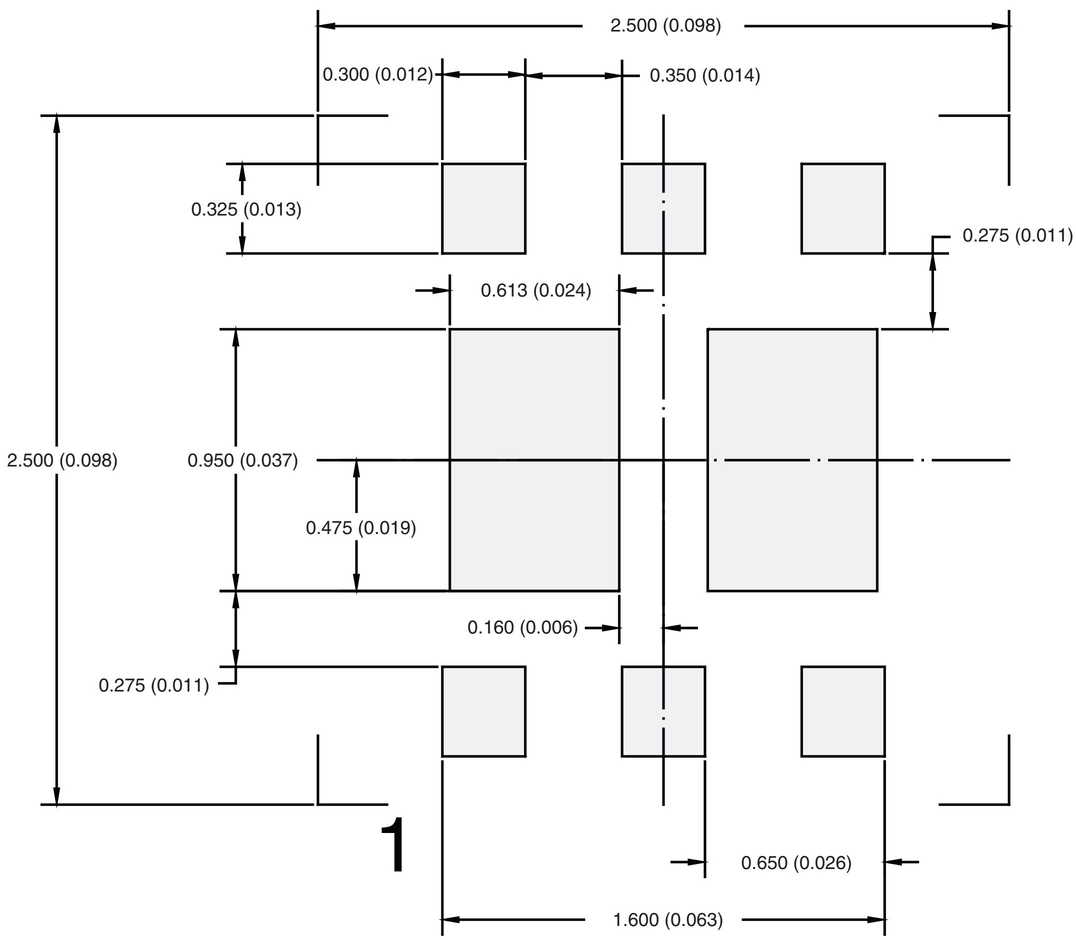

DETAIL Z

Notes:
1. All dimensions are in millimeters
2. Package outline exclusive of mold flash and metal burr
3. Package outline inclusive of plating

| DIM | SINGLE PAD | | | | | | DUAL PAD | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MILLIMETERS | | | INCHES | | | MILLIMETERS | | | INCHES | | |
| | Min | Nom | Max | Min | Nom | Max | Min | Nom | Max | Min | Nom | Max |
| A | 0.675 | 0.75 | 0.80 | 0.027 | 0.030 | 0.032 | 0.675 | 0.75 | 0.80 | 0.027 | 0.030 | 0.032 |
| A1 | 0 | - | 0.05 | 0 | - | 0.002 | 0 | - | 0.05 | 0 | - | 0.002 |
| b | 0.23 | 0.30 | 0.38 | 0.009 | 0.012 | 0.015 | 0.23 | 0.30 | 0.38 | 0.009 | 0.012 | 0.015 |
| C | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 | 0.15 | 0.20 | 0.25 | 0.006 | 0.008 | 0.010 |
| D | 1.98 | 2.05 | 2.15 | 0.078 | 0.081 | 0.085 | 1.98 | 2.05 | 2.15 | 0.078 | 0.081 | 0.085 |
| D1 | 0.85 | 0.95 | 1.05 | 0.033 | 0.037 | 0.041 | 0.513 | 0.613 | 0.713 | 0.020 | 0.024 | 0.028 |
| D2 | 0.135 | 0.235 | 0.335 | 0.005 | 0.009 | 0.013 | | | | | | |
| E | 1.98 | 2.05 | 2.15 | 0.078 | 0.081 | 0.085 | 1.98 | 2.05 | 2.15 | 0.078 | 0.081 | 0.085 |
| E1 | 1.40 | 1.50 | 1.60 | 0.055 | 0.059 | 0.063 | 0.85 | 0.95 | 1.05 | 0.033 | 0.037 | 0.041 |
| E2 | 0.345 | 0.395 | 0.445 | 0.014 | 0.016 | 0.018 | | | | | | |
| E3 | 0.425 | 0.475 | 0.525 | 0.017 | 0.019 | 0.021 | | | | | | |
| e | 0.65 BSC | | | 0.026 BSC | | | 0.65 BSC | | | 0.026 BSC | | |
| K | 0.275 TYP | | | 0.011 TYP | | | 0.275 TYP | | | 0.011 TYP | | |
| K1 | 0.400 TYP | | | 0.016 TYP | | | 0.320 TYP | | | 0.013 TYP | | |
| K2 | 0.240 TYP | | | 0.009 TYP | | | 0.252 TYP | | | 0.010 TYP | | |
| K3 | 0.225 TYP | | | 0.009 TYP | | | | | | | | |
| K4 | 0.355 TYP | | | 0.014 TYP | | | | | | | | |
| L | 0.175 | 0.275 | 0.375 | 0.007 | 0.011 | 0.015 | 0.175 | 0.275 | 0.375 | 0.007 | 0.011 | 0.015 |
| T | | | | | | | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |

ECN: C-07431 − Rev. C, 06-Aug-07
DWG: 5934

**RECOMMENDED PAD LAYOUT FOR PowerPAK® SC70-6L Dual**




Dimensions in mm (inches)

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