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

| PRODUCT SUMMARY | | | |
|---|---|---|---|
| $V_{DS}$ (V) | $R_{DS(on)}$ (Ω) | $I_D$ (A)[e] | $Q_g$ (Typ.) |
| - 20 | 0.084 at $V_{GS}$ = - 4.5 V | - 9.8 | 9.5 nC |
| | 0.100 at $V_{GS}$ = - 2.5 V | - 9.0 | |
| | 0.120 at $V_{GS}$ = - 1.8 V | - 5.0 | |
| | 0.155 at $V_{GS}$ = - 1.5 V | - 2.0 | |
| | 0.495 at $V_{GS}$ = - 1.2 V | - 0.5 | |

## FEATURES

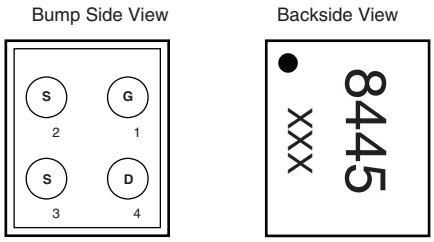
- TrenchFET® Power MOSFET
- Ultra Small 1.2 mm Length x 1 mm Width
- Ultra Thin 0.59 mm Height

Pb-free
RoHS COMPLIANT

## APPLICATIONS

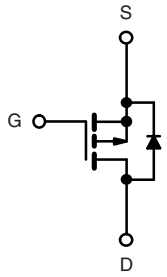
- Portable Devices
  - Battery Management
  - Low Threshold Load Switch
  - Battery Protection

**MICRO FOOT**




**Device Marking:** 8445
xxx = Date/Lot Traceability Code

**Ordering Information:** Si8445DB-T2-E1 (Lead (Pb)-free)




P-Channel MOSFET

| ABSOLUTE MAXIMUM RATINGS $T_A$ = 25 °C, unless otherwise noted | | | | |
|---|---|---|---|---|
| **Parameter** | | **Symbol** | **Limit** | **Unit** |
| Drain-Source Voltage | | $V_{DS}$ | - 20 | V |
| Gate-Source Voltage | | $V_{GS}$ | ± 5 | |
| Continuous Drain Current ($T_J$ = 150 °C) | $T_C$ = 25 °C | $I_D$ | - 9.8 | A |
| | $T_C$ = 70 °C | | - 7.9 | |
| | $T_A$ = 25 °C | | - 3.9[a, b] | |
| | $T_A$ = 70 °C | | - 3.1[a, b] | |
| Pulsed Drain Current | | $I_{DM}$ | - 10 | |
| Continuous Source-Drain Diode Current | $T_C$ = 25 °C | $I_S$ | - 9.5 | |
| | $T_A$ = 25 °C | | - 1.5[a, b] | |
| Maximum Power Dissipation | $T_C$ = 25 °C | $P_D$ | 11.4 | W |
| | $T_C$ = 70 °C | | 7.3 | |
| | $T_A$ = 25 °C | | 1.8[a, b] | |
| | $T_A$ = 70 °C | | 1.1[a, b] | |
| Operating Junction and Storage Temperature Range | | $T_J$, $T_{stg}$ | - 55 to 150 | °C |
| Package Reflow Conditions[c] | IR/Convection | | 260 | |

Notes:
a. Surface Mounted on 1" x 1" FR4 board.
b. t = 5 s.
c. Refer to IPC/JEDEC (J-STD-020C), no manual or hand soldering.
d. In this document, any reference to case represents the body of the MICRO FOOT device and foot is the bump.
e. Based on $T_C$ = 25 °C.

## THERMAL RESISTANCE RATINGS

| Parameter | | Symbol | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| Maximum Junction-to-Ambient[a, b] | | $R_{thJA}$ | 55 | 70 | °C/W |
| Maximum Junction-to-Foot (Drain) | Steady State | $R_{thJF}$ | 8.5 | 11 | |

Notes:
a. Surface Mounted on 1" x 1" FR4 board.
b. Maximum under Steady State conditions is 100 °C/W.
c. Case is defined as top surface of the package.

## SPECIFICATIONS $T_J$ = 25 °C, unless otherwise noted

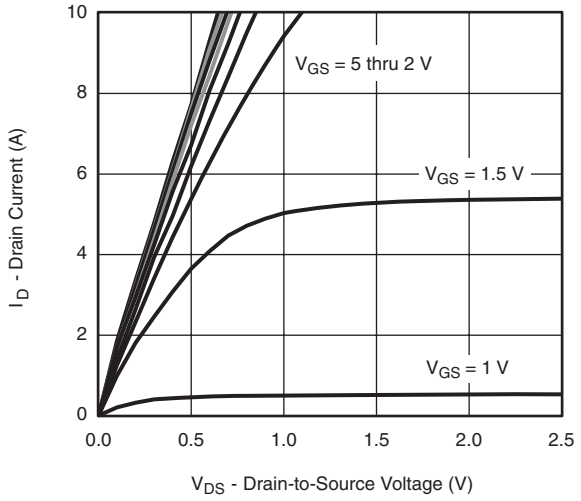
| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Static** | | | | | | |
| Drain-Source Breakdown Voltage | $V_{DS}$ | $V_{GS}$ = 0 V, $I_D$ = - 250 µA | - 20 | | | V |
| $V_{DS}$ Temperature Coefficient | $\Delta V_{DS}/T_J$ | $I_D$ = - 250 µA | | - 19 | | mV/°C |
| $V_{GS(th)}$ Temperature Coefficient | $\Delta V_{GS(th)}/T_J$ | | | 2.3 | | |
| Gate-Source Threshold Voltage | $V_{GS(th)}$ | $V_{DS}$ = $V_{GS}$, $I_D$ = - 250 µA | - 0.35 | | - 0.85 | V |
| Gate-Source Leakage | $I_{GSS}$ | $V_{DS}$ = 0 V, $V_{GS}$ = ± 5 V | | | ± 100 | nA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | $V_{DS}$ = - 20 V, $V_{GS}$ = 0 V | | | - 1 | µA |
| | | $V_{DS}$ = - 20 V, $V_{GS}$ = 0 V, $T_J$ = 70 °C | | | - 10 | |
| On-State Drain Current[a] | $I_{D(on)}$ | $V_{DS} \leq$ - 5 V, $V_{GS}$ = - 4.5 V | - 5 | | | A |
| Drain-Source On-State Resistance[a] | $R_{DS(on)}$ | $V_{GS}$ = - 4.5 V, $I_D$ = - 1 A | | 0.070 | 0.084 | Ω |
| | | $V_{GS}$ = - 2.5 V, $I_D$ = - 1 A | | 0.082 | 0.100 | |
| | | $V_{GS}$ = - 1.8 V, $I_D$ = - 1 A | | 0.097 | 0.120 | |
| | | $V_{GS}$ = - 1.5 V, $I_D$ = - 0.7 A | | 0.115 | 0.155 | |
| | | $V_{GS}$ = - 1.2 V, $I_D$ = - 0.2 A | | 0.165 | 0.495 | |
| Forward Transconductance[a] | $g_{fs}$ | $V_{DS}$ = - 10 V, $I_D$ = - 1 A | | 6.5 | | S |
| **Dynamic[b]** | | | | | | |
| Input Capacitance | $C_{iss}$ | $V_{DS}$ = - 10 V, $V_{GS}$ = 0 V, f = 1 MHz | | 700 | | pF |
| Output Capacitance | $C_{oss}$ | | | 130 | | |
| Reverse Transfer Capacitance | $C_{rss}$ | | | 80 | | |
| Total Gate Charge | $Q_g$ | $V_{DS}$ = - 10 V, $V_{GS}$ = - 5 V, $I_D$ = - 1 A | | 10.5 | 16 | nC |
| | | $V_{DS}$ = - 10 V, $V_{GS}$ = - 4.5 V, $I_D$ = 1 A | | 9.5 | 15 | |
| Gate-Source Charge | $Q_{gs}$ | | | 0.9 | | |
| Gate-Drain Charge | $Q_{gd}$ | | | 2.2 | | |
| Gate Resistance | $R_g$ | $V_{GS}$ = - 0.1 V, f = 1 MHz | | 5.5 | | Ω |
| Turn-On Delay Time | $t_{d(on)}$ | $V_{DD}$ = - 10 V, $R_L$ = 10 Ω<br>$I_D \cong$ - 1 A, $V_{GEN}$ = - 4.5 V, $R_g$ = 1 Ω | | 11 | 20 | ns |
| Rise Time | $t_r$ | | | 25 | 40 | |
| Turn-Off Delay Time | $t_{d(off)}$ | | | 37 | 55 | |
| Fall Time | $t_f$ | | | 10 | 15 | |

| **SPECIFICATIONS** $T_J$ = 25 °C, unless otherwise noted | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Test Conditions** | **Min.** | **Typ.** | **Max.** | **Unit** |
| **Drain-Source Body Diode Characteristics** | | | | | | |
| Continuous Source-Drain Diode Current | $I_S$ | $T_C$ = 25 °C | | | - 9.5 | A |
| Pulse Diode Forward Current | $I_{SM}$ | | | | - 10 | |
| Body Diode Voltage | $V_{SD}$ | $I_S$ = - 1 A, $V_{GS}$ = 0 V | | - 0.7 | - 1.2 | V |
| Body Diode Reverse Recovery Time | $t_{rr}$ | $I_F$ = - 1 A, dI/dt = 100 A/µs, $T_J$ = 25 °C | | 25 | 50 | ns |
| Body Diode Reverse Recovery Charge | $Q_{rr}$ | | | 10 | 20 | nC |
| Reverse Recovery Fall Time | $t_a$ | | | 9 | | ns |
| Reverse Recovery Rise Time | $t_b$ | | | 16 | | |

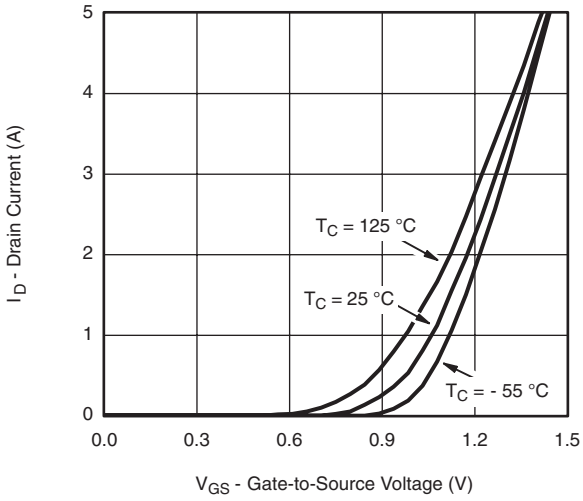
Notes:
a. Pulse test; pulse width ≤ 300 µs, duty cycle ≤ 2 %.
b. Guaranteed by design, not subject to production testing.

*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.*

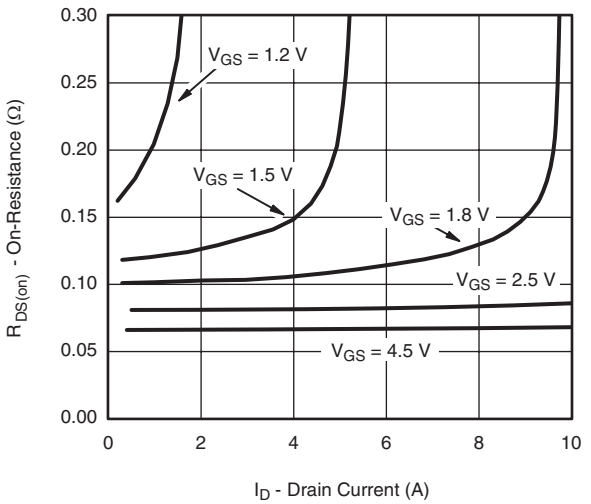
## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



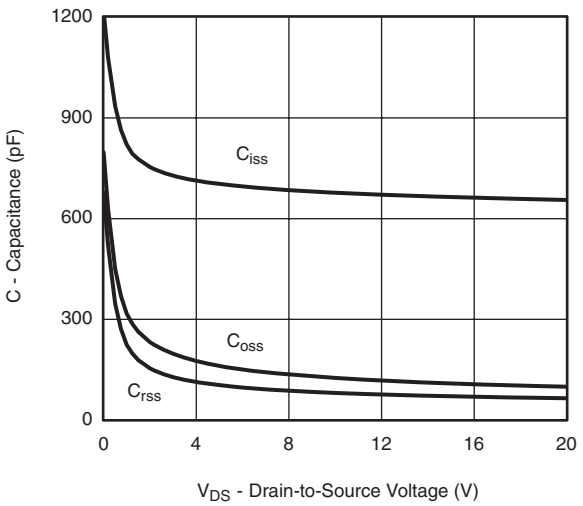

**Output Characteristics**



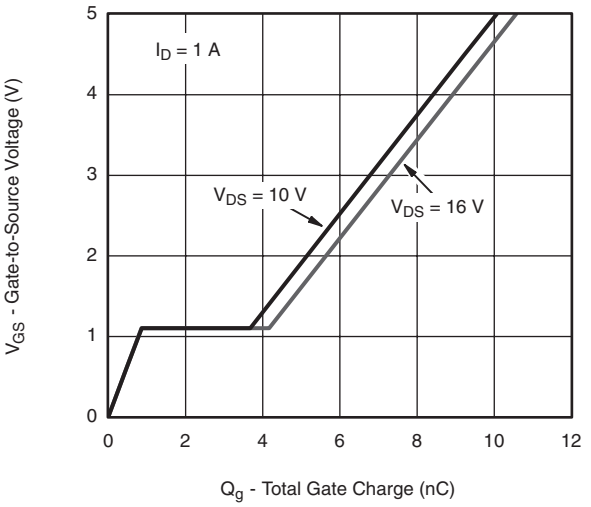

**Transfer Characteristics**



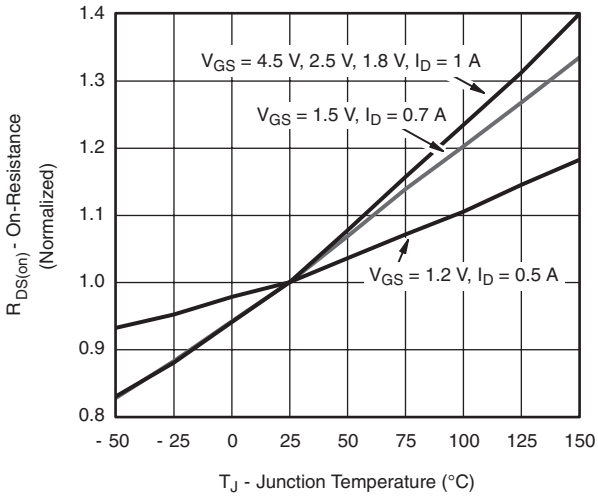

**On-Resistance vs. Drain Current and Gate Voltage**




**Capacitance**

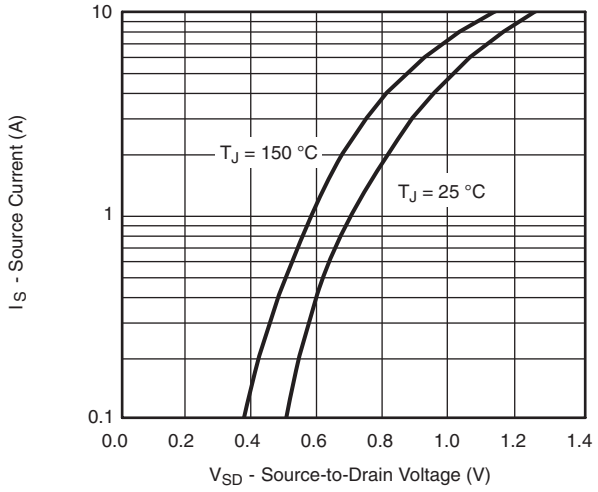



**Gate Charge**

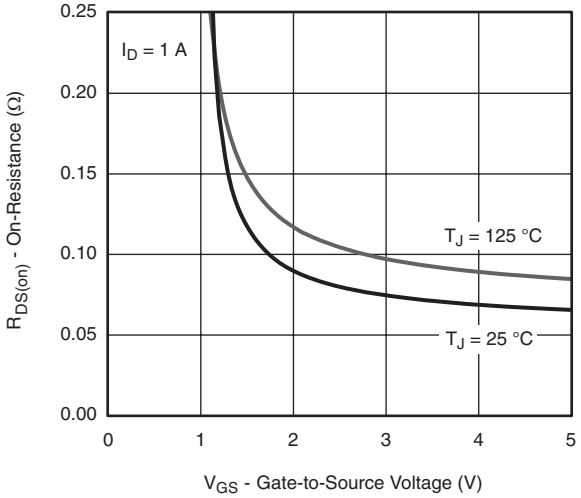



**On-Resistance vs. Junction Temperature**

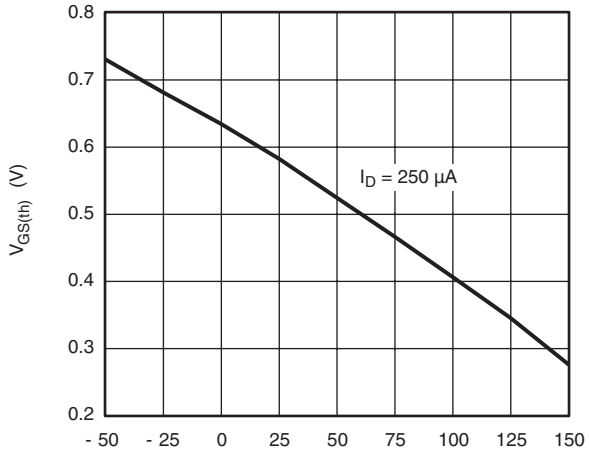
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



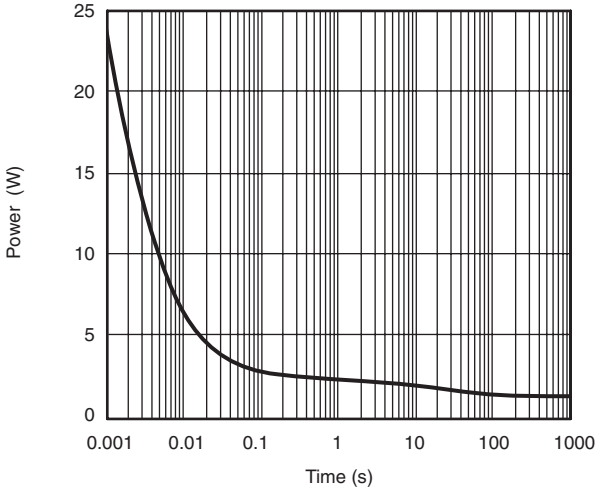

**Source-Drain Diode Forward Voltage**



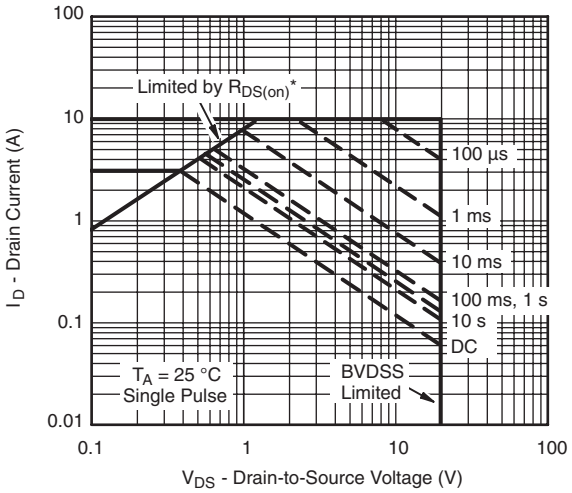

**On-Resistance vs. Gate-to-Source Voltage**




**Threshold Voltage**



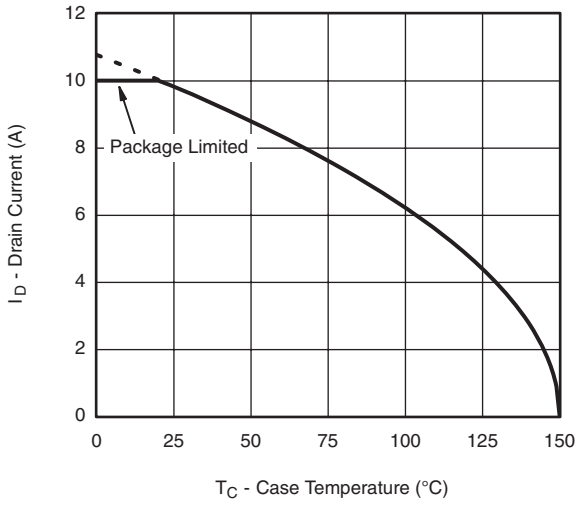

**Single Pulse Power, Junction-to-Ambient**



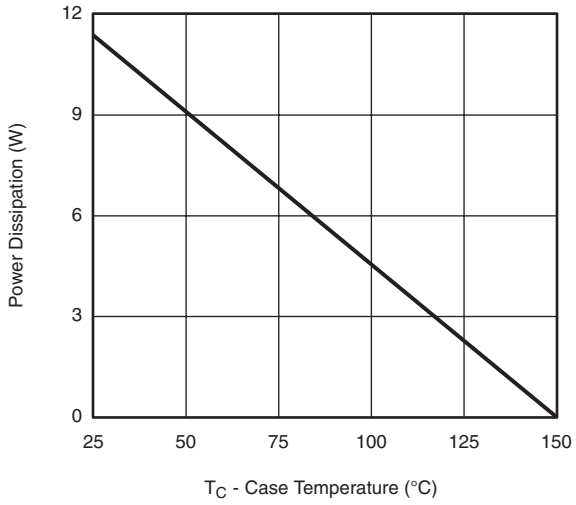

* $V_{GS}$ > minimum $V_{GS}$ at which $R_{DS(on)}$ is specified

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

## TYPICAL CHARACTERISTICS 25 °C, unless otherwise noted



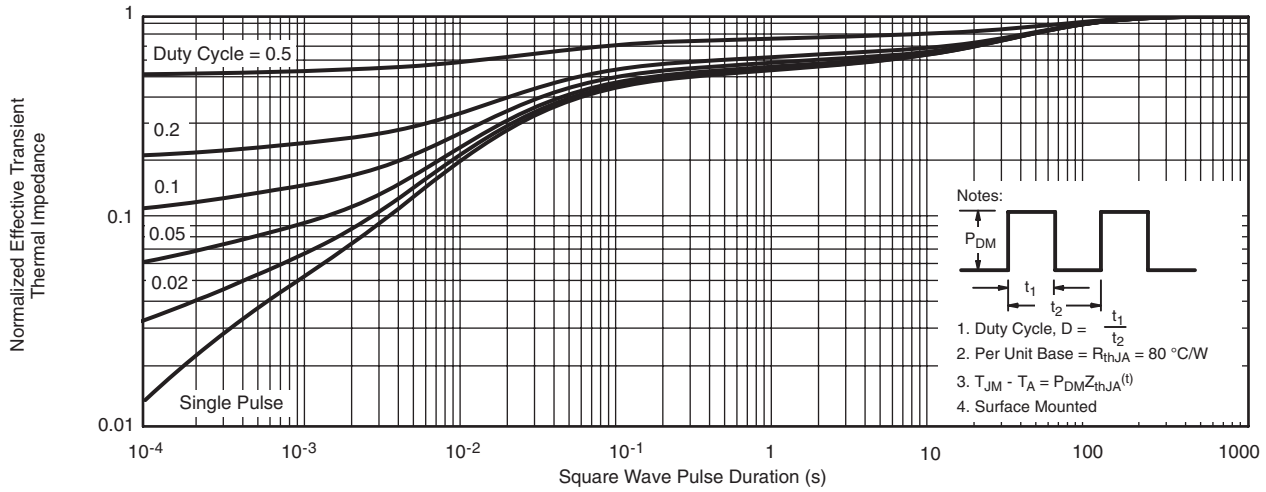

**Current Derating***



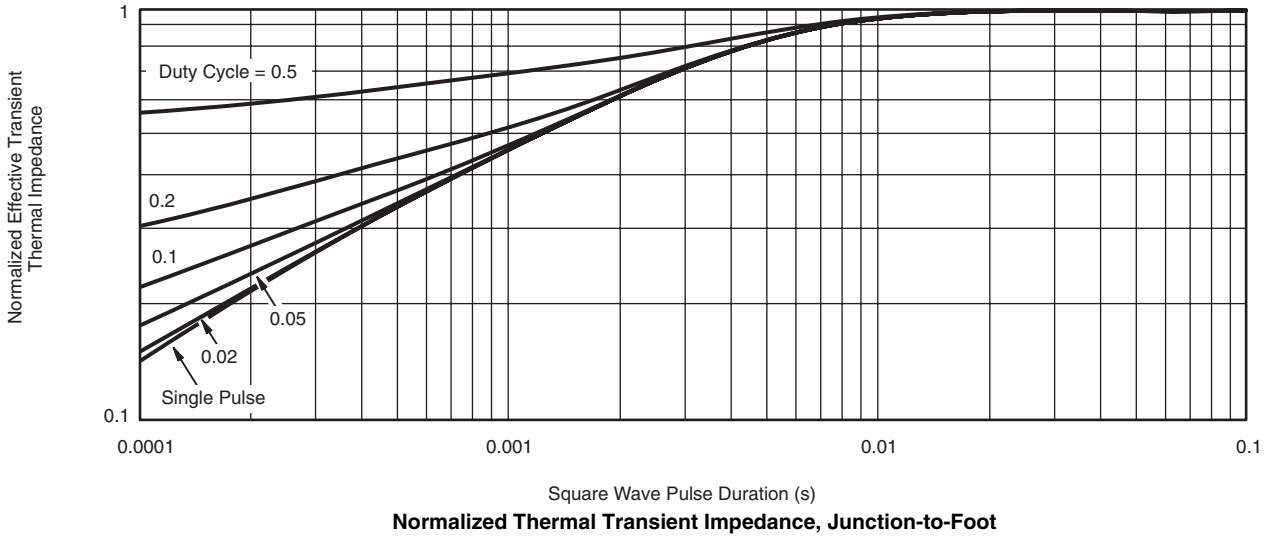

**Power Derating**

* 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



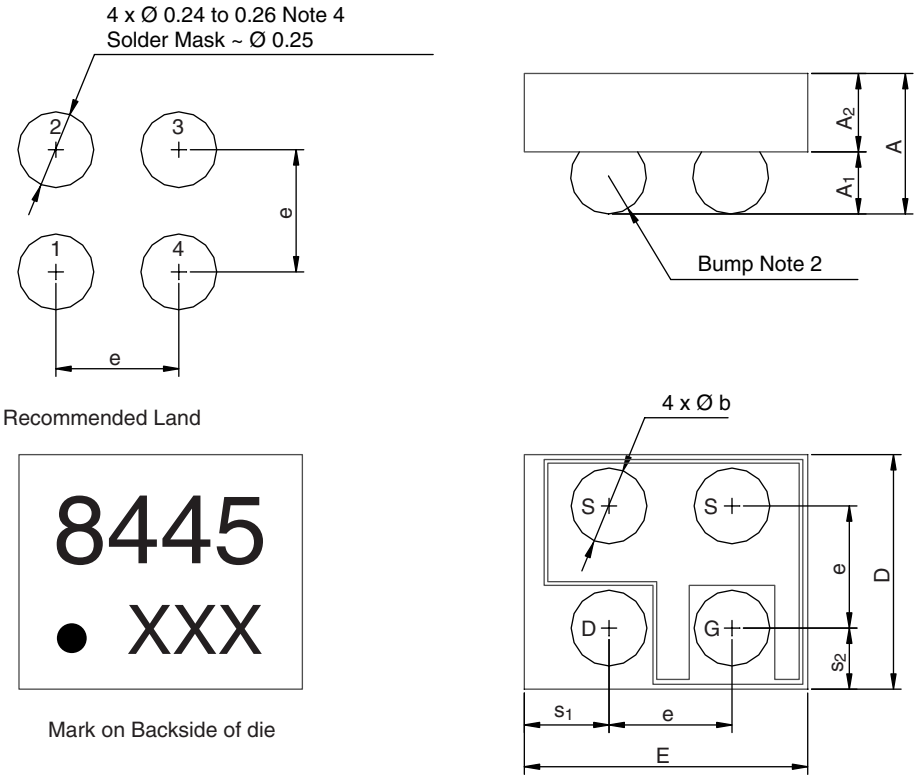

**Normalized Thermal Transient Impedance, Junction-to-Ambient**




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

## PACKAGE OUTLINE

### MICRO FOOT: 4-BUMP (2 x 2, 0.5 mm PITCH)




Notes (Unless otherwise specified):
1. All dimensions are in millimeters.
2. Four (4) solder bumps are lead (Pb)-free 95.5Sn/3.8Ag/0.7Cu with diameter ∅ 0.30 to 0.32 mm.
3. Backside surface is coated with a Ti/Ni/Ag layer.
4. Non-solder mask defined copper landing pad.
5. • is location of pin 1.

| Dim. | Millimeters[a] | | | Inches | | |
|---|---|---|---|---|---|---|
| | Min. | Nom. | Max. | Min. | Nom. | Max. |
| **A** | 0.510 | 0.550 | 0.590 | 0.0201 | 0.0217 | 0.0232 |
| **$A_1$** | 0.220 | 0.250 | 0.280 | 0.0087 | 0.0098 | 0.0110 |
| **$A_2$** | 0.290 | 0.300 | 0.310 | 0.0114 | 0.0118 | 0.0122 |
| **b** | 0.300 | 0.310 | 0.320 | 0.0118 | 0.0122 | 0.0126 |
| **e** | | 0.500 | | | 0.0197 | |
| **$s_1$** | 0.330 | 0.340 | 0.350 | 0.0130 | 0.0134 | 0.0138 |
| **$s_2$** | 0.230 | 0.240 | 0.250 | 0.0090 | 0.0094 | 0.0098 |
| **D** | 0.960 | 0.980 | 1.000 | 0.0378 | 0.0388 | 0.0394 |
| **E** | 1.160 | 1.180 | 1.200 | 0.0457 | 0.0465 | 0.0472 |

Notes:
a. Use millimeters as the primary measurement.

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