

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

PRODUCT SUMMARY			
$V_{DS}$ (V)	$R_{DS(on)}$ ( $\Omega$ )	$I_D$ (A) <sup>a, e</sup>	$Q_g$ (Typ.)
- 20	0.100 at $V_{GS} = - 4.5$ V	- 3.7	9.5 nC
	0.118 at $V_{GS} = - 2.5$ V	- 3.4	
	0.140 at $V_{GS} = - 1.8$ V	- 3.1	
	0.205 at $V_{GS} = - 1.5$ V	- 2	

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET<sup>®</sup> Power MOSFET
- Compliant to RoHS Directive 2002/95/EC

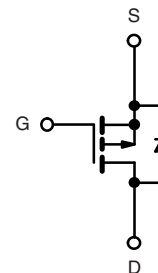
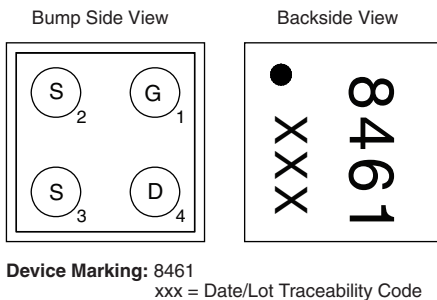


**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- Load Switch
- Battery Switch
- Charger Switch

### MICRO FOOT



P-Channel MOSFET

**Ordering Information:** Si8461DB-T2-E1 (Lead (Pb)-free and Halogen-free)

ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °C, unless otherwise noted				
Parameter	Symbol	Limit	Unit	
Drain-Source Voltage	$V_{DS}$	- 20	V	
Gate-Source Voltage	$V_{GS}$	$\pm 8$		
Continuous Drain Current ( $T_J = 150$ °C)	$I_D$	$T_A = 25$ °C	- 3.7 <sup>a</sup>	A
		$T_A = 70$ °C	- 3 <sup>a</sup>	
		$T_A = 25$ °C	- 2.5 <sup>b</sup>	
		$T_A = 70$ °C	- 1.9 <sup>b</sup>	
Pulsed Drain Current	$I_{DM}$	- 20		
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25$ °C	- 1.5 <sup>a</sup>	
		$T_A = 25$ °C	- 0.65 <sup>b</sup>	
Maximum Power Dissipation	$P_D$	$T_A = 25$ °C	1.8 <sup>a</sup>	W
		$T_A = 70$ °C	1.1 <sup>a</sup>	
		$T_A = 25$ °C	0.78 <sup>b</sup>	
		$T_A = 70$ °C	0.5 <sup>b</sup>	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to 150		
Package Reflow Conditions <sup>c</sup>	VPR	260	°C	
	IR/Convection	260		

**Notes:**

- Surface mounted on 1" x 1" FR4 board with full copper,  $t = 10$  s.
- Surface mounted on 1" x 1" FR4 board with minimum copper,  $t = 10$  s.
- Refer to IPC/JEDEC (J-STD-020C), no manual or hand soldering.
- In this document, any reference to case represents the body of the MICRO FOOT device and foot is the bump.
- Based on  $T_A = 25$  °C.

**THERMAL RESISTANCE RATINGS**

Parameter		Symbol	Typical	Maximum	Unit
Maximum Junction-to-Ambient <sup>a, b</sup>	$t = 10 \text{ s}$	$R_{thJA}$	55	70	°C/W
Maximum Junction-to-Ambient <sup>c, d</sup>	$t = 10 \text{ s}$		125	160	

Notes:

- a. Surface mounted on 1" x 1" FR4 board with full copper.  
b. Maximum under steady state conditions is 100 °C/W.  
c. Surface mounted on 1" x 1" FR4 board with minimum copper.  
d. Maximum under steady state conditions is 190 °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	$V_{DS}$	$V_{GS} = 0 \text{ V}, I_D = -250 \mu\text{A}$	-20			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = -250 \mu\text{A}$		-12		mV/°C
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$		2.5			
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250 \mu\text{A}$	-0.4		-1.0	V
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0 \text{ V}, V_{GS} = \pm 8 \text{ V}$			$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = -20 \text{ V}, V_{GS} = 0 \text{ V}$			-1	$\mu\text{A}$
		$V_{DS} = -20 \text{ V}, V_{GS} = 0 \text{ V}, T_J = 70 \text{ }^\circ\text{C}$			-10	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \leq -5 \text{ V}, V_{GS} = -4.5 \text{ V}$	-10			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -4.5 \text{ V}, I_D = -1.5 \text{ A}$		0.083	0.100	$\Omega$
		$V_{GS} = -2.5 \text{ V}, I_D = -1.5 \text{ A}$		0.098	0.118	
		$V_{GS} = -1.8 \text{ V}, I_D = -1 \text{ A}$		0.115	0.140	
		$V_{GS} = -1.5 \text{ V}, I_D = -0.5 \text{ A}$		0.136	0.205	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = -10 \text{ V}, I_D = -1 \text{ A}$		7		S
<b>Dynamic<sup>b</sup></b>						
Input Capacitance	$C_{iss}$	$V_{DS} = -10 \text{ V}, V_{GS} = 0 \text{ V}, f = 1 \text{ MHz}$		610		pF
Output Capacitance	$C_{oss}$		120			
Reverse Transfer Capacitance	$C_{rss}$		95			
Total Gate Charge	$Q_g$	$V_{DS} = -10 \text{ V}, V_{GS} = -8 \text{ V}, I_D = -1 \text{ A}$		16	24	nC
				9.5	15	
Gate-Source Charge	$Q_{gs}$	$V_{DS} = -10 \text{ V}, V_{GS} = -4.5 \text{ V}, I_D = 1 \text{ A}$		0.9		
Gate-Drain Charge	$Q_{gd}$		2.6			
Gate Resistance	$R_g$	$V_{GS} = -0.1 \text{ V}, f = 1 \text{ MHz}$		6.5		$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -10 \text{ V}, R_L = 10 \Omega$ $I_D \cong -1 \text{ A}, V_{GEN} = -4.5 \text{ V}, R_g = 1 \Omega$		15	25	ns
Rise Time	$t_r$		25	40		
Turn-Off Delay Time	$t_{d(off)}$		35	55		
Fall Time	$t_f$		10	15		
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -10 \text{ V}, R_L = 10 \Omega$ $I_D \cong -1 \text{ A}, V_{GEN} = -8 \text{ V}, R_g = 1 \Omega$		7	15	
Rise Time	$t_r$		12	20		
Turn-Off Delay Time	$t_{d(off)}$		32	50		
Fall Time	$t_f$		12	20		

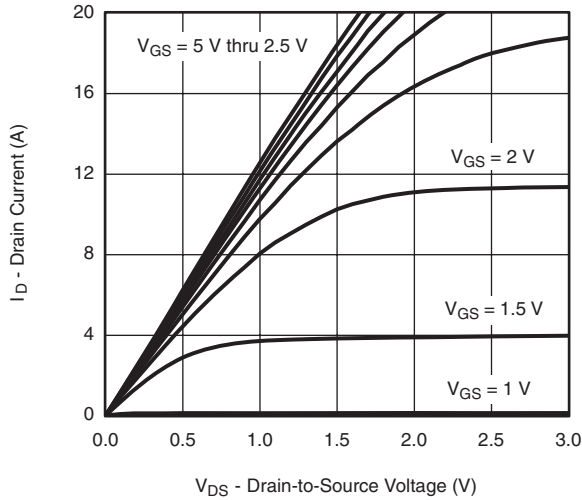
<b>SPECIFICATIONS</b> $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	$I_S$	$T_A = 25\text{ }^\circ\text{C}$			- 1.5	A
Pulse Diode Forward Current	$I_{SM}$				- 20	
Body Diode Voltage	$V_{SD}$	$I_S = - 1\text{ A}, V_{GS} = 0\text{ V}$		- 0.8	- 1.2	V
Body Diode Reverse Recovery Time	$t_{rr}$	$I_F = - 1\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$		15	30	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$			10	20	nC
Reverse Recovery Fall Time	$t_a$			9		ns
Reverse Recovery Rise Time	$t_b$			6		

Notes:

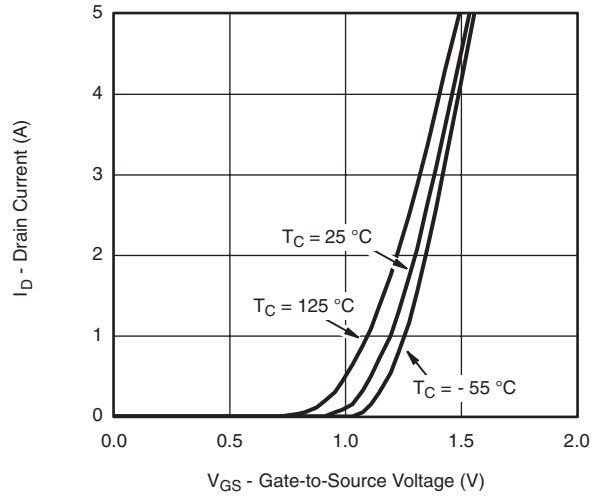
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- b. Guaranteed by design, not subject to production testing.

*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.*

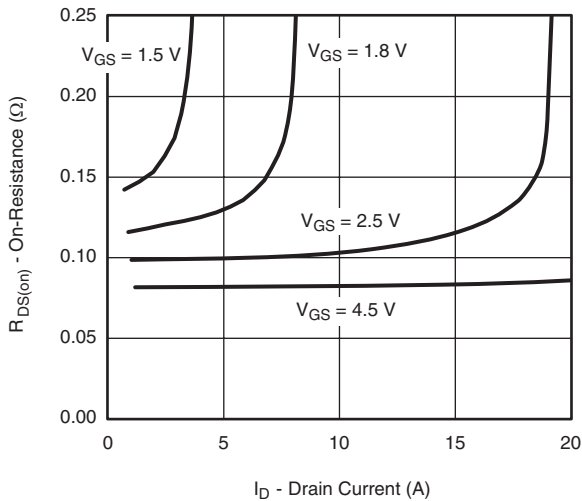
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



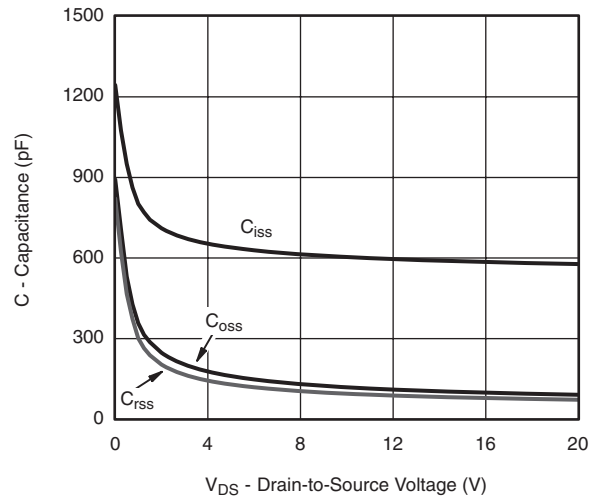
**Output Characteristics**



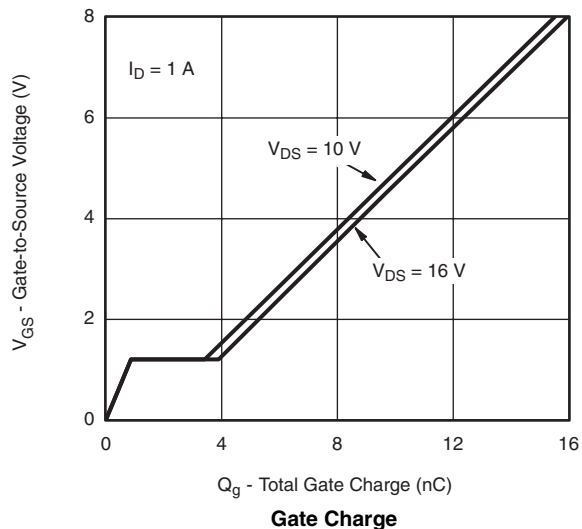
**Transfer Characteristics**



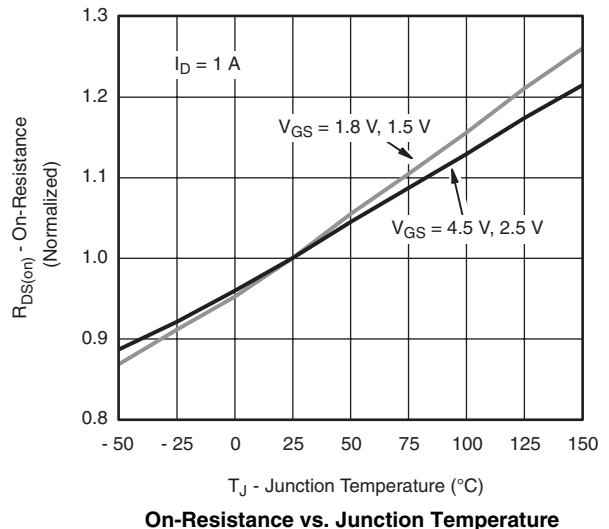
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**

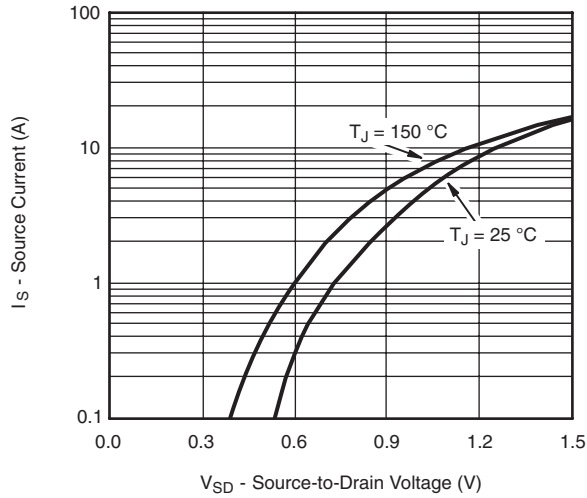


**Gate Charge**

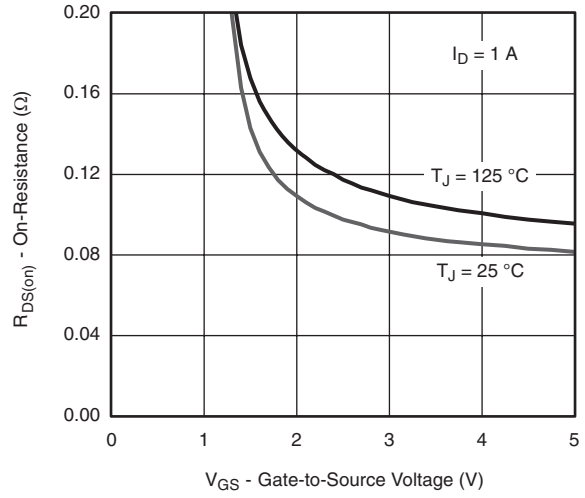


**On-Resistance vs. Junction Temperature**

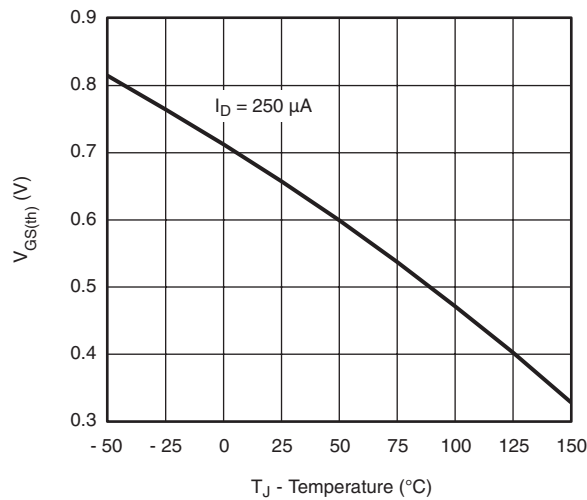
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



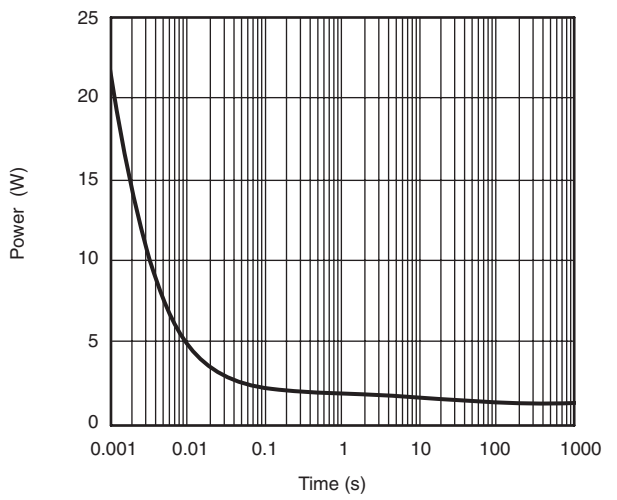
**Source-Drain Diode Forward Voltage**



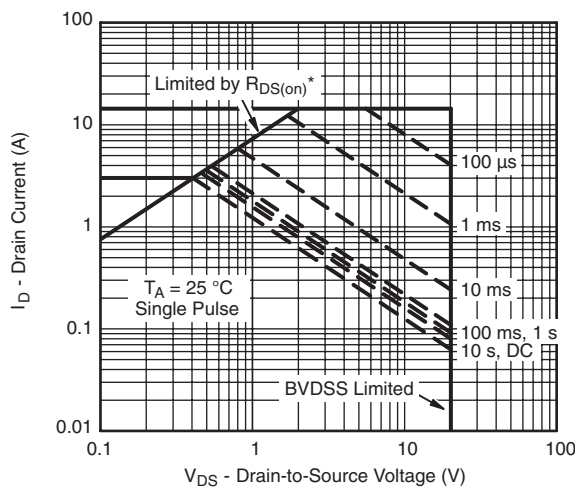
**On-Resistance vs. Gate-to-Source Voltage**



**Threshold Voltage**

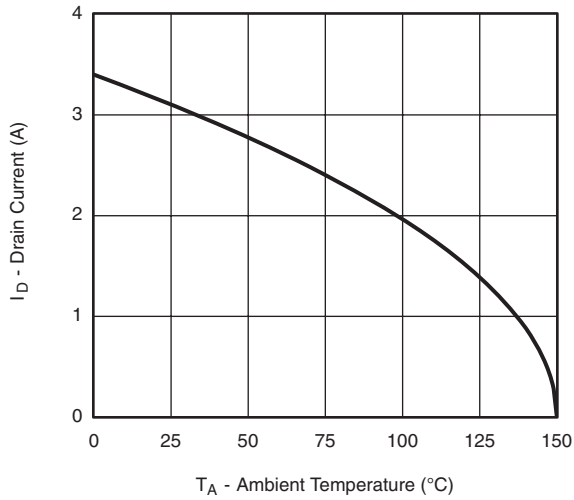


**Single Pulse Power, Junction-to-Ambient**

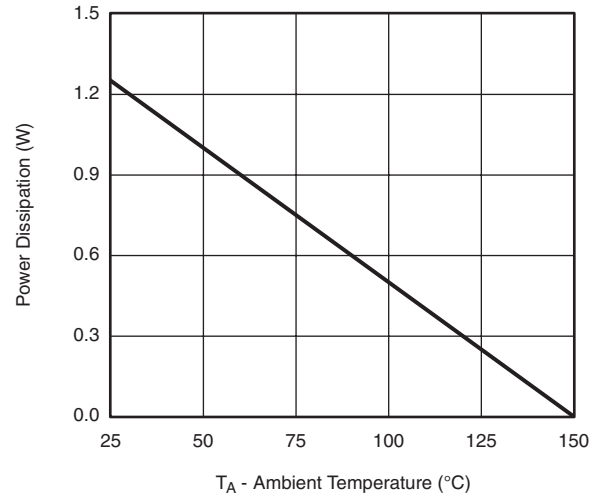


**Safe Operating Area, Junction-to-Ambient**  
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

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



**Current Derating\***



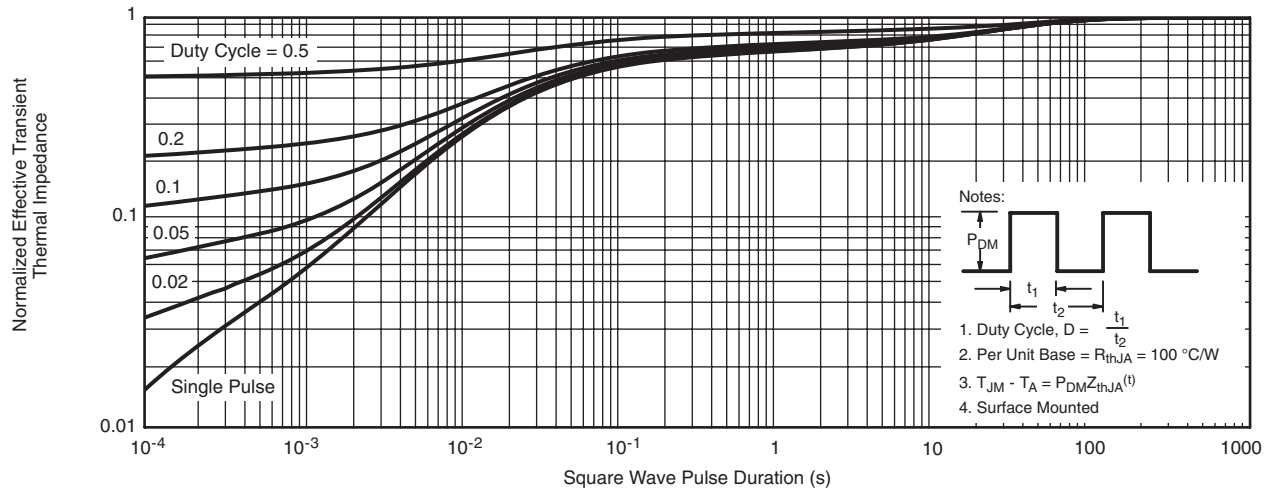
**Power Derating**

Note:

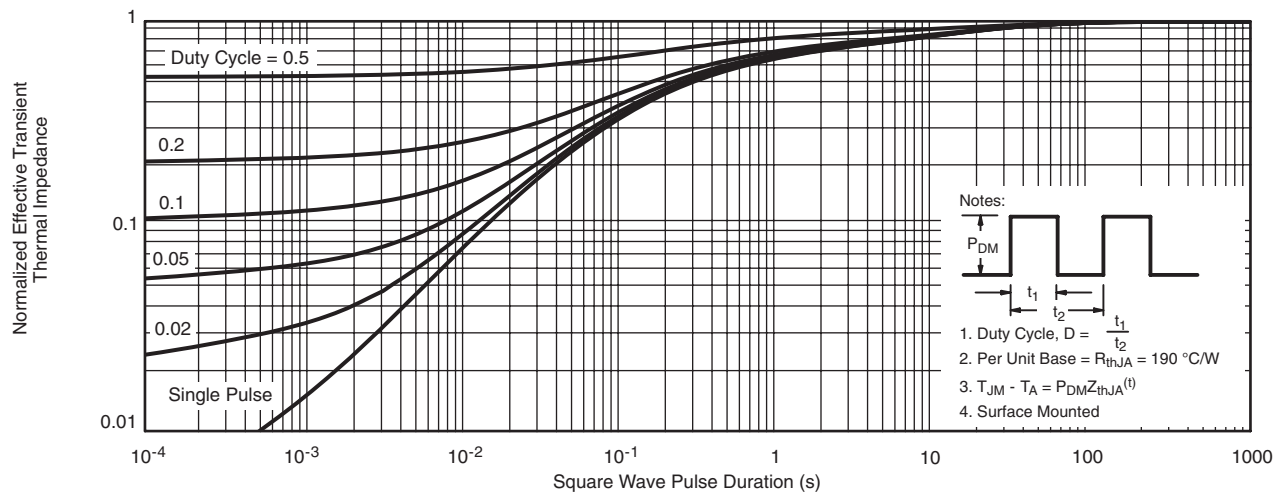
When Mounted on 1" x 1" FR4 with Full Copper.

\* 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.

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



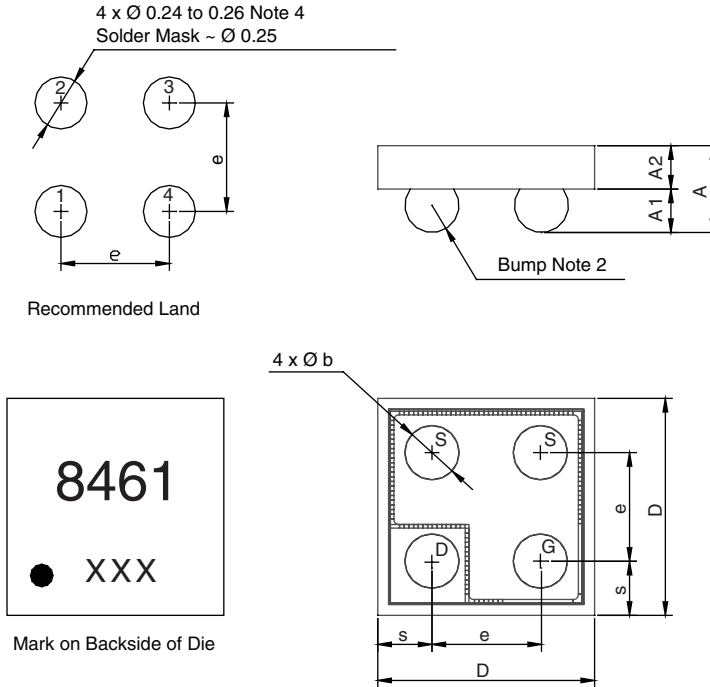
**Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Full Copper)**



**Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Minimum Copper)**

## 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  $\varnothing$  0.30 mm 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 <sup>a</sup>			Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	0.462	0.505	0.548	0.0181	0.0198	0.0215
A <sub>1</sub>	0.220	0.250	0.280	0.0086	0.0098	0.0110
A <sub>2</sub>	0.242	0.255	0.268	0.0095	0.0100	0.0105
b	0.300	0.310	0.320	0.0118	0.0122	0.0126
e	0.500			0.0197		
s	0.230	0.250	0.270	0.0090	0.0098	0.0106
D	0.920	0.960	1.000	0.0362	0.0378	0.0394

Notes:

- a. Use millimeters as the primary measurement.

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