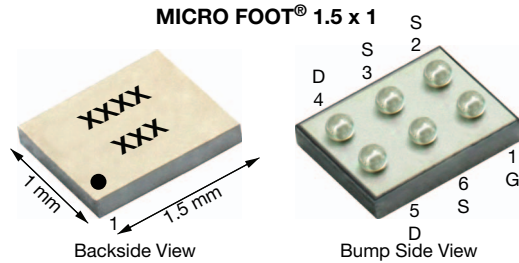


## P-Channel 20 V (D-S) MOSFET

| PRODUCT SUMMARY     |                                   |                                 |                       |
|---------------------|-----------------------------------|---------------------------------|-----------------------|
| V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)           | I <sub>D</sub> (A) <sup>e</sup> | Q <sub>g</sub> (TYP.) |
| -20                 | 0.032 at V <sub>GS</sub> = -4.5 V | -16                             | 14.5 nC               |
|                     | 0.046 at V <sub>GS</sub> = -2.5 V | -14.3                           |                       |
|                     | 0.065 at V <sub>GS</sub> = -2.0 V | -12                             |                       |
|                     | 0.120 at V <sub>GS</sub> = -1.8 V | -2.5                            |                       |



**Marking Code:** xxxx = 8499  
xxx = Date / lot traceability code

**Ordering Information:**  
Si8499DB-T2-E1 (Lead (Pb)-free and halogen-free)

### FEATURES

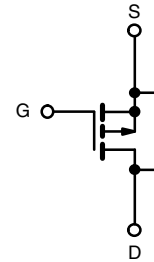
- TrenchFET® power MOSFET
- Ultra-small 1.5 mm x 1 mm maximum outline
- Ultra-thin 0.59 mm maximum height
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### APPLICATIONS

- Low on-resistance load switch, charger switch and battery switch for portable devices
- Low power consumption
- Increased battery life



P-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted) |                                   |                        |                      |
|---|-----------------------------------|------------------------|----------------------|
| PARAMETER   | SYMBOL                            | LIMIT                  | UNIT                 |
| Drain-Source Voltage  | V <sub>DS</sub>                   | -20                    | V                    |
| Gate-Source Voltage   | V <sub>GS</sub>                   | ± 12                   |                      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C)                        | I <sub>D</sub>                    | T <sub>C</sub> = 25 °C | -16                  |
|   |                                   | T <sub>C</sub> = 70 °C | -13.7                |
|   |                                   | T <sub>A</sub> = 25 °C | -7.8 <sup>a, b</sup> |
|   |                                   | T <sub>A</sub> = 70 °C | -6.3 <sup>a, b</sup> |
| Pulsed Drain Current  | I <sub>DM</sub>                   | -20                    | A                    |
| Continuous Source-Drain Diode Current                                     | I <sub>S</sub>                    | T <sub>C</sub> = 25 °C |                      |
|   |                                   | T <sub>A</sub> = 25 °C | -2.3 <sup>a, b</sup> |
| Maximum Power Dissipation   | P <sub>D</sub>                    | T <sub>C</sub> = 25 °C | 13                   |
|   |                                   | T <sub>C</sub> = 70 °C | 8.4                  |
|   |                                   | T <sub>A</sub> = 25 °C | 2.77 <sup>a, b</sup> |
|   |                                   | T <sub>A</sub> = 70 °C | 1.77 <sup>a, b</sup> |
| Operating Junction and Storage Temperature Range                          | T <sub>J</sub> , T <sub>stg</sub> | -55 to +150            | °C                   |
| Package Reflow Conditions <sup>c</sup>                                    | IR/Convection                     | 260                    |                      |

| THERMAL RESISTANCE RATINGS                  |                   |         |         |      |
|---|-------------------|---------|---------|------|
| PARAMETER                                   | SYMBOL            | TYPICAL | MAXIMUM | UNIT |
| Maximum Junction-to-Ambient <sup>a, f</sup> | R <sub>thJA</sub> | 37      | 45      | °C/W |
| Maximum Junction-to-Case (Drain)            | R <sub>thJC</sub> | 7       | 9.5     |      |

### Notes

- Surface mounted on 1" x 1" FR4 board.
- t = 10 s.
- Refer to IPC/JEDEC® (J-STD-020), no manual or hand soldering.
- Case is defined as the top surface of the package.
- Based on T<sub>C</sub> = 25 °C.
- Maximum under steady state conditions is 85 °C/W.



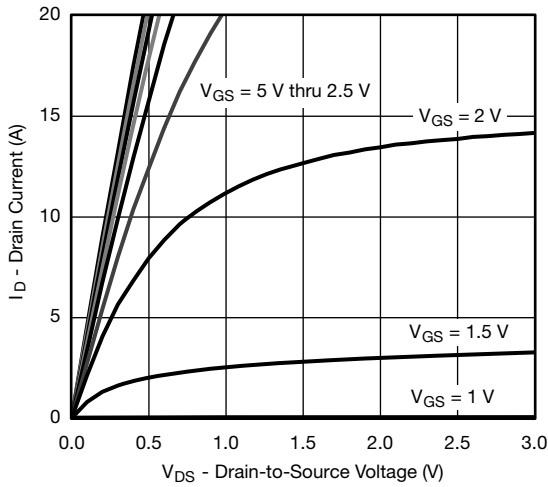
| SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted) |                                      |   |  |       |       |       |    |
|---|--------------------------------------|---|--|-------|-------|-------|----|
| PARAMETER   | SYMBOL                               | TEST CONDITIONS   | MIN.   | TYP.  | MAX.  | UNIT  |    |
| <b>Static</b>   |                                      |   |  |       |       |       |    |
| Drain-Source Breakdown Voltage                                  | V <sub>DS</sub>                      | V <sub>GS</sub> = 0, I <sub>D</sub> = -250 μA   | -20  | -     | -     | V     |    |
| V <sub>DS</sub> Temperature Coefficient                         | ΔV <sub>DS</sub> /T <sub>J</sub>     | I <sub>D</sub> = -250 μA  | -  | -20   | -     | mV/°C |    |
| V <sub>GS(th)</sub> Temperature Coefficient                     | ΔV <sub>GS(th)</sub> /T <sub>J</sub> |   | -  | 2.2   | -     |       |    |
| Gate-Source Threshold Voltage                                   | V <sub>GS(th)</sub>                  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA  | -0.5   | -     | -1.3  | V     |    |
| Gate-Source Leakage   | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 12 V   | -  | -     | ± 100 | nA    |    |
| Zero Gate Voltage Drain Current                                 | I <sub>DSS</sub>                     | V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V  | -  | -     | -1    | μA    |    |
|   |                                      | V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 70 °C  | -  | -     | -10   |       |    |
| On-State Drain Current <sup>a</sup>                             | I <sub>D(on)</sub>                   | V <sub>DS</sub> ≤ -5 V, V <sub>GS</sub> = -4.5 V  | -5   | -     | -     | A     |    |
| Drain-Source On-State Resistance <sup>a</sup>                   | R <sub>DS(on)</sub>                  | V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.5 A   | -  | 0.026 | 0.032 | Ω     |    |
|   |                                      | V <sub>GS</sub> = -2.5 V, I <sub>D</sub> = -1.5 A   | -  | 0.036 | 0.046 |       |    |
|   |                                      | V <sub>GS</sub> = -2 V, I <sub>D</sub> = -1 A   | -  | 0.048 | 0.065 |       |    |
|   |                                      | V <sub>GS</sub> = -1.8 V, I <sub>D</sub> = -0.5 A   | -  | 0.060 | 0.120 |       |    |
| Forward Transconductance <sup>a</sup>                           | g <sub>fs</sub>                      | V <sub>DS</sub> = -10 V, I <sub>D</sub> = -1.5 A  | -  | 10    | -     | S     |    |
| <b>Dynamic<sup>b</sup></b>                                      |                                      |   |  |       |       |       |    |
| Input Capacitance   | C <sub>ISS</sub>                     | V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V, f = 1 MHz   | -  | 1300  | -     | pF    |    |
| Output Capacitance  | C <sub>OSS</sub>                     |   | -  | 250   | -     |       |    |
| Reverse Transfer Capacitance                                    | C <sub>RSS</sub>                     |   | -  | 200   | -     |       |    |
| Total Gate Charge   | Q <sub>g</sub>                       | V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -5 V, I <sub>D</sub> = -1.5 A  | -  | 20    | 30    | nC    |    |
|   |                                      |   | V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.5 A | -     | 14.5  |       | 22 |
|   |                                      |   |  | -     | 2     |       | -  |
| Gate-Source Charge  | Q <sub>gs</sub>                      | V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.5 A  | -  | 4.1   | -     | Ω     |    |
| Gate-Drain Charge   | Q <sub>gd</sub>                      |   | -  | 7     | -     |       |    |
| Gate Resistance   | R <sub>g</sub>                       | V <sub>GS</sub> = -0.1 V, f = 1 MHz   | -  | 7     | -     | Ω     |    |
| Turn-On Delay Time  | t <sub>d(on)</sub>                   | V <sub>DD</sub> = -10 V, R <sub>L</sub> = 6.7 Ω<br>I <sub>D</sub> ≅ -1.5 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω | -  | 20    | 40    | ns    |    |
| Rise Time   | t <sub>r</sub>                       |   | -  | 25    | 50    |       |    |
| Turn-Off Delay Time   | t <sub>d(off)</sub>                  |   | -  | 50    | 100   |       |    |
| Fall Time   | t <sub>f</sub>                       |   | -  | 30    | 60    |       |    |
| Turn-On Delay Time  | t <sub>d(on)</sub>                   | V <sub>DD</sub> = -10 V, R <sub>L</sub> = 6.7 Ω<br>I <sub>D</sub> ≅ -1.5 A, V <sub>GEN</sub> = -10 V, R <sub>g</sub> = 1 Ω  | -  | 7     | 15    |       |    |
| Rise Time   | t <sub>r</sub>                       |   | -  | 10    | 20    |       |    |
| Turn-Off Delay Time   | t <sub>d(off)</sub>                  |   | -  | 55    | 110   |       |    |
| Fall Time   | t <sub>f</sub>                       |   | -  | 30    | 60    |       |    |
| <b>Drain-Source Body Diode Characteristics</b>                  |                                      |   |  |       |       |       |    |
| Continuous Source-Drain Diode Current                           | I <sub>S</sub>                       | T <sub>C</sub> = 25 °C  | -  | -     | -10.8 | A     |    |
| Pulse Diode Forward Current                                     | I <sub>SM</sub>                      |   | -  | -     | -20   |       |    |
| Body Diode Voltage  | V <sub>SD</sub>                      | I <sub>S</sub> = -1.5 A, V <sub>GS</sub> = 0  | -  | -0.8  | -1.2  | V     |    |
| Body Diode Reverse Recovery Time                                | t <sub>rr</sub>                      | I <sub>F</sub> = -1.5 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C   | -  | 40    | 80    | ns    |    |
| Body Diode Reverse Recovery Charge                              | Q <sub>rr</sub>                      |   | -  | 22    | 45    | nC    |    |
| Reverse Recovery Fall Time                                      | t <sub>a</sub>                       |   | -  | 15    | -     | ns    |    |
| Reverse Recovery Rise Time                                      | t <sub>b</sub>                       |   | -  | 25    | -     |       |    |

**Notes**

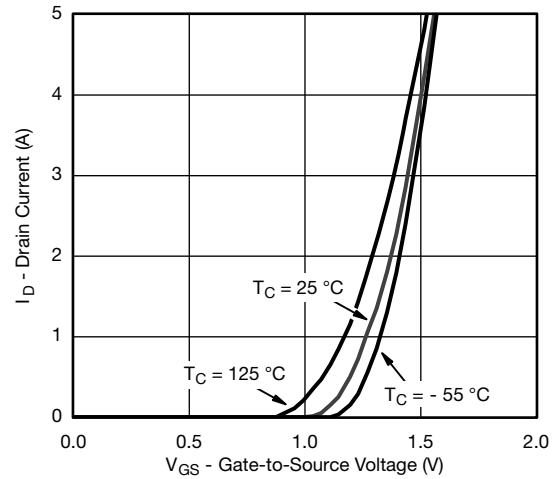
- a. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %.
- b. Guaranteed by design, not subject to production testing.

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

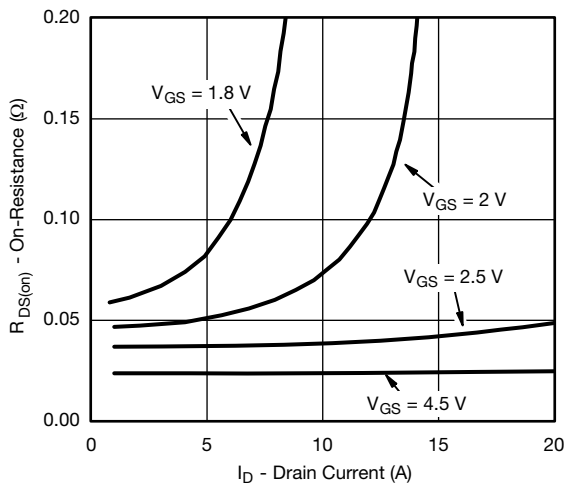
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



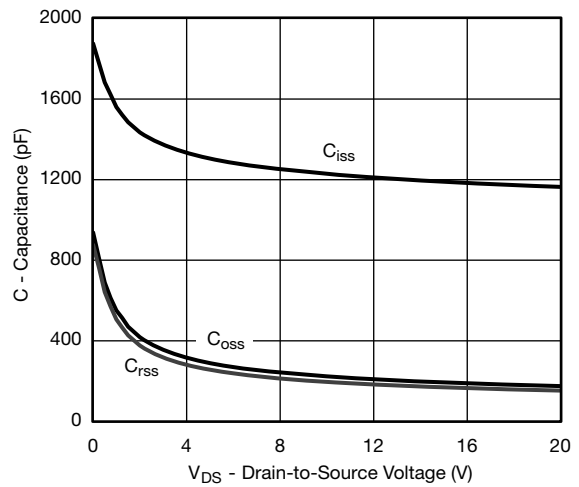
**Output Characteristics**



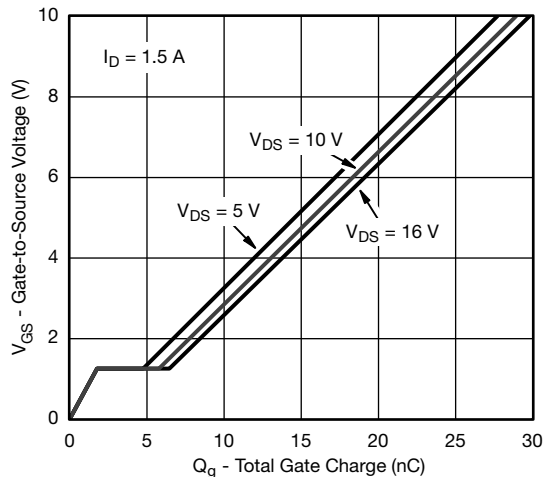
**Transfer Characteristics**



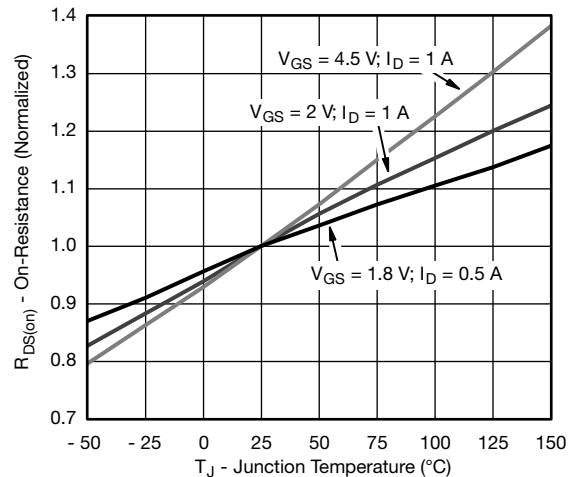
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



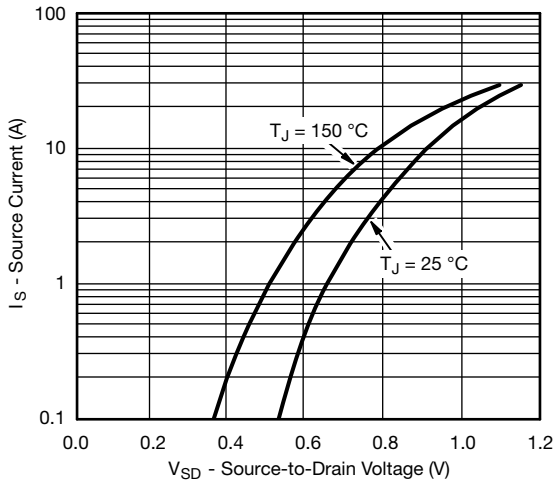
**Gate Charge**



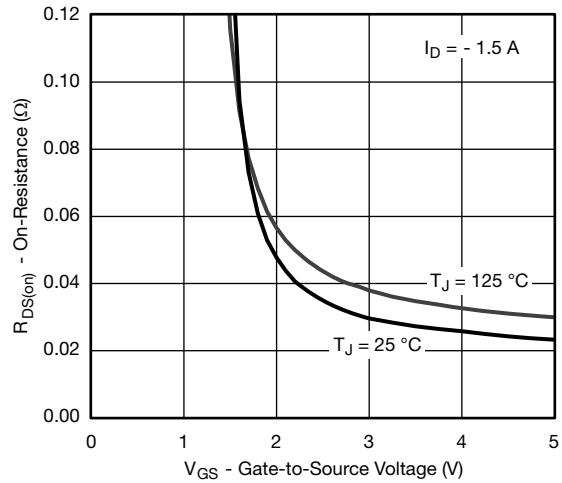
**On-Resistance vs. Junction Temperature**



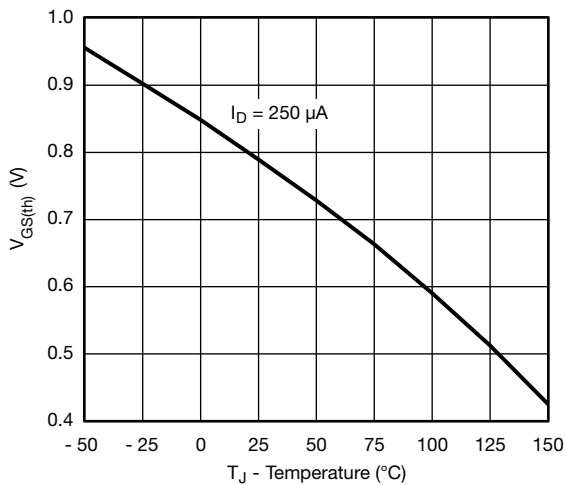
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



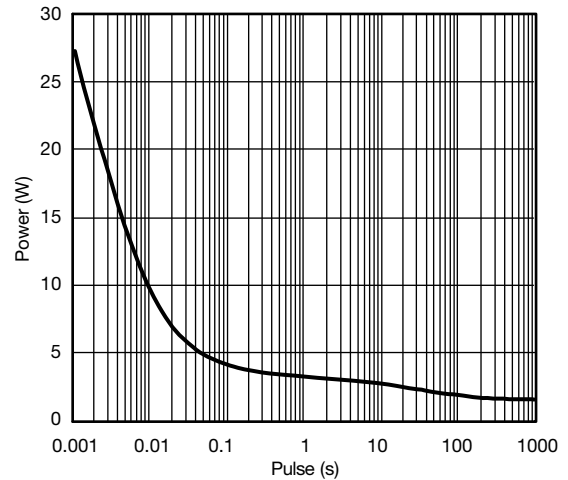
Source-Drain Diode Forward Voltage



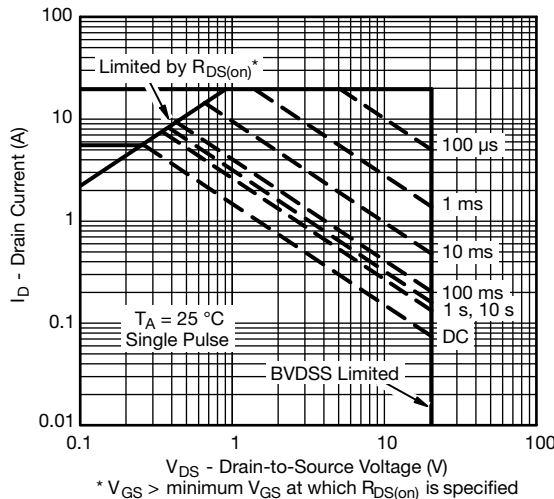
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



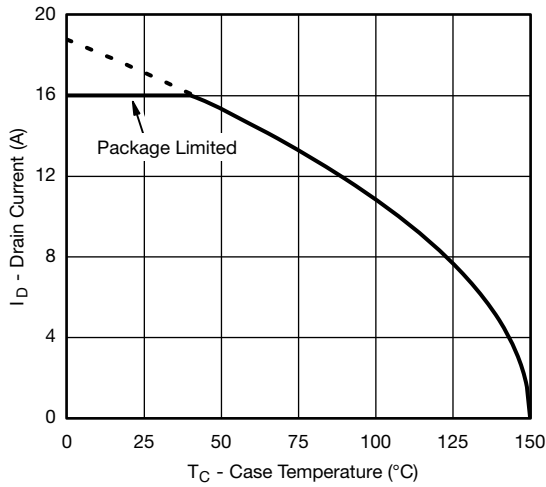
Single Pulse Power, Junction-to-Ambient



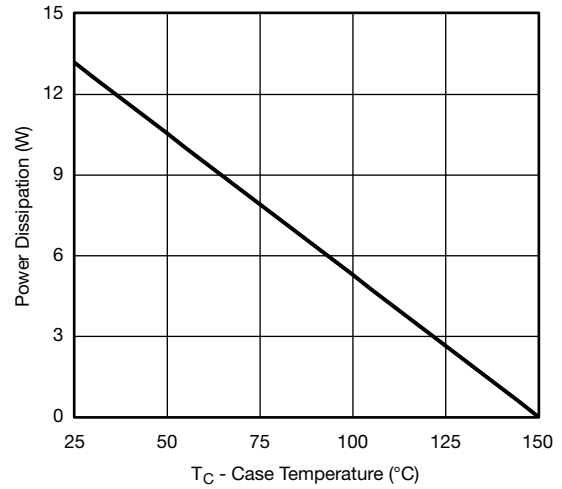
Safe Operating Area, Junction-to-Ambient



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



**Current Derating\***

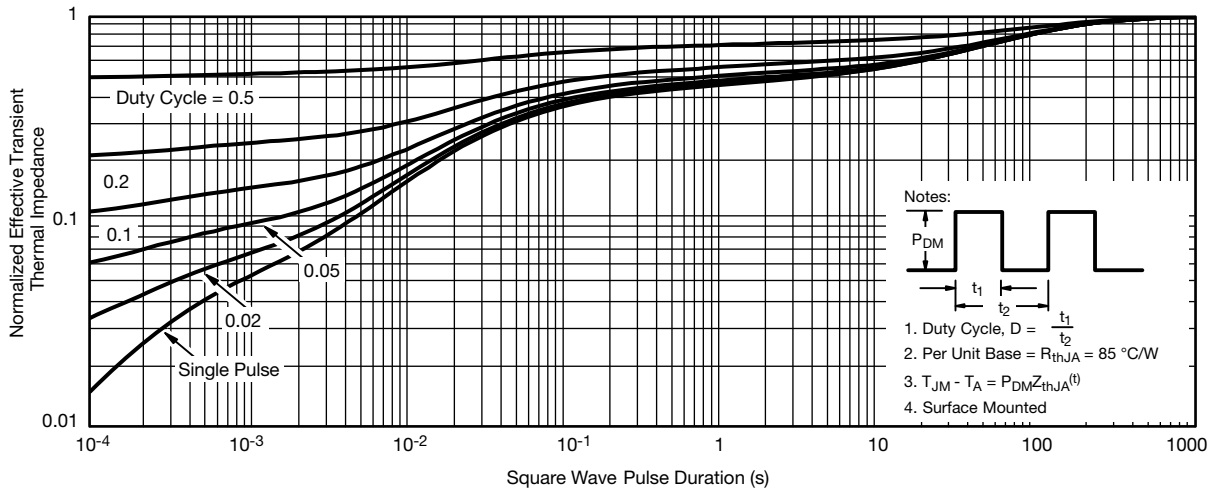


**Power Derating**

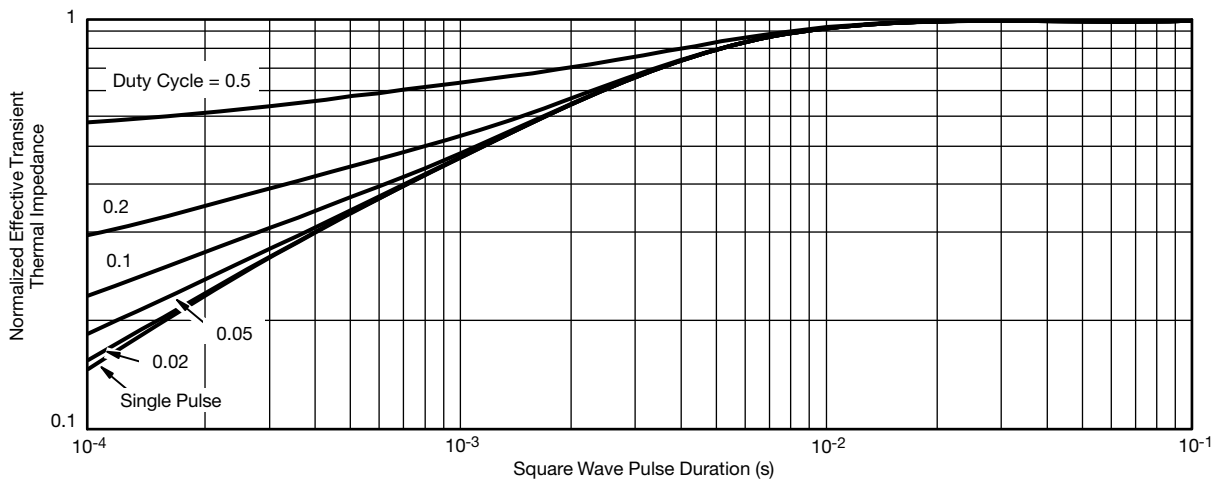
\* The power dissipation  $P_D$  is based on  $T_J$  (max.) = 150 °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package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



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



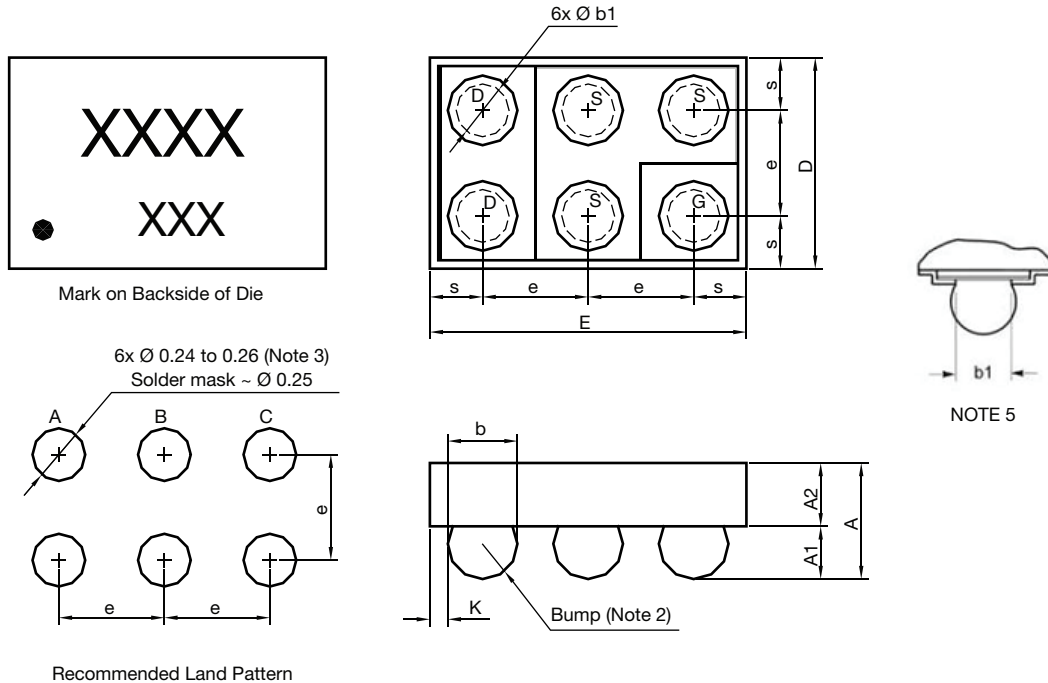
Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Case

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## MICRO FOOT<sup>®</sup>: 6-Bump (1.5 mm x 1 mm, 0.5 mm Pitch, 0.250 mm Bump Height)


**Notes**

(unless otherwise specified)

1. Six (6) solder bumps are 95.5/3.8/0.7 Sn/Ag/Cu.
2. Backside surface is coated with a Ti/Ni/Ag layer.
3. Non-solder mask defined copper landing pad.
4. Laser marks on the silicon die back.
5. "b1" is the diameter of the solderable substrate surface, defined by an opening in the solder resist layer solder mask defined.
6. • is the location of pin 1

| DIM.           | MILLIMETERS |       |       | INCHES |        |        |
|----------------|-------------|-------|-------|--------|--------|--------|
|                | MIN.        | NOM.  | MAX.  | MIN.   | NOM.   | MAX.   |
| A              | 0.510       | 0.575 | 0.590 | 0.0201 | 0.0226 | 0.0232 |
| A <sub>1</sub> | 0.220       | 0.250 | 0.280 | 0.0087 | 0.0098 | 0.0110 |
| A <sub>2</sub> | 0.290       | 0.300 | 0.310 | 0.0114 | 0.0118 | 0.0122 |
| b              | 0.297       | 0.330 | 0.363 | 0.0116 | 0.0129 | 0.0143 |
| b1             |             | 0.250 |       |        | 0.0098 |        |
| e              |             | 0.500 |       |        | 0.0197 |        |
| s              | 0.210       | 0.230 | 0.250 | 0.0082 | 0.0090 | 0.0098 |
| D              | 0.920       | 0.960 | 1.000 | 0.0362 | 0.0378 | 0.0394 |
| E              | 1.420       | 1.460 | 1.500 | 0.0559 | 0.0575 | 0.0591 |
| K              | 0.028       | 0.065 | 0.102 | 0.0011 | 0.0025 | 0.0040 |

**Note**

- Use millimeters as the primary measurement.

 ECN: T15-0140-Rev. A, 20-Apr-15  
 DWG: 6035



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