



## N-Channel 12 V and 20 V (D-S) MOSFETs

| PRODUCT SUMMARY |                     |                                    |                    |                       |
|-----------------|---------------------|------------------------------------|--------------------|-----------------------|
|                 | V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)            | I <sub>D</sub> (A) | Q <sub>g</sub> (Typ.) |
| Channel 1       | 12                  | 0.029 at V <sub>GS</sub> = 4.5 V   | 4.5 <sup>a</sup>   | 5.6 nC                |
|                 |                     | 0.034 at V <sub>GS</sub> = 2.5 V   | 4.5 <sup>a</sup>   |                       |
|                 |                     | 0.044 at V <sub>GS</sub> = 1.8 V   | 4.5 <sup>a</sup>   |                       |
|                 |                     | 0.065 at V <sub>GS</sub> = 1.5 V   | 4.5 <sup>a</sup>   |                       |
| Channel 2       | 20                  | 0.225 at V <sub>GS</sub> = - 4.5 V | 1.5 <sup>a</sup>   | 1.1 nC                |
|                 |                     | 0.270 at V <sub>GS</sub> = - 2.5 V | 1.5 <sup>a</sup>   |                       |
|                 |                     | 0.345 at V <sub>GS</sub> = - 1.8 V | 1.5 <sup>a</sup>   |                       |
|                 |                     | 0.960 at V <sub>GS</sub> = - 1.5 V | 0.5 <sup>a</sup>   |                       |

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFETs
- New Thermally Enhanced PowerPAK® SC-70 Package
  - Small Footprint Area
  - Low On-Resistance
- Typical ESD Performance for Channel 2: 2800 V
- Compliant to RoHS Directive 2002/95/EC

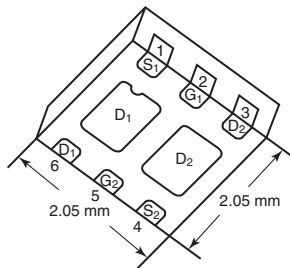


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

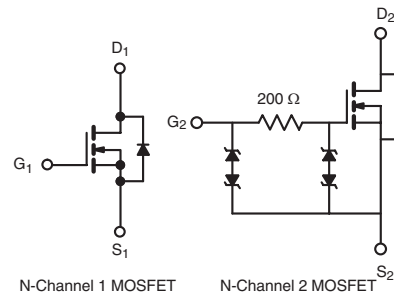
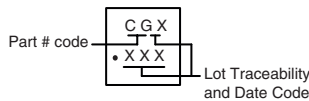
### APPLICATIONS

- N-Channel Level Shift Load Switch for Portable Devices
  - for 0 V to 8 V Power Lines

PowerPAK SC-70-6 Dual



Marking Code



Ordering Information: SiA778DJ-T1-GE3 (Lead (Pb)-free and Halogen-free)

N-Channel 1 MOSFET

N-Channel 2 MOSFET

| ABSOLUTE MAXIMUM RATINGS T <sub>A</sub> = 25 °C, unless otherwise noted |                                   |                        |                        |                     |   |
|---|-----------------------------------|------------------------|------------------------|---------------------|---|
| Parameter   | Symbol                            | Channel 1              | Channel 2              | Unit                |   |
| Drain-Source Voltage  | V <sub>DS</sub>                   | 12                     | 20                     | V                   |   |
| Gate-Source Voltage   | V <sub>GS</sub>                   | ± 8                    | ± 6                    |                     |   |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)                      | I <sub>D</sub>                    | T <sub>C</sub> = 25 °C | 4.5 <sup>a</sup>       | 1.5 <sup>a</sup>    | A |
|   |                                   | T <sub>C</sub> = 70 °C | 4.5 <sup>a</sup>       | 1.5 <sup>a</sup>    |   |
|   |                                   | T <sub>A</sub> = 25 °C | 4.5 <sup>a, b, c</sup> | 1.5 <sup>b, c</sup> |   |
|   |                                   | T <sub>A</sub> = 70 °C | 4.5 <sup>a, b, c</sup> | 1.5 <sup>b, c</sup> |   |
| Pulsed Drain Current  | I <sub>DM</sub>                   | 20                     | 4                      |                     |   |
| Source Drain Current Diode Current                                      | I <sub>S</sub>                    | T <sub>C</sub> = 25 °C | 4.5 <sup>a</sup>       | 1.5 <sup>a</sup>    |   |
|   |                                   | T <sub>A</sub> = 25 °C | 1.6 <sup>b, c</sup>    | 1.5 <sup>b, c</sup> |   |
| Maximum Power Dissipation   | P <sub>D</sub>                    | T <sub>C</sub> = 25 °C | 6.5                    | 5                   | W |
|   |                                   | T <sub>C</sub> = 70 °C | 5                      | 3.2                 |   |
|   |                                   | T <sub>A</sub> = 25 °C | 1.9 <sup>b, c</sup>    | 1.9 <sup>b, c</sup> |   |
|   |                                   | T <sub>A</sub> = 70 °C | 1.2 <sup>b, c</sup>    | 1.2 <sup>b, c</sup> |   |
| Operating Junction and Storage Temperature Range                        | T <sub>J</sub> , T <sub>stg</sub> | - 55 to 150            |                        | °C                  |   |
| Soldering Recommendations (Peak Temperature) <sup>d, e</sup>            |                                   | 260                    |                        |                     |   |

| THERMAL RESISTANCE RATINGS                  |              |                   |           |      |           |      |      |
|---|--------------|-------------------|-----------|------|-----------|------|------|
| Parameter                                   |              | Symbol            | Channel 1 |      | Channel 2 |      | Unit |
|   |              |                   | Typ.      | Max. | Typ.      | Max. |      |
| Maximum Junction-to-Ambient <sup>b, f</sup> | t ≤ 5 s      | R <sub>thJA</sub> | 52        | 65   | 52        | 65   | °C/W |
| Maximum Junction-to-Case (Drain)            | Steady State | R <sub>thJC</sub> | 12.5      | 16   | 20        | 25   |      |

Notes:

a. Package limited.

b. Surface mounted on 1" x 1" FR4 board.

c. t = 5 s.

d. See solder profile ([www.vishay.com/ppg?73257](http://www.vishay.com/ppg?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 for channel 1 and channel 2 is 110 °C/W.

| SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted |                         |  |      |      |       |           |                      |          |
|--|-------------------------|--|------|------|-------|-----------|----------------------|----------|
| Parameter  | Symbol                  | Test Conditions  | Min. | Typ. | Max.  | Unit      |                      |          |
| <b>Static</b>  |                         |  |      |      |       |           |                      |          |
| Drain-Source Breakdown Voltage   | $V_{DS}$                | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                            | Ch-1 | 12   |       |           | V                    |          |
|  |                         | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                            | Ch-2 | 20   |       |           |                      |          |
| $V_{DS}$ Temperature Coefficient   | $\Delta V_{DS}/T_J$     | $I_D = 250\text{ }\mu\text{A}$   | Ch-1 |      | 12    |           | mV/ $^\circ\text{C}$ |          |
|  |                         | $I_D = 250\text{ }\mu\text{A}$   | Ch-2 |      | 21    |           |                      |          |
| $V_{GS(th)}$ Temperature Coefficient                                     | $\Delta V_{GS(th)}/T_J$ | $I_D = 250\text{ }\mu\text{A}$   | Ch-1 |      | -2.5  |           |                      |          |
|  |                         | $I_D = 250\text{ }\mu\text{A}$   | Ch-2 |      | -2.3  |           |                      |          |
| Gate Threshold Voltage   | $V_{GS(th)}$            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                | Ch-1 | 0.4  |       | 1         | V                    |          |
|  |                         | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                | Ch-2 | 0.4  |       | 1         |                      |          |
| Gate-Body Leakage  | $I_{GSS}$               | $V_{DS} = 0\text{ V}, V_{GS} = \pm 8\text{ V}$                                 | Ch-1 |      |       | $\pm 100$ | nA                   |          |
|  |                         | $V_{DS} = 0\text{ V}, V_{GS} = \pm 6\text{ V}$                                 | Ch-2 |      |       | 1         | mA                   |          |
| Zero Gate Voltage Drain Current  | $I_{DSS}$               | $V_{DS} = 12\text{ V}, V_{GS} = 0\text{ V}$                                    | Ch-1 |      |       | 1         | $\mu\text{A}$        |          |
|  |                         | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$                                    | Ch-2 |      |       | 1         |                      |          |
|  |                         | $V_{DS} = 12\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$    | Ch-1 |      |       | 10        |                      |          |
|  |                         | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$    | Ch-2 |      |       | 10        |                      |          |
| On-State Drain Current <sup>b</sup>                                      | $I_{D(on)}$             | $V_{DS} \geq 5\text{ V}, V_{GS} = 4.5\text{ V}$                                | Ch-1 | 15   |       |           | A                    |          |
|  |                         | $V_{DS} \geq 5\text{ V}, V_{GS} = 4.5\text{ V}$                                | Ch-2 | 4    |       |           |                      |          |
| Drain-Source On-State Resistance <sup>b</sup>                            | $R_{DS(on)}$            | $V_{GS} = 4.5\text{ V}, I_D = 5\text{ A}$                                      | Ch-1 |      | 0.024 | 0.029     | $\Omega$             |          |
|  |                         | $V_{GS} = 4.5\text{ V}, I_D = 1.6\text{ A}$                                    | Ch-2 |      | 0.183 | 0.225     |                      |          |
|  |                         | $V_{GS} = 2.5\text{ V}, I_D = 4.6\text{ A}$                                    | Ch-1 |      | 0.028 | 0.034     |                      |          |
|  |                         | $V_{GS} = 2.5\text{ V}, I_D = 1.5\text{ A}$                                    | Ch-2 |      | 0.220 | 0.270     |                      |          |
|  |                         | $V_{GS} = 1.8\text{ V}, I_D = 4.1\text{ A}$                                    | Ch-1 |      | 0.032 | 0.044     |                      |          |
|  |                         | $V_{GS} = 1.8\text{ V}, I_D = 1.3\text{ A}$                                    | Ch-2 |      | 0.275 | 0.345     |                      |          |
|  |                         | $V_{GS} = 1.5\text{ V}, I_D = 2\text{ A}$                                      | Ch-1 |      | 0.042 | 0.065     |                      |          |
|  |                         | $V_{GS} = 1.5\text{ V}, I_D = 0.3\text{ A}$                                    | Ch-2 |      | 0.320 | 0.960     |                      |          |
| Forward Transconductance <sup>b</sup>                                    | $g_{fs}$                | $V_{DS} = 6\text{ V}, I_D = 5\text{ A}$  | Ch-1 |      | 21    |           | S                    |          |
|  |                         | $V_{DS} = 10\text{ V}, I_D = 1.6\text{ A}$                                     | Ch-2 |      | 3.5   |           |                      |          |
| <b>Dynamic<sup>a</sup></b>   |                         |  |      |      |       |           |                      |          |
| Input Capacitance  | $C_{iss}$               | Channel 1<br>$V_{DS} = 6\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$      | Ch-1 |      | 500   |           | pF                   |          |
| Output Capacitance   | $C_{oss}$               |  | Ch-1 |      | 160   |           |                      |          |
| Reverse Transfer Capacitance   | $C_{rss}$               |  | Ch-1 |      | 100   |           |                      |          |
| Total Gate Charge  | $Q_g$                   | $V_{DS} = 6\text{ V}, V_{GS} = 8\text{ V}, I_D = 6.5\text{ A}$                 | Ch-1 |      | 9.7   | 15        | nC                   |          |
|  |                         | $V_{DS} = 10\text{ V}, V_{GS} = 5\text{ V}, I_D = 1.7\text{ A}$                | Ch-2 |      | 1.3   | 2.2       |                      |          |
|  |                         | Channel 1<br>$V_{DS} = 6\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 6.5\text{ A}$  | Ch-1 |      | 5.6   | 8.5       |                      |          |
|  |                         |  | Ch-2 |      | 1.1   | 1.7       |                      |          |
| Gate-Source Charge   | $Q_{gs}$                | Channel 2<br>$V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 1.7\text{ A}$ | Ch-1 |      | 0.72  |           |                      |          |
| Gate-Drain Charge  | $Q_{gd}$                |  | Ch-2 |      | 0.2   |           |                      |          |
| Gate Resistance  | $R_g$                   | $f = 1\text{ MHz}$   | Ch-1 | 0.7  | 3.5   | 7         |                      | $\Omega$ |
|  |                         |  | Ch-2 | 40   | 200   | 400       |                      |          |

Notes:

a. Guaranteed by design, not subject to production testing.

b. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .



| SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted |              |  |      |      |      |      |    |
|--|--------------|--|------|------|------|------|----|
| Parameter  | Symbol       | Test Conditions  | Min. | Typ. | Max. | Unit |    |
| <b>Dynamic<sup>a</sup></b>   |              |  |      |      |      |      |    |
| Turn-On Delay Time   | $t_{d(on)}$  | Channel 1<br>$V_{DD} = 6\text{ V}$ , $R_L = 1.2\ \Omega$<br>$I_D \cong 5.2\text{ A}$ , $V_{GEN} = 4.5\text{ V}$ , $R_g = 1\ \Omega$  | Ch-1 |      | 10   | 15   | ns |
|  |              |  | Ch-2 |      | 20   | 30   |    |
| Rise Time  | $t_r$        | Channel 2<br>$V_{DD} = 10\text{ V}$ , $R_L = 7.7\ \Omega$<br>$I_D \cong 1.3\text{ A}$ , $V_{GEN} = 4.5\text{ V}$ , $R_g = 1\ \Omega$ | Ch-1 |      | 10   | 15   |    |
|  |              |  | Ch-2 |      | 12   | 20   |    |
| Turn-Off Delay Time  | $t_{d(off)}$ |  | Ch-1 |      | 22   | 30   |    |
|  |              |  | Ch-2 |      | 70   | 105  |    |
| Fall Time  | $t_f$        |  | Ch-1 |      | 10   | 15   |    |
|  |              |  | Ch-2 |      | 20   | 30   |    |
| <b>Drain-Source Body Diode Characteristics</b>                           |              |  |      |      |      |      |    |
| Continuous Source-Drain Diode Current                                    | $I_S$        | $T_C = 25\text{ }^\circ\text{C}$   | Ch-1 |      |      | 4.5  | A  |
|  |              |  | Ch-2 |      |      | 1.5  |    |
| Pulse Diode Forward Current <sup>a</sup>                                 | $I_{SM}$     |  | Ch-1 |      |      | 20   | A  |
|  |              |  | Ch-2 |      |      | 4    |    |
| Body Diode Voltage   | $V_{SD}$     | $I_S = 5.2\text{ A}$ , $V_{GS} = 0\text{ V}$   | Ch-1 |      | 0.85 | 1.2  | V  |
|  |              | $I_S = 1.3\text{ A}$ , $V_{GS} = 0\text{ V}$   | Ch-2 |      | 0.9  | 1.2  |    |
| Body Diode Reverse Recovery Time   | $t_{rr}$     | Channel 1<br>$I_F = 5.2\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 25\text{ }^\circ\text{C}$                            | Ch-1 |      | 20   | 40   | ns |
|  |              |  | Ch-2 |      | 50   | 75   |    |
| Body Diode Reverse Recovery Charge                                       | $Q_{rr}$     | Channel 2<br>$I_F = 1.3\text{ A}$ , $di/dt = 100\text{ A}/\mu\text{s}$ , $T_J = 25\text{ }^\circ\text{C}$                            | Ch-1 |      | 5    | 10   | nC |
|  |              |  | Ch-2 |      | 30   | 45   |    |
| Reverse Recovery Fall Time   | $t_a$        |  | Ch-1 |      | 8    |      | ns |
|  |              |  | Ch-2 |      | 115  |      |    |
| Reverse Recovery Rise Time   | $t_b$        |  | Ch-1 |      | 12   |      |    |
|  |              |  | Ch-2 |      | 35   |      |    |

Notes:

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

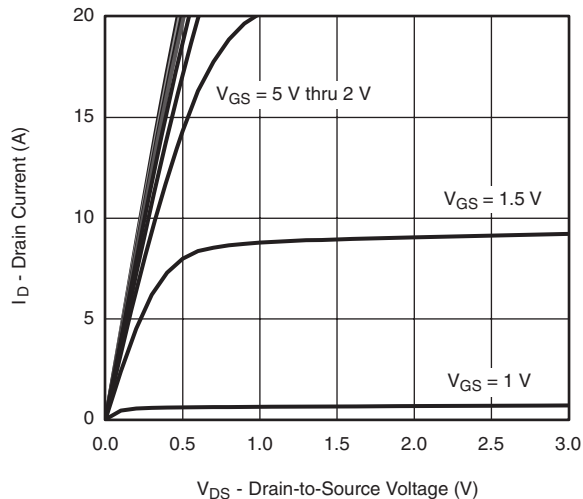
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

# SiA778DJ

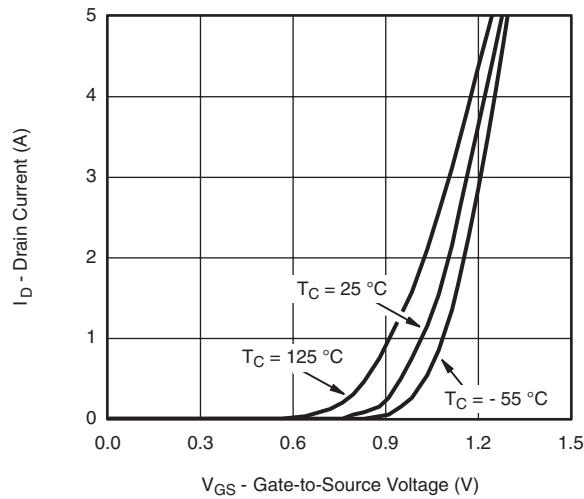
Vishay Siliconix



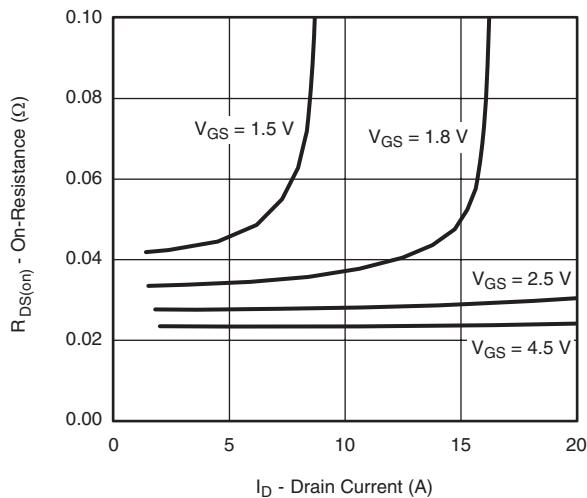
## CHANNEL 1 TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



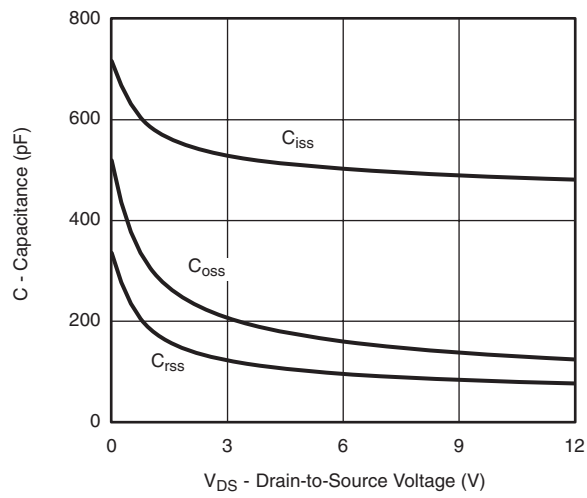
Output Characteristics



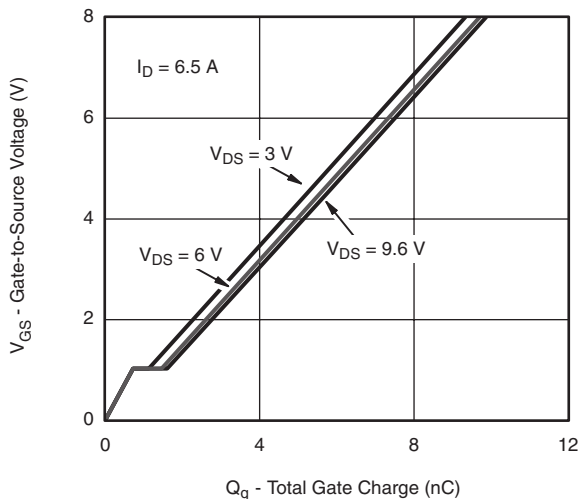
Transfer Characteristics



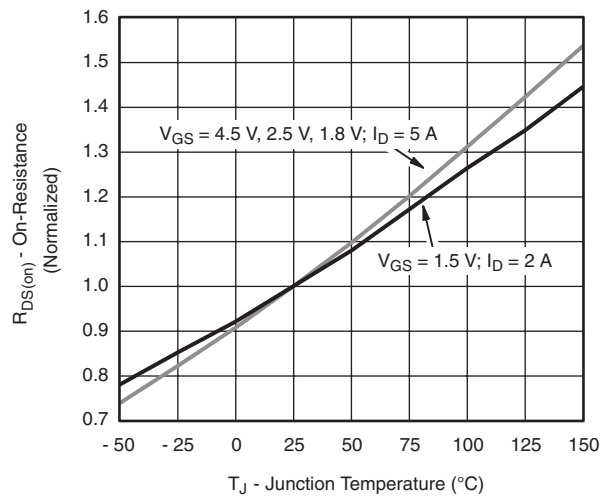
On-Resistance vs. Drain Current and Gate Voltage



Capacitance



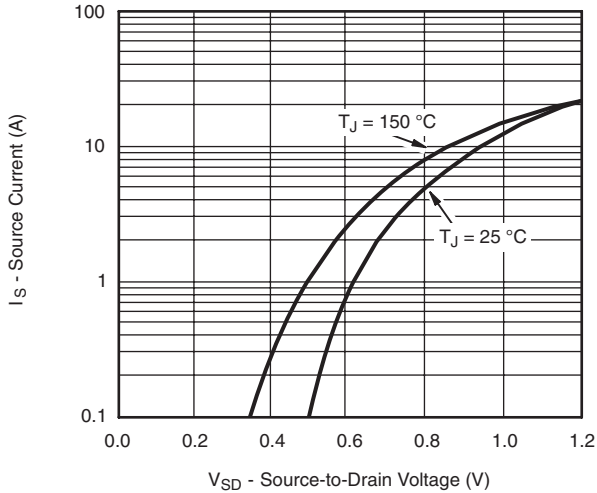
Gate Charge



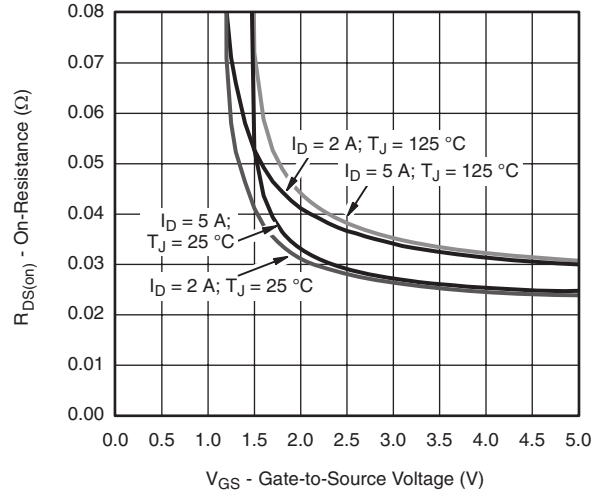
On-Resistance vs. Junction Temperature



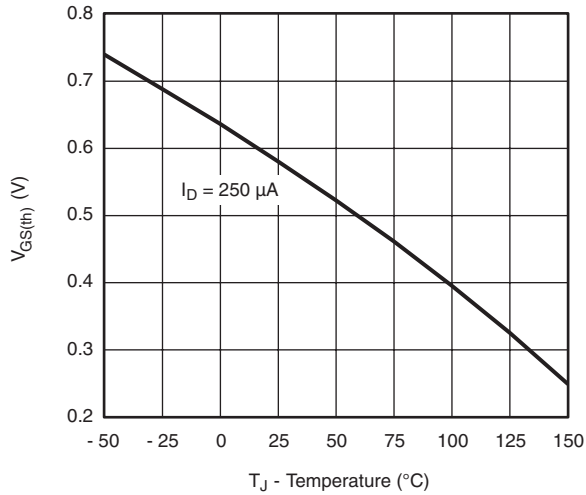
**CHANNEL 1 TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



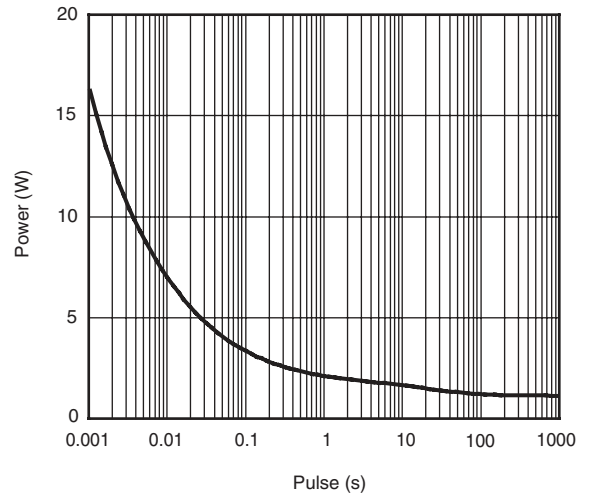
Source-Drain Diode Forward Voltage



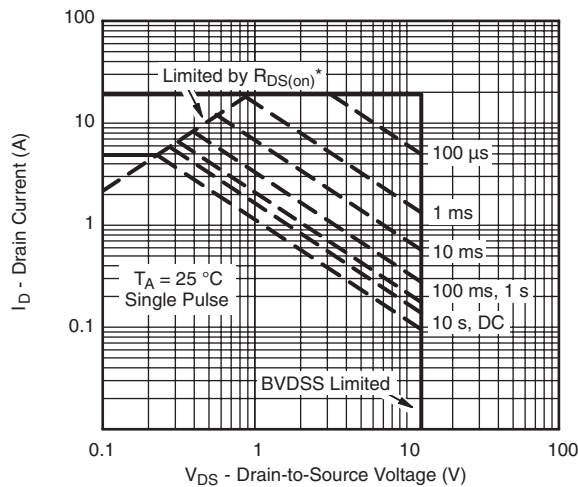
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



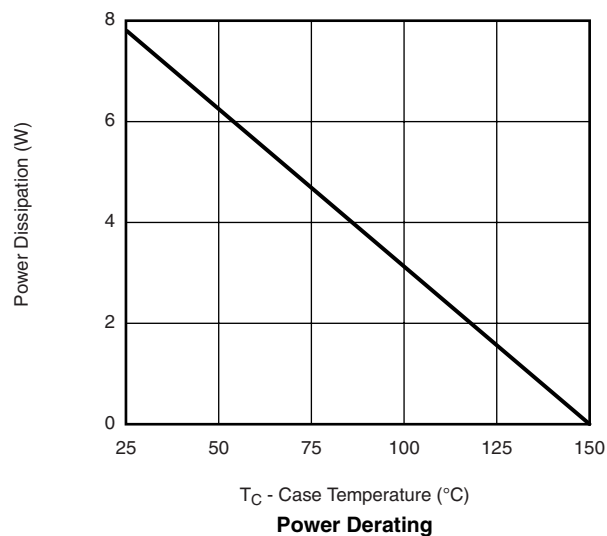
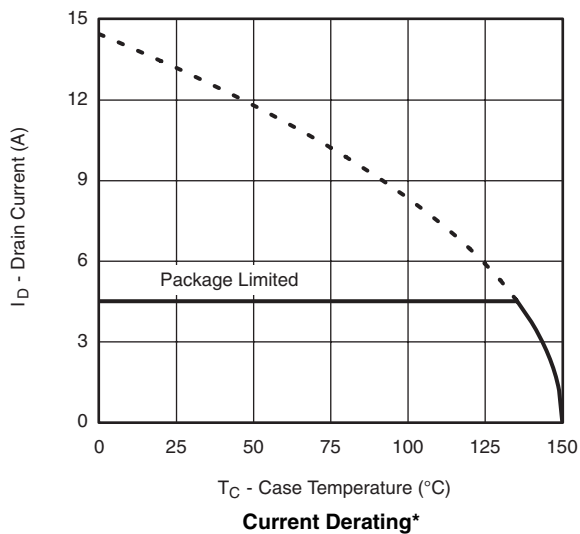
Single Pulse Power (Junction-to-Ambient)



\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified  
**Safe Operating Area, Junction-to-Ambient**



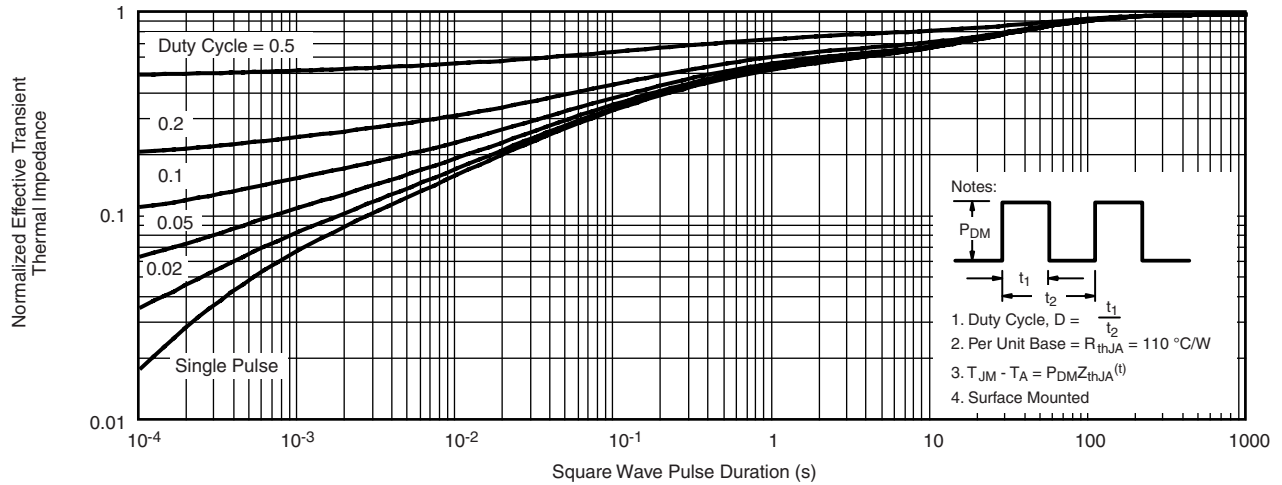
**CHANNEL 1 TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



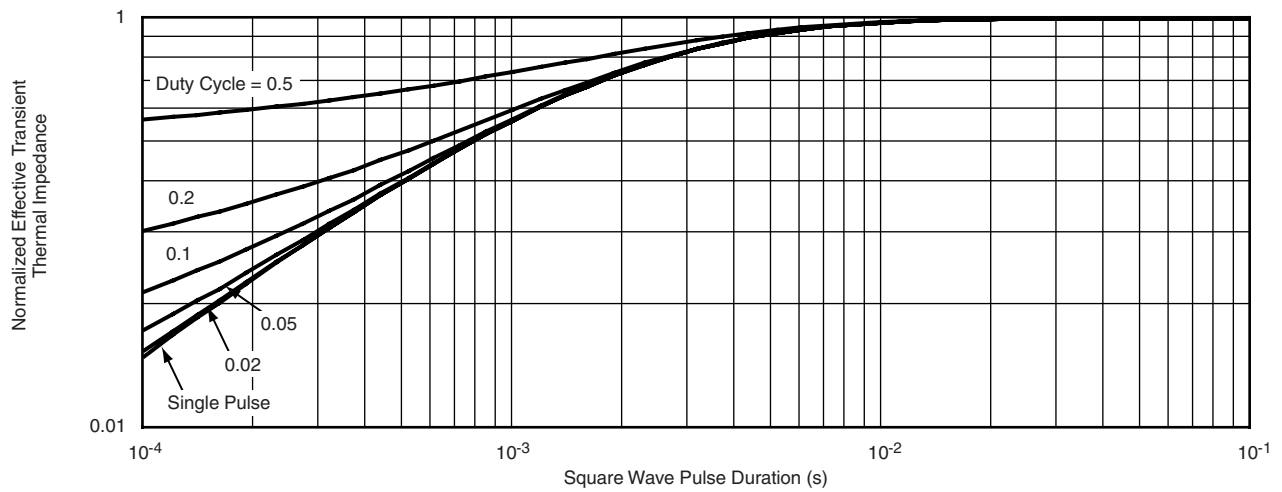
\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150\text{ °C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the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



**CHANNEL 1 TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

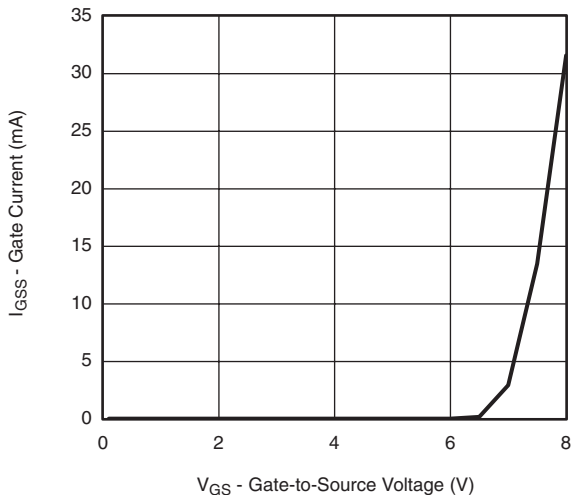


**Normalized Thermal Transient Impedance, Junction-to-Ambient**

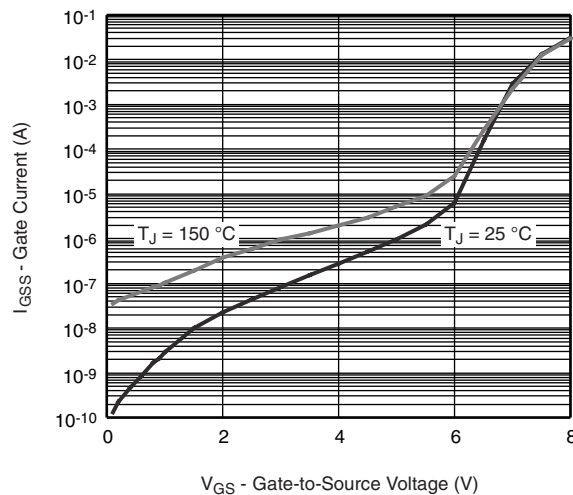


**Normalized Thermal Transient Impedance, Junction-to-Case**

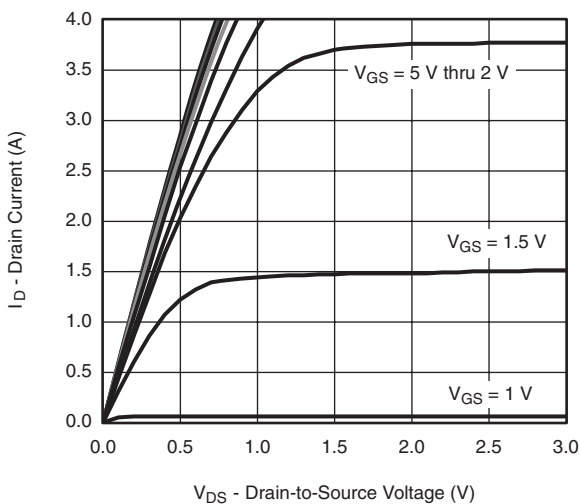
**CHANNEL 2 TYPICAL CHARACTERISTICS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



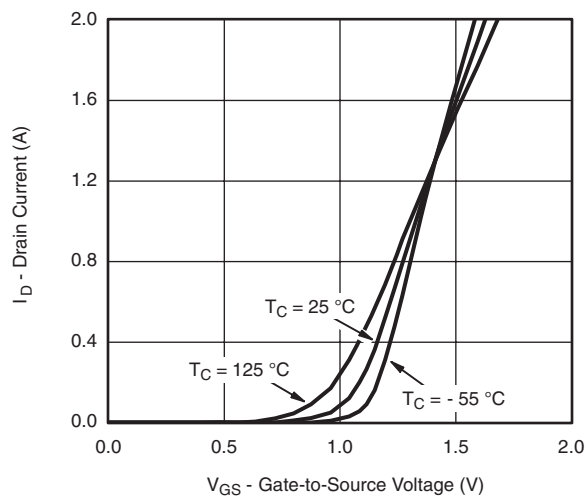
Gate Current vs. Gate-to-Source Voltage



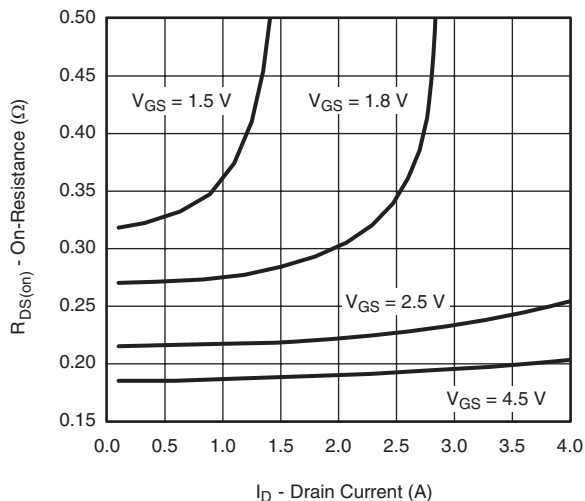
Gate Current vs. Gate-to-Source Voltage



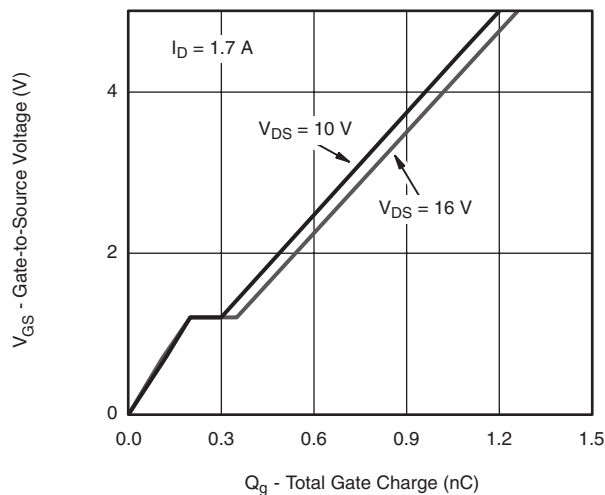
Output Characteristics



Transfer Characteristics



On-Resistance vs. Drain Current

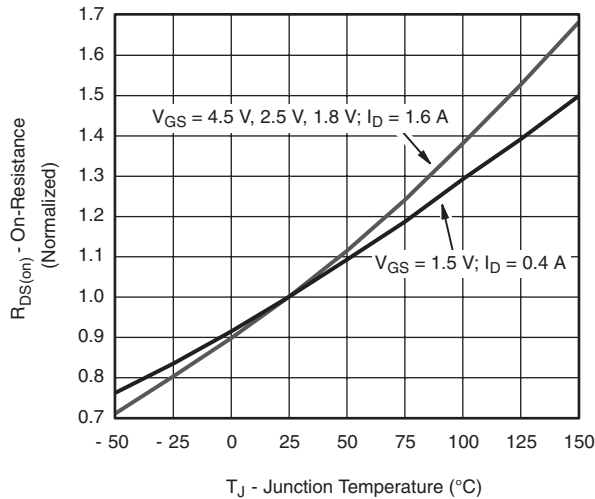


Gate Charge

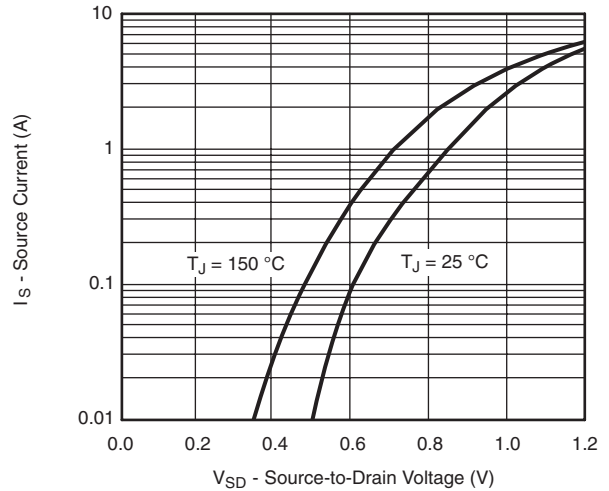




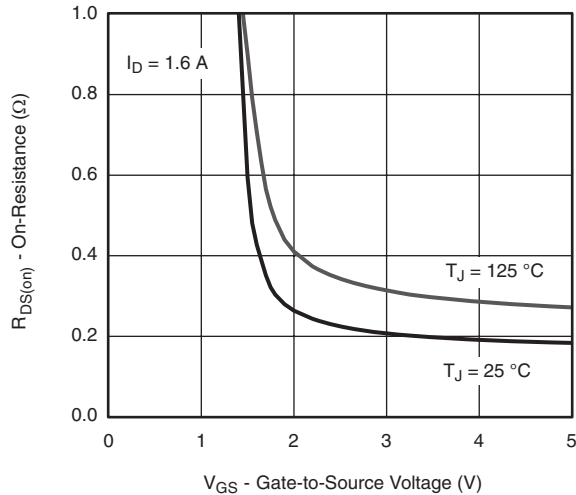
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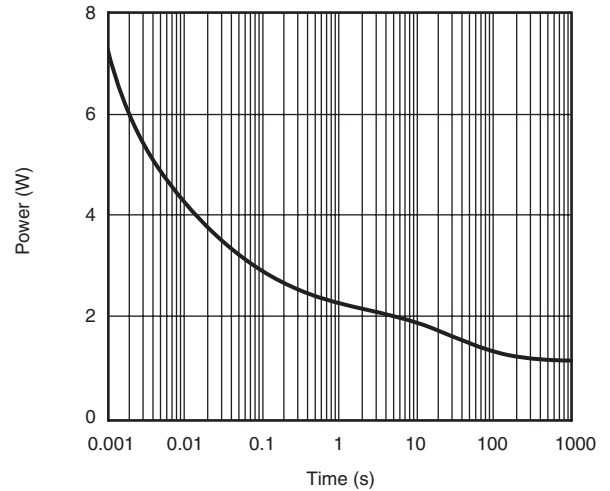
Normalized On-Resistance vs. Junction Temperature



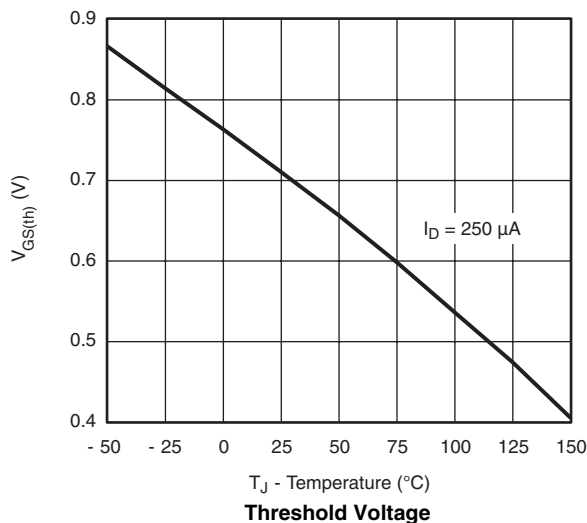
Source-Drain Diode Forward Voltage



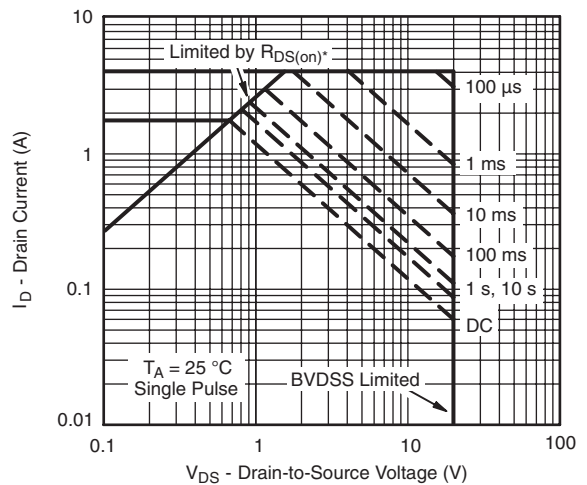
On-Resistance vs. Gate-to-Source Voltage



Single Pulse Power, Junction-to-Ambient



Threshold Voltage



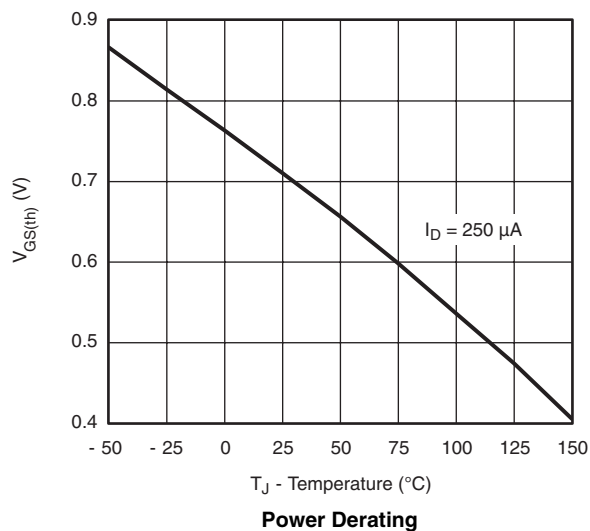
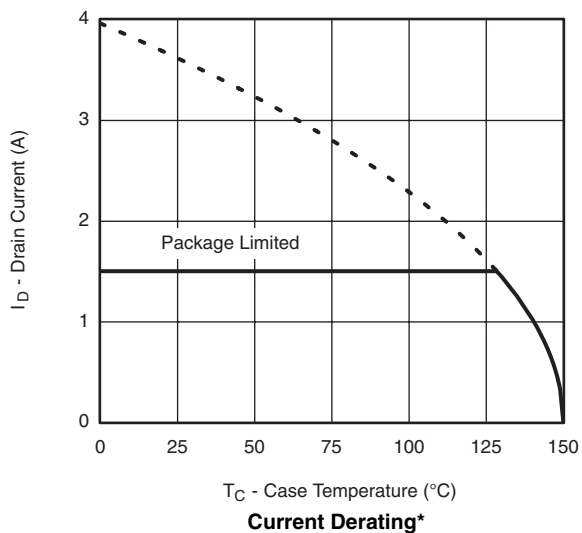
Safe Operating Area, Junction-to-Ambient  
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

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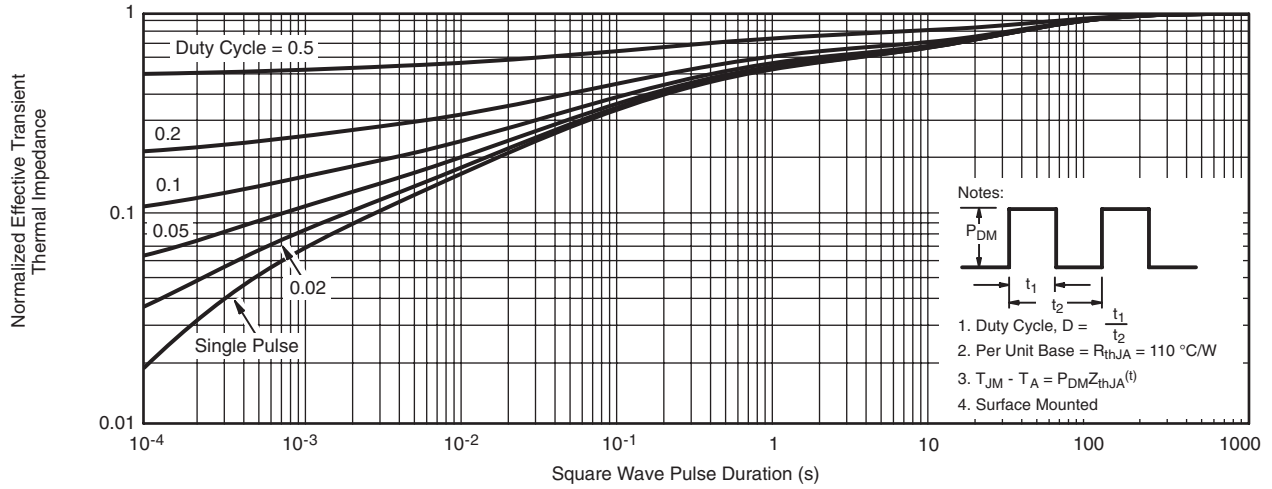
## CHANNEL 2 TYPICAL CHARACTERISTICS $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



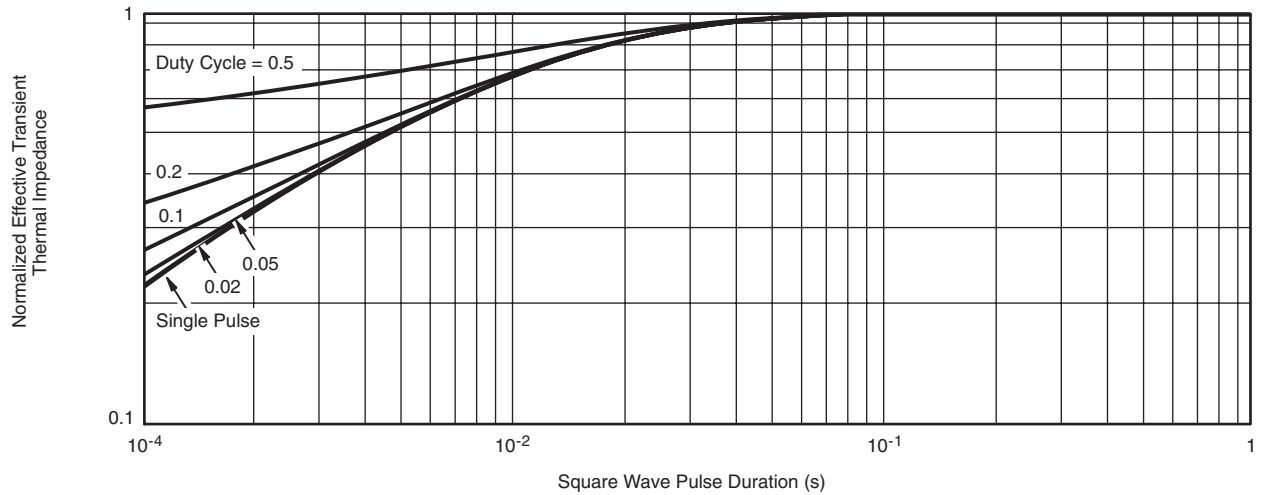
\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150\text{ }^\circ\text{C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.



**CHANNEL 2 TYPICAL CHARACTERISTICS**  $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted



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



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

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