

# SM2001CSK-VB Datasheet

## N- and P-Channel 20-V (D-S) MOSFETS

### PRODUCT SUMMARY

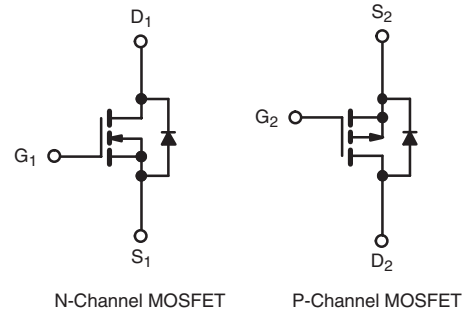
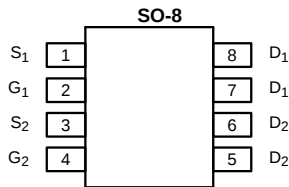
|           | V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)            | I <sub>D</sub> (A) | Q <sub>g</sub> (Typ.) |
|-----------|---------------------|------------------------------------|--------------------|-----------------------|
| N-Channel | 20                  | 0.006 at V <sub>GS</sub> = 4.5 V   | 15 <sup>a</sup>    | 11 nC                 |
|           |                     | 0.010 at V <sub>GS</sub> = 2.5 V   | 12 <sup>a</sup>    |                       |
| P-Channel | - 20                | 0.016 at V <sub>GS</sub> = - 4.5 V | - 8.5 <sup>a</sup> | 25 nC                 |
|           |                     | 0.020 at V <sub>GS</sub> = - 2.5 V | - 7.0 <sup>a</sup> |                       |

### FEATURES

- Halogen-free
- Trench Power MOSFETs

### APPLICATIONS

- Load Switch
- DC/DC Converter


**RoHS**  
 COMPLIANT


### ABSOLUTE MAXIMUM RATINGS T<sub>A</sub> = 25 °C, unless otherwise noted

| Parameter                                          | Symbol                            | N-Channel           | P-Channel             | Unit |
|----------------------------------------------------|-----------------------------------|---------------------|-----------------------|------|
| Drain-Source Voltage                               | V <sub>DS</sub>                   | 20                  | - 20                  | V    |
| Gate-Source Voltage                                | V <sub>GS</sub>                   | ± 12                |                       |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C) | I <sub>D</sub>                    | 15                  | -8.5                  | A    |
|                                                    |                                   | 12                  | -6.8                  |      |
|                                                    |                                   | 13 <sup>b, c</sup>  | - 7.0 <sup>b, c</sup> |      |
|                                                    |                                   | 11 <sup>b, c</sup>  | - 5.6 <sup>b, c</sup> |      |
| Pulsed Drain Current                               | I <sub>DM</sub>                   | 30                  | - 30                  |      |
| Source Drain Current Diode Current                 | I <sub>S</sub>                    | 5.3                 | -4.4                  |      |
|                                                    |                                   | 3.9 <sup>b, c</sup> | - 2.9 <sup>b, c</sup> |      |
| Maximum Power Dissipation                          | P <sub>D</sub>                    | 3.1                 | 3.2                   | W    |
|                                                    |                                   | 2.1                 | 2.2                   |      |
|                                                    |                                   | 2.1 <sup>b, c</sup> | 2.2 <sup>b, c</sup>   |      |
|                                                    |                                   | 1.7 <sup>b, c</sup> | 1.76 <sup>b, c</sup>  |      |
| Operating Junction and Storage Temperature Range   | T <sub>J</sub> , T <sub>stg</sub> | - 55 to 150         |                       | °C   |

### THERMAL RESISTANCE RATINGS

| Parameter                                   |              | Symbol            | N-Channel |      | P-Channel |      | Unit |
|---------------------------------------------|--------------|-------------------|-----------|------|-----------|------|------|
|                                             |              |                   | Typ.      | Max. | Typ.      | Max. |      |
| Maximum Junction-to-Ambient <sup>b, d</sup> | t ≤ 10 s     | R <sub>thJA</sub> | 85        | 110  | 81        | 105  | °C/W |
| Maximum Junction-to-Foot (Drain)            | Steady State | R <sub>thJF</sub> | 62        | 80   | 57        | 75   |      |

Notes:

 a. T<sub>C</sub> = 25 °C.

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

c. t = 10 s.

d. Maximum under Steady State conditions is 145 °C/W.

| SPECIFICATIONS $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted |                         |                                                                                |                                                                                   |              |              |                        |                        |
|----------------------------------------------------------------------------|-------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|--------------|--------------|------------------------|------------------------|
| Parameter                                                                  | Symbol                  | Test Conditions                                                                |                                                                                   | Min.         | Typ.         | Max.                   | Unit                   |
| Static                                                                     |                         |                                                                                |                                                                                   |              |              |                        |                        |
| Drain-Source Breakdown Voltage                                             | $V_{DS}$                | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$                            | N-Ch                                                                              | 20           |              |                        | V                      |
|                                                                            |                         | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$                           | P-Ch                                                                              | -20          |              |                        |                        |
| $V_{DS}$ Temperature Coefficient                                           | $\Delta V_{DS}/T_J$     | $I_D = 250\text{ }\mu\text{A}$                                                 | N-Ch                                                                              |              | 22           |                        | mV/ $^{\circ}\text{C}$ |
|                                                                            |                         | $I_D = -250\text{ }\mu\text{A}$                                                | P-Ch                                                                              |              | -21          |                        |                        |
| $V_{GS(th)}$ Temperature Coefficient                                       | $\Delta V_{GS(th)}/T_J$ | $I_D = 250\text{ }\mu\text{A}$                                                 | N-Ch                                                                              |              | -3.5         |                        |                        |
|                                                                            |                         | $I_D = -250\text{ }\mu\text{A}$                                                | P-Ch                                                                              |              | 3.5          |                        |                        |
| Gate Threshold Voltage                                                     | $V_{GS(th)}$            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$                                | N-Ch                                                                              | 0.6          |              | 1.5                    | V                      |
|                                                                            |                         | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$                               | P-Ch                                                                              | -0.6         |              | -1.5                   |                        |
| Gate-Body Leakage                                                          | $I_{GSS}$               | $V_{DS} = 0\text{ V}, V_{GS} = \pm 12\text{ V}$                                | N-Ch<br>P-Ch                                                                      |              |              | $\pm 100$<br>$\pm 100$ | nA                     |
| Zero Gate Voltage Drain Current                                            | $I_{DSS}$               | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}$                                    | N-Ch                                                                              |              |              | 1                      | $\mu\text{A}$          |
|                                                                            |                         | $V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}$                                   | P-Ch                                                                              |              |              | -1                     |                        |
|                                                                            |                         | $V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^{\circ}\text{C}$  | N-Ch                                                                              |              |              | 10                     |                        |
|                                                                            |                         | $V_{DS} = -20\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^{\circ}\text{C}$ | P-Ch                                                                              |              |              | -10                    |                        |
| On-State Drain Current <sup>b</sup>                                        | $I_{D(on)}$             | $V_{DS} \geq 5\text{ V}, V_{GS} = 4.5\text{ V}$                                | N-Ch                                                                              | 30           |              |                        | A                      |
|                                                                            |                         | $V_{DS} \leq -5\text{ V}, V_{GS} = -4.5\text{ V}$                              | P-Ch                                                                              | -30          |              |                        |                        |
| Drain-Source On-State Resistance <sup>b</sup>                              | $R_{DS(on)}$            | $V_{GS} = 4.5\text{ V}, I_D = 5.7\text{ A}$                                    | N-Ch                                                                              |              | 0.006        |                        | $\Omega$               |
|                                                                            |                         | $V_{GS} = -4.5\text{ V}, I_D = -5.1\text{ A}$                                  | P-Ch                                                                              |              | 0.016        |                        |                        |
|                                                                            |                         | $V_{GS} = 2.5\text{ V}, I_D = 4.4\text{ A}$                                    | N-Ch                                                                              |              | 0.010        |                        |                        |
|                                                                            |                         | $V_{GS} = -2.5\text{ V}, I_D = -4.2\text{ A}$                                  | P-Ch                                                                              |              | 0.020        |                        |                        |
| Forward Transconductance <sup>b</sup>                                      | $g_{fs}$                | $V_{DS} = 10\text{ V}, I_D = 5.7\text{ A}$                                     | N-Ch                                                                              |              | 17           |                        | S                      |
|                                                                            |                         | $V_{DS} = -10\text{ V}, I_D = -5.1\text{ A}$                                   | P-Ch                                                                              |              | 22           |                        |                        |
| Dynamic <sup>a</sup>                                                       |                         |                                                                                |                                                                                   |              |              |                        |                        |
| Input Capacitance                                                          | $C_{iss}$               | N-Channel<br>$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$     | N-Ch<br>P-Ch                                                                      |              | 1250<br>1600 |                        | pF                     |
| Output Capacitance                                                         | $C_{oss}$               |                                                                                | N-Ch<br>P-Ch                                                                      |              | 180<br>280   |                        |                        |
| Reverse Transfer Capacitance                                               | $C_{rss}$               | P-Channel<br>$V_{DS} = -10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$    | N-Ch<br>P-Ch                                                                      |              | 100<br>65    |                        |                        |
|                                                                            |                         |                                                                                |                                                                                   |              |              |                        |                        |
| Total Gate Charge                                                          | $Q_g$                   | $V_{DS} = 10\text{ V}, V_{GS} = 10\text{ V}, I_D = 5.7\text{ A}$               | N-Ch                                                                              |              | 23           | 35                     | nC                     |
|                                                                            |                         | $V_{DS} = -10\text{ V}, V_{GS} = -10\text{ V}, I_D = -5.1\text{ A}$            | P-Ch                                                                              |              | 44           | 61                     |                        |
|                                                                            |                         | N-Channel<br>$V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 5.7\text{ A}$ | N-Ch<br>P-Ch                                                                      |              | 11<br>25     | 20<br>35               |                        |
|                                                                            |                         |                                                                                | P-Channel<br>$V_{DS} = -10\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -5.1\text{ A}$ | N-Ch<br>P-Ch |              | 1.8<br>3               |                        |
| Gate-Source Charge                                                         | $Q_{gs}$                |                                                                                |                                                                                   | N-Ch<br>P-Ch |              | 0.9<br>5.5             |                        |
|                                                                            |                         |                                                                                |                                                                                   |              |              |                        |                        |
| Gate-Drain Charge                                                          | $Q_{gd}$                |                                                                                | N-Ch<br>P-Ch                                                                      |              |              |                        |                        |
|                                                                            |                         |                                                                                |                                                                                   |              |              |                        |                        |
| Gate Resistance                                                            | $R_g$                   | $f = 1\text{ MHz}$                                                             | N-Ch<br>P-Ch                                                                      |              | 2<br>6       |                        | $\Omega$               |

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 |     |   |
| Dynamic <sup>a</sup>                                                       |              |                                                                                                                                            |                                    |      |      |      |      |     |   |
| Turn-On Delay Time                                                         | $t_{d(on)}$  | N-Channel<br>$V_{DD} = 10\text{ V}, R_L = 2.2\text{ }\Omega$<br>$I_D \cong 4.5\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 1\text{ }\Omega$    | N-Ch                               |      | 12   | 20   | ns   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 30   | 45   |      |     |   |
| Rise Time                                                                  | $t_r$        |                                                                                                                                            | N-Ch                               |      | 10   | 15   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 25   | 40   |      |     |   |
| Turn-Off Delay Time                                                        | $t_{d(off)}$ |                                                                                                                                            | N-Ch                               |      | 25   | 40   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 45   | 70   |      |     |   |
| Fall Time                                                                  | $t_f$        | P-Channel<br>$V_{DD} = -10\text{ V}, R_L = 2.4\text{ }\Omega$<br>$I_D \cong -4.1\text{ A}, V_{GEN} = -4.5\text{ V}, R_g = 1\text{ }\Omega$ | N-Ch                               |      | 10   | 15   | ns   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 15   | 25   |      |     |   |
| Turn-On Delay Time                                                         | $t_{d(on)}$  |                                                                                                                                            | N-Ch                               |      | 10   | 15   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 10   | 15   |      |     |   |
| Rise Time                                                                  | $t_r$        |                                                                                                                                            | N-Ch                               |      | 10   | 15   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 10   | 15   |      |     |   |
| Turn-Off Delay Time                                                        | $t_{d(off)}$ | N-Channel<br>$V_{DD} = 10\text{ V}, R_L = 2.2\text{ }\Omega$<br>$I_D \cong 4.5\text{ A}, V_{GEN} = 10\text{ V}, R_g = 1\text{ }\Omega$     | N-Ch                               |      | 20   | 30   | ns   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 45   | 70   |      |     |   |
| Fall Time                                                                  | $t_f$        |                                                                                                                                            | N-Ch                               |      | 8    | 15   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 15   | 25   |      |     |   |
| Drain-Source Body Diode Characteristics                                    |              |                                                                                                                                            |                                    |      |      |      |      |     |   |
| Continuous Source-Drain Diode Current                                      | $I_S$        |                                                                                                                                            | $T_C = 25\text{ }^{\circ}\text{C}$ | N-Ch |      |      |      | 1.3 | A |
|                                                                            |              | P-Ch                                                                                                                                       |                                    |      |      | -1.4 |      |     |   |
| Pulse Diode Forward Current <sup>a</sup>                                   | $I_{SM}$     |                                                                                                                                            | N-Ch                               |      |      | 30   |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      |      | -30  |      |     |   |
| Body Diode Voltage                                                         | $V_{SD}$     | $I_S = 4.5\text{ A}, V_{GS} = 0\text{ V}$                                                                                                  | N-Ch                               |      | 0.8  | 1.2  | V    |     |   |
|                                                                            |              | $I_S = -4.1\text{ A}, V_{GS} = 0\text{ V}$                                                                                                 | P-Ch                               |      | -0.8 | -1.2 |      |     |   |
| Body Diode Reverse Recovery Time                                           | $t_{rr}$     | N-Channel<br>$I_F = 4.5\text{ A}, di/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^{\circ}\text{C}$                                      | N-Ch                               |      | 15   | 30   | ns   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 35   | 55   |      |     |   |
| Body Diode Reverse Recovery Charge                                         | $Q_{rr}$     |                                                                                                                                            | N-Ch                               |      | 6    | 12   | nC   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 21   | 35   |      |     |   |
| Reverse Recovery Fall Time                                                 | $t_a$        |                                                                                                                                            | N-Ch                               |      | 7.6  |      | ns   |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 18   |      |      |     |   |
| Reverse Recovery Rise Time                                                 | $t_b$        |                                                                                                                                            | N-Ch                               |      | 7.4  |      |      |     |   |
|                                                                            |              |                                                                                                                                            | P-Ch                               |      | 17   |      |      |     |   |

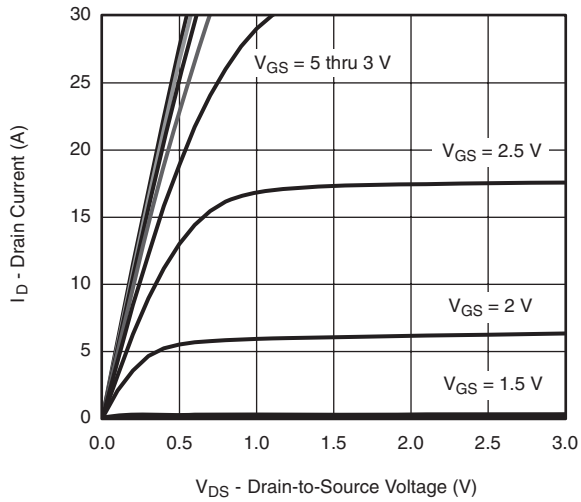
Notes:

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

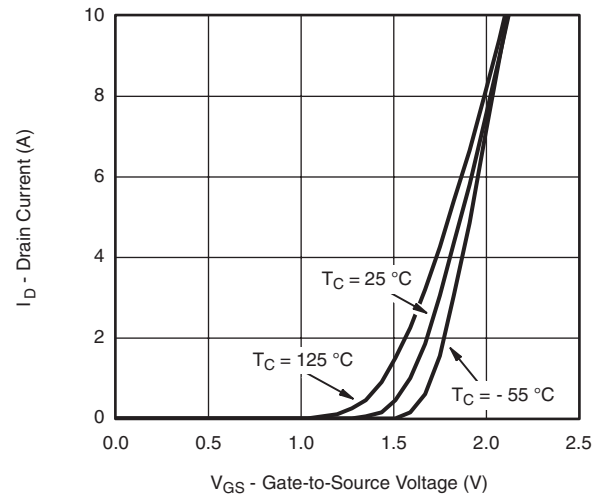
b. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

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.

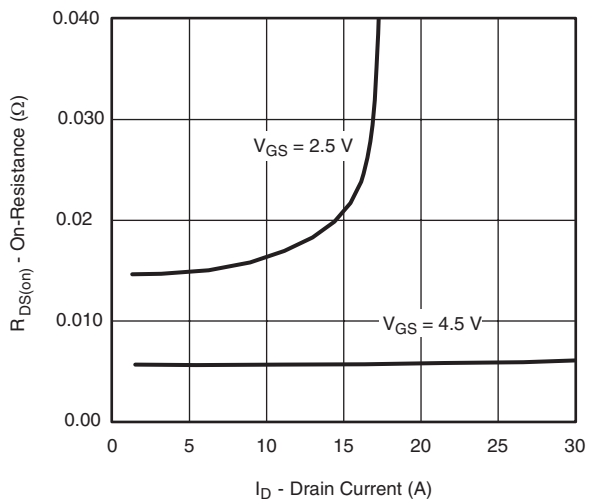
**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



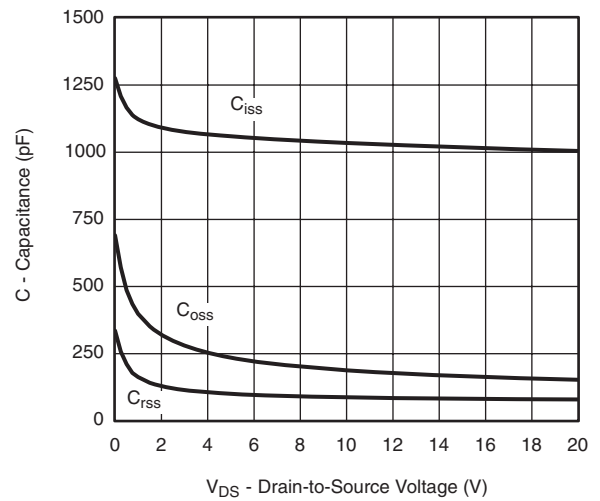
**Output Characteristics**



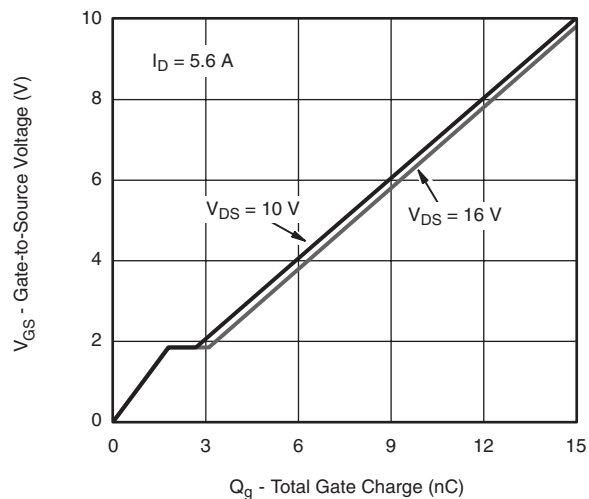
**Transfer Characteristics**



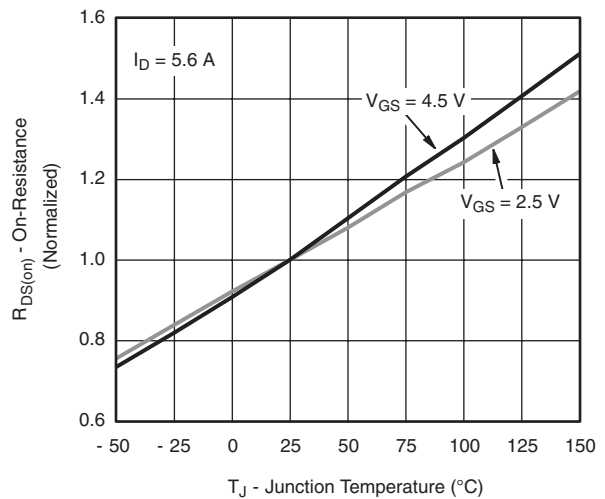
**On-Resistance vs. Drain Current**



**Capacitance**

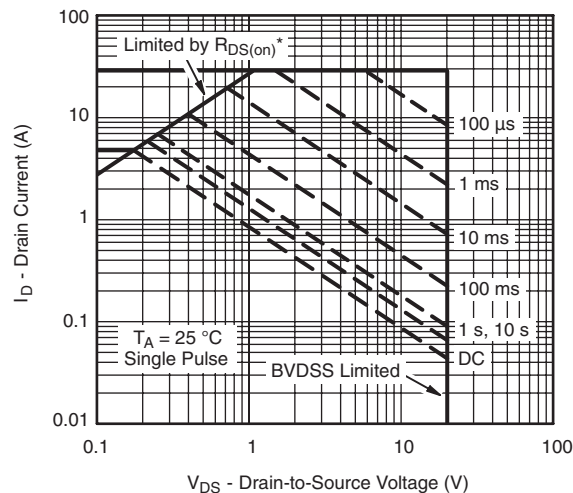
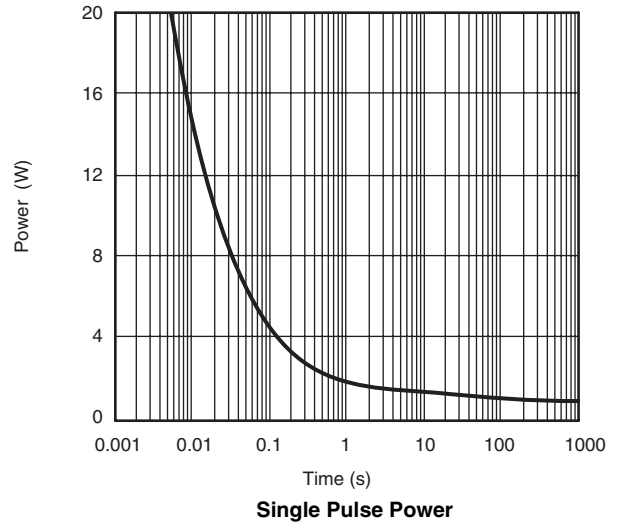
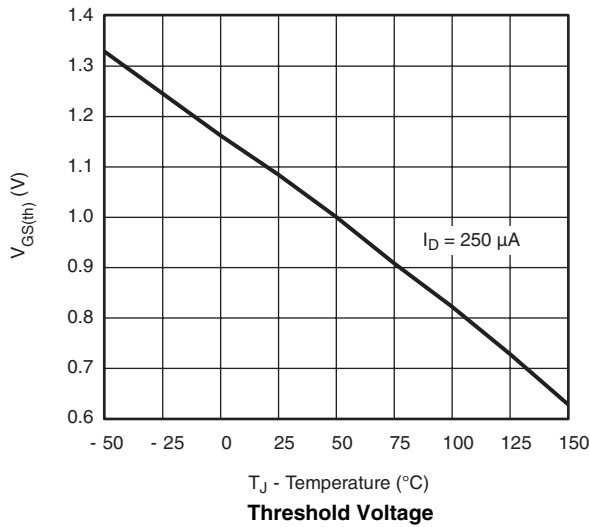
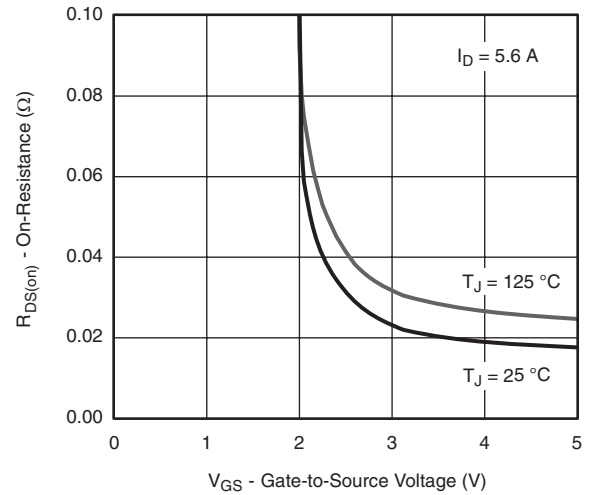
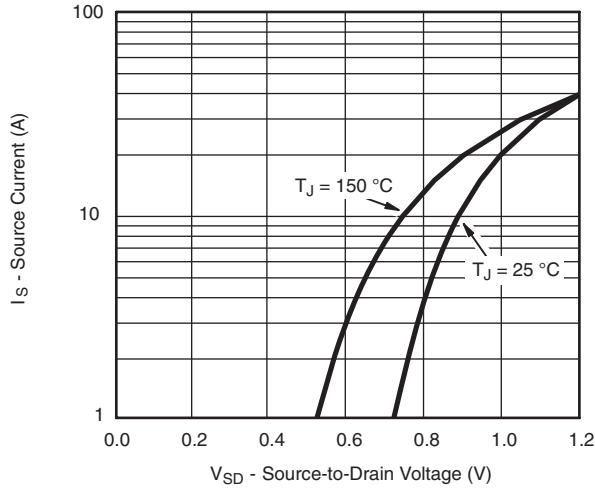


**Gate Charge**



**On-Resistance vs. Junction Temperature**

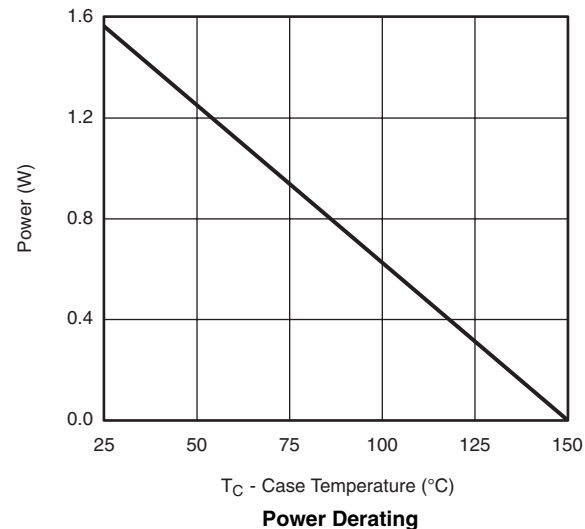
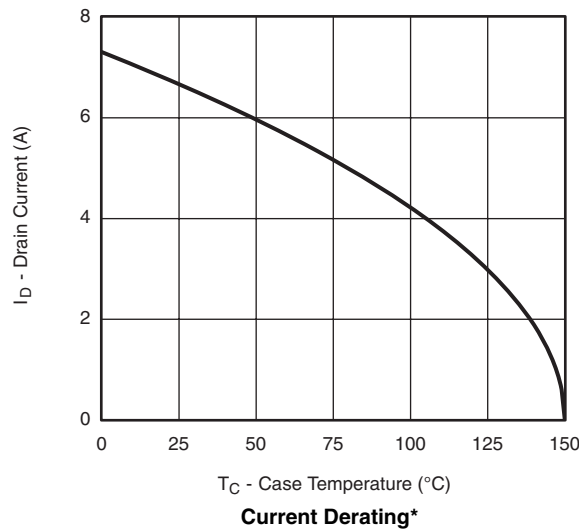
**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



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

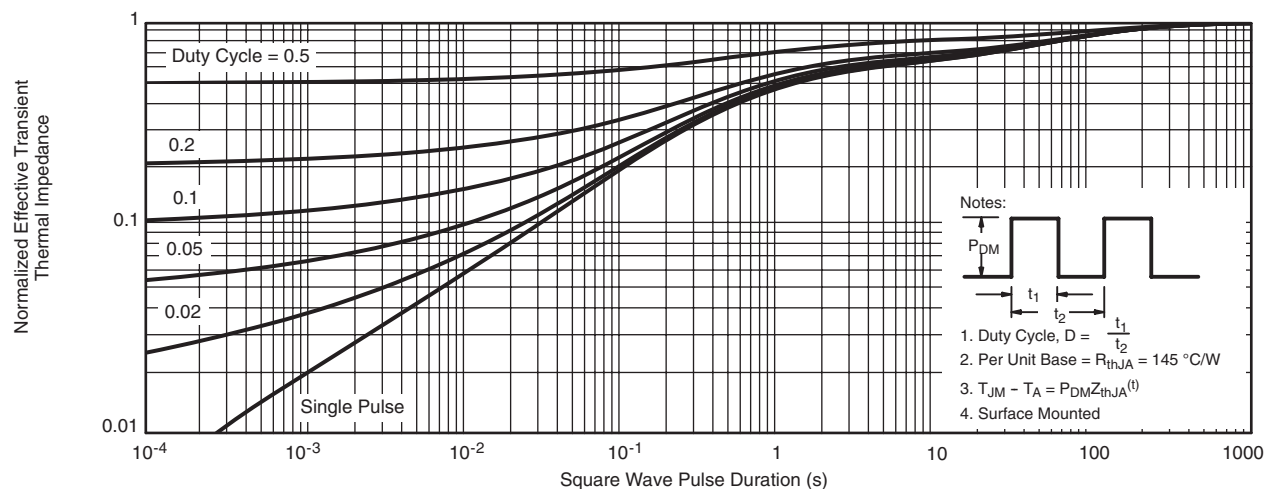
**Safe Operating Area, Junction-to-Ambient**

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

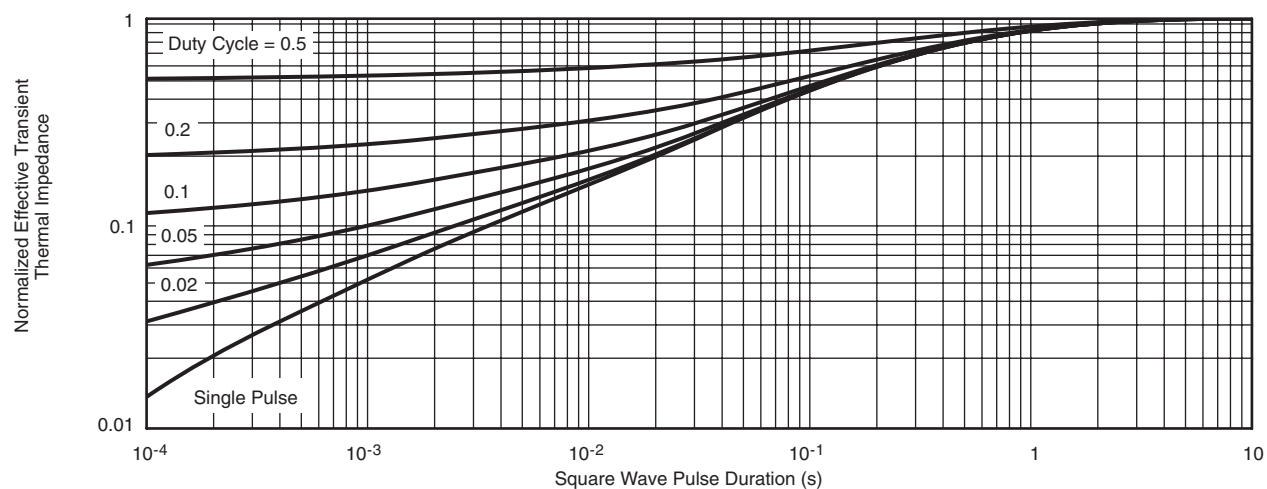


\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150\text{ }^{\circ}\text{C}$ , using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating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

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

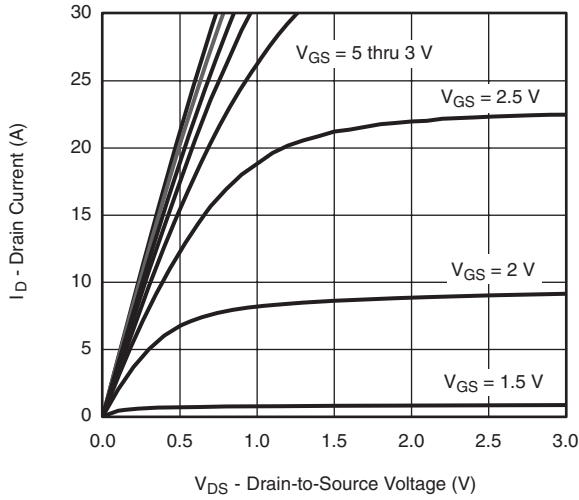


**Normalized Thermal Transient Impedance, Junction-to-Ambient**

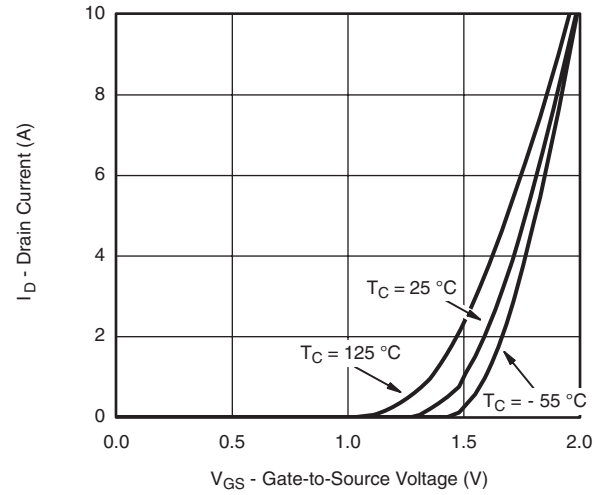


**Normalized Thermal Transient Impedance, Junction-to-Foot**

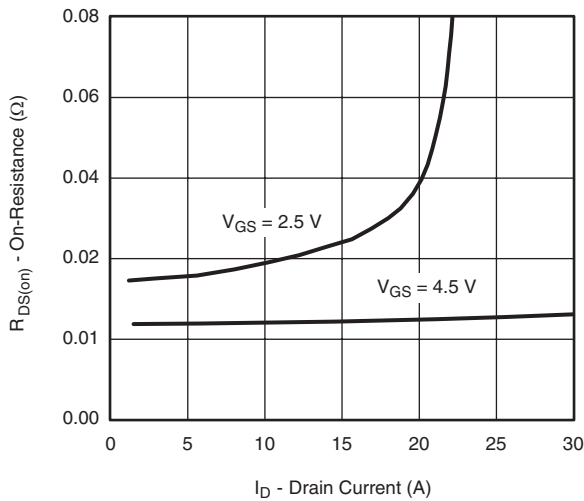
**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



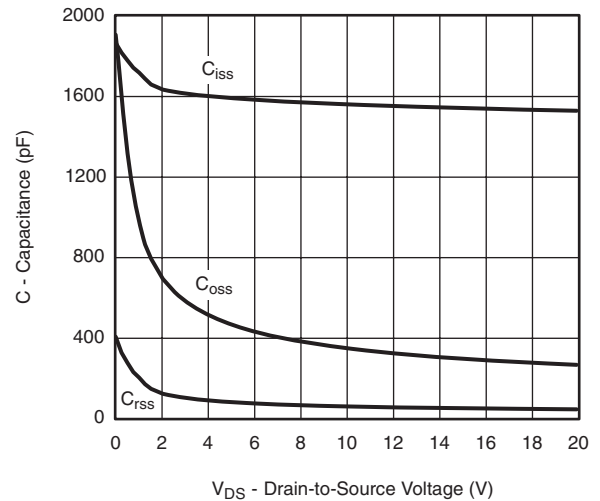
**Output Characteristics**



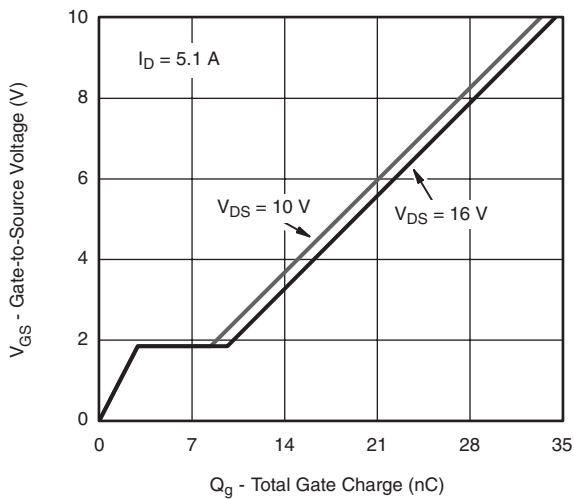
**Transfer Characteristics**



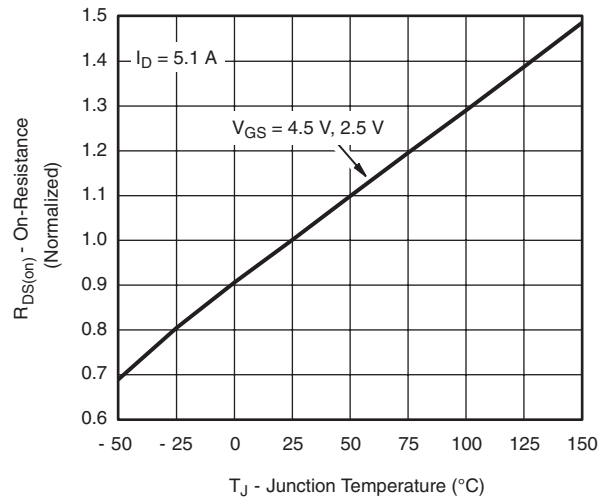
**On-Resistance vs. Drain Current**



**Capacitance**

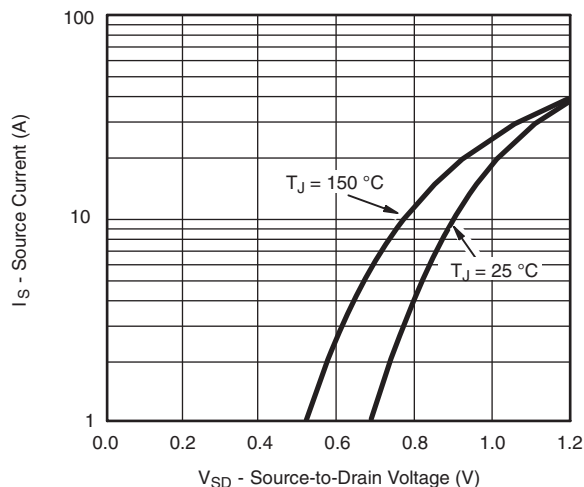


**Gate Charge**

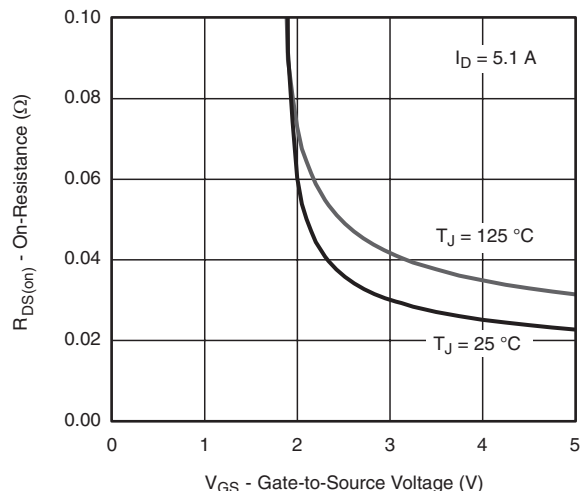


**On-Resistance vs. Junction Temperature**

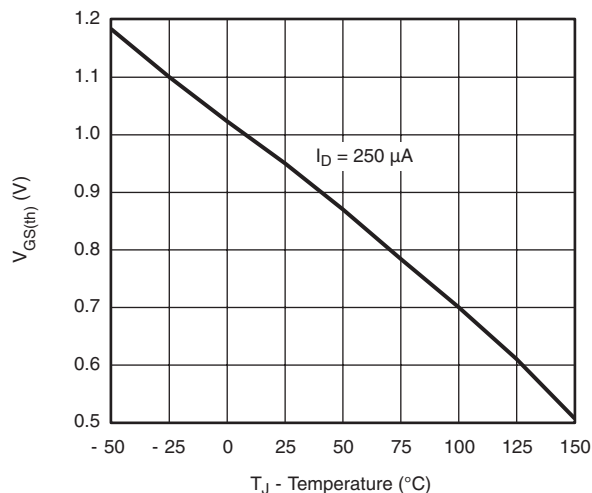
**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



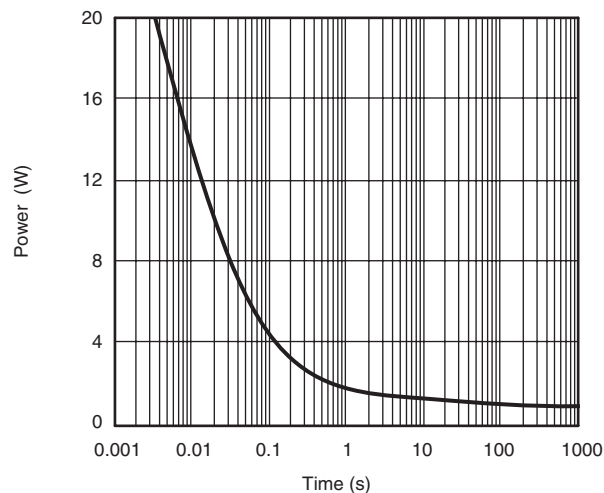
Source-Drain Diode Forward Voltage



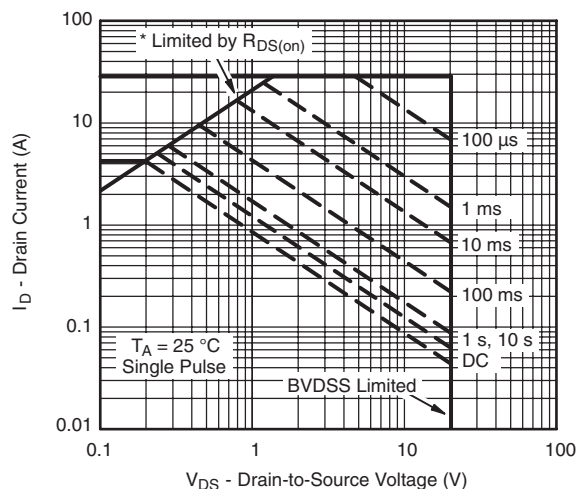
On-Resistance vs. Gate-to-Source



Threshold Voltage



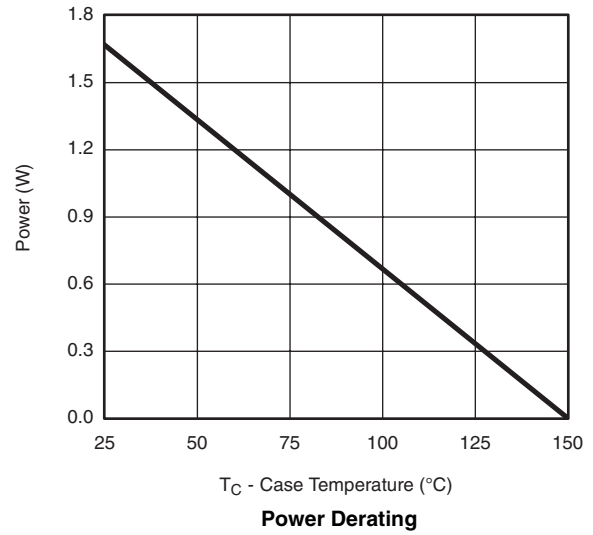
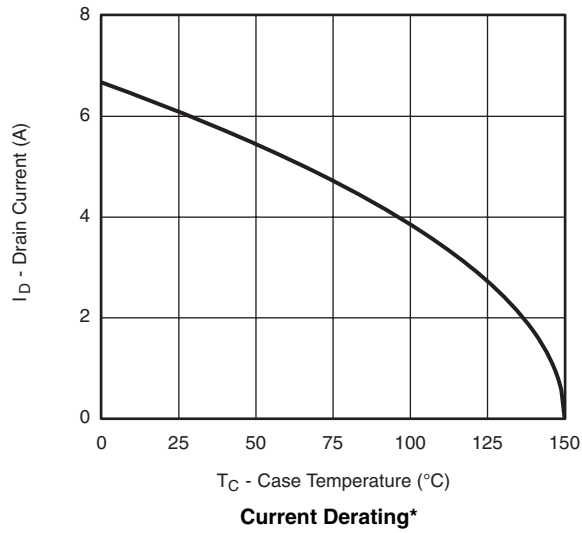
Single Pulse Power



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

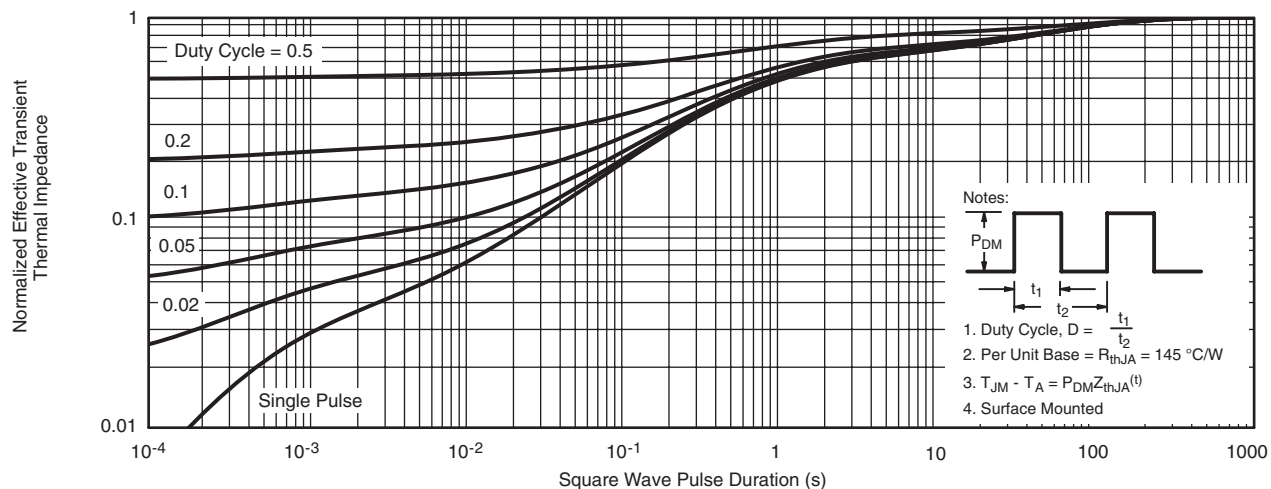
Safe Operating Area, Junction-to-Ambient

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

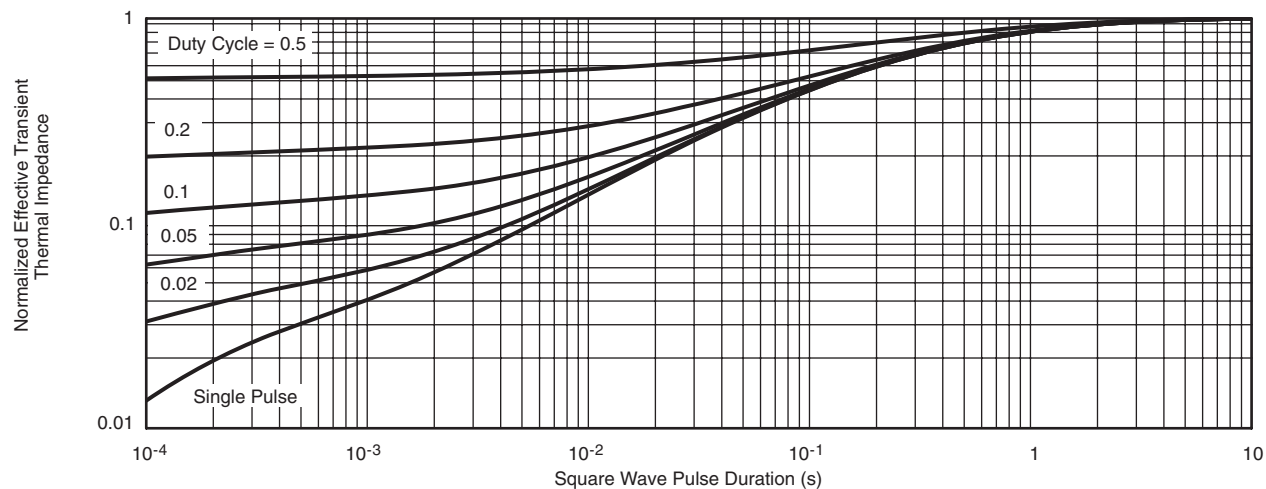


\* The power dissipation  $P_D$  is based on  $T_{J(max)} = 150$  °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package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

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

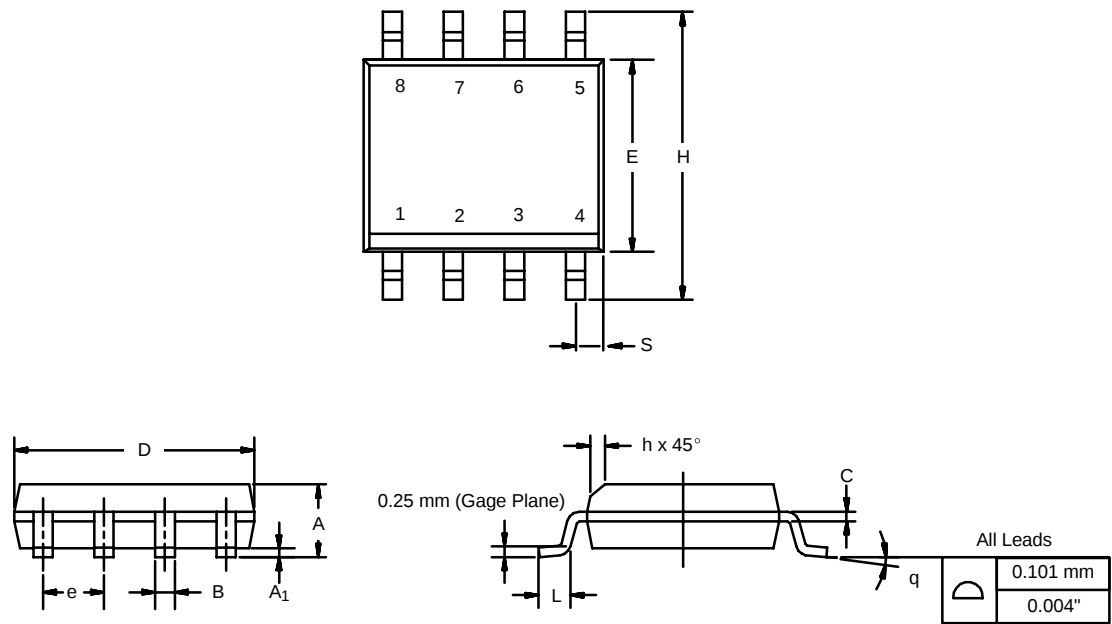


**Normalized Thermal Transient Impedance, Junction-to-Ambient**



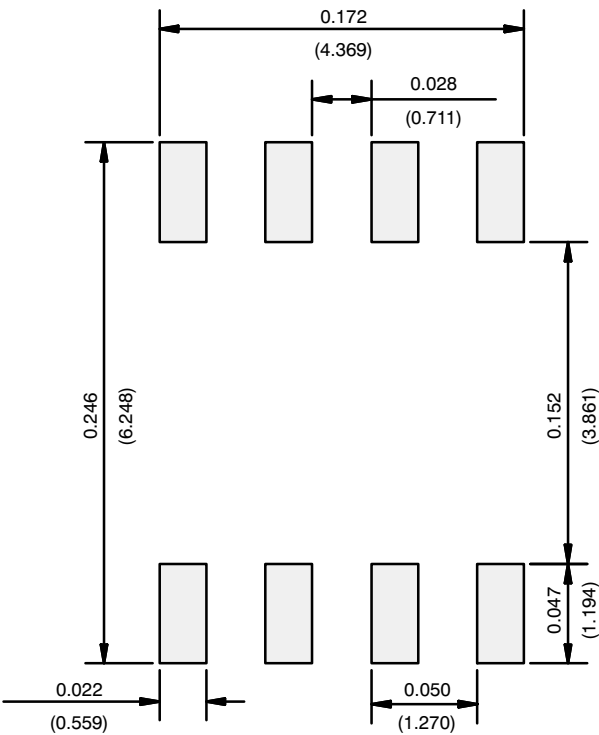
**Normalized Thermal Transient Impedance, Junction-to-Foot**

SOIC (NARROW): 8-LEAD  
JEDEC Part Number: MS-012



| DIM                                         | MILLIMETERS |      | INCHES    |       |
|---------------------------------------------|-------------|------|-----------|-------|
|                                             | Min         | Max  | Min       | Max   |
| A                                           | 1.35        | 1.75 | 0.053     | 0.069 |
| A <sub>1</sub>                              | 0.10        | 0.20 | 0.004     | 0.008 |
| B                                           | 0.35        | 0.51 | 0.014     | 0.020 |
| C                                           | 0.19        | 0.25 | 0.0075    | 0.010 |
| D                                           | 4.80        | 5.00 | 0.189     | 0.196 |
| E                                           | 3.80        | 4.00 | 0.150     | 0.157 |
| e                                           | 1.27 BSC    |      | 0.050 BSC |       |
| H                                           | 5.80        | 6.20 | 0.228     | 0.244 |
| h                                           | 0.25        | 0.50 | 0.010     | 0.020 |
| L                                           | 0.50        | 0.93 | 0.020     | 0.037 |
| q                                           | 0°          | 8°   | 0°        | 8°    |
| S                                           | 0.44        | 0.64 | 0.018     | 0.026 |
| ECN: C-06527-Rev. I, 11-Sep-06<br>DWG: 5498 |             |      |           |       |

RECOMMENDED MINIMUM PADS FOR SO-8



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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