

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

PRODUCT SUMMARY			
V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω) MAX.	I <sub>D</sub> (A) <sup>a, e</sup>	Q <sub>g</sub> (TYP.)
-20	0.044 at V <sub>GS</sub> = -10 V	-5.4	9.5 nC
	0.054 at V <sub>GS</sub> = -4.5 V	-4.9	
	0.082 at V <sub>GS</sub> = -2.5 V	-3.9	

### FEATURES

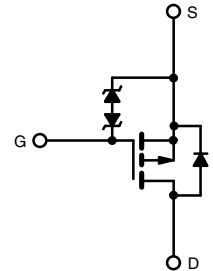
- TrenchFET<sup>®</sup> power MOSFET
- Small 1 mm x 1 mm max. outline area
- Low 0.548 mm max. profile
- Typical ESD protection 2500 V HBM
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



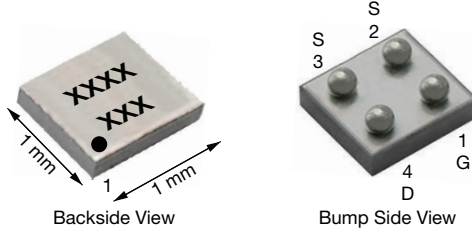
**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**

### APPLICATIONS

- Load switches and charger switches
- Battery management
- For smart phones and tablet PCs



P-Channel MOSFET

**MICRO FOOT<sup>®</sup> 1 x 1**


**Marking Code:** xxxx = 8489

xxx = Date / lot traceability code

### Ordering Information:

Si8489EDB-T2-E1 (lead (Pb)-free and halogen-free)

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>A</sub> = 25 °C	-5.4 <sup>a</sup>
		T <sub>A</sub> = 70 °C	-4.3 <sup>a</sup>
		T <sub>A</sub> = 25 °C	-3.6 <sup>b</sup>
		T <sub>A</sub> = 70 °C	-2.8 <sup>b</sup>
Pulsed Drain Current (t = 300 μs)	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	-0.65 <sup>b</sup>
Maximum Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = 25 °C	1.8 <sup>a</sup>
		T <sub>A</sub> = 70 °C	1.1 <sup>a</sup>
		T <sub>A</sub> = 25 °C	0.78 <sup>b</sup>
		T <sub>A</sub> = 70 °C	0.5 <sup>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>	VPR	260	
	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<sup>®</sup> (J-STD-020), 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<sub>A</sub> = 25 °C.



THERMAL RESISTANCE RATINGS					
PARAMETER		SYMBOL	TYPICAL	MAXIMUM	UNIT
Maximum Junction-to-Ambient <sup>a, b</sup>	t = 10 s	R <sub>thJA</sub>	55	70	°C/W
Maximum Junction-to-Ambient <sup>c, d</sup>	t = 10 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 <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 V, 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	-	-15	-	mV/°C
V <sub>GS(th)</sub> Temperature Coefficient	ΔV <sub>GS(th)</sub> /T <sub>J</sub>		-	2.4	-	
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	-	-1.2	V
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 4.5 V	-	-	± 1	μA
		V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 12 V	-	-	± 5	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V	-	-	-1	
		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	-10	-	-	A
Drain-Source On-State Resistance <sup>a</sup>	R <sub>DS(on)</sub>	V <sub>GS</sub> = -10 V, I <sub>D</sub> = -1.5 A	-	0.036	0.044	Ω
		V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -1.5 A	-	0.045	0.054	
		V <sub>GS</sub> = -2.5 V, I <sub>D</sub> = -1 A	-	0.065	0.082	
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	-	765	-	pF
Output Capacitance	C <sub>oss</sub>		-	125	-	
Reverse Transfer Capacitance	C <sub>rss</sub>		-	115	-	
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -10 V, I <sub>D</sub> = -1.5 A	-	17.5	27	nC
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	-	8.6	13	
Gate-Drain Charge	Q <sub>gd</sub>		-	1.5	-	
Gate Resistance	R <sub>g</sub>		V <sub>GS</sub> = -0.1 V, f = 1 MHz	-	2.6	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = -10 V, R <sub>L</sub> = 10 Ω I <sub>D</sub> ≅ -1.5 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω	-	14	-	Ω
Rise Time	t <sub>r</sub>		-	27	50	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	20	40	
Fall Time	t <sub>f</sub>		-	50	100	
Turn-On Delay Time	t <sub>d(on)</sub>	V <sub>DD</sub> = -10 V, R <sub>L</sub> = 10 Ω I <sub>D</sub> ≅ -1.5 A, V <sub>GEN</sub> = -8 V, R <sub>g</sub> = 1 Ω	-	25	50	ns
Rise Time	t <sub>r</sub>		-	6	15	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	8	20	
Fall Time	t <sub>f</sub>		-	68	130	
			-	28	60	



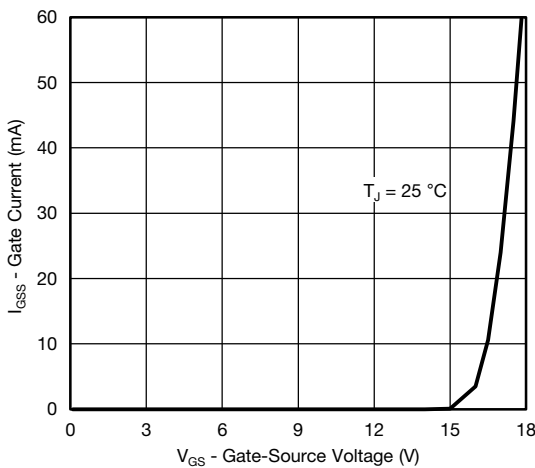
SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)						
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	I <sub>S</sub>	T <sub>A</sub> = 25 °C	-	-	-1.5	A
Pulse Diode Forward Current	I <sub>SM</sub>		-	-	-20	
Body Diode Voltage	V <sub>SD</sub>	I <sub>S</sub> = -1.5 A, V <sub>GS</sub> = 0 V	-	-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	-	25	50	ns
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>		-	9	20	nC
Reverse Recovery Fall Time	t <sub>a</sub>		-	15	-	ns
Reverse Recovery Rise Time	t <sub>b</sub>		-	10	-	

**Notes**

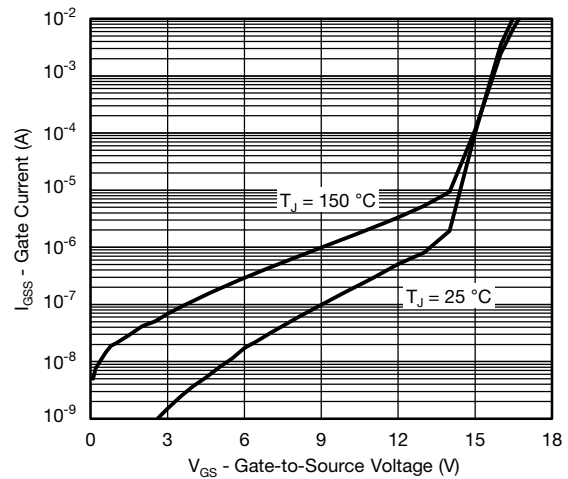
- a. Pulse test; pulse width ≤ 300 μs, duty cycle ≤ 2 %.
- b. Guaranteed by design, not subject to production testing.

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.

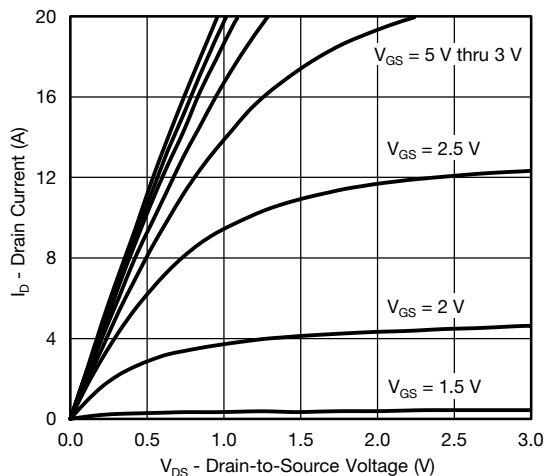
**TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)**



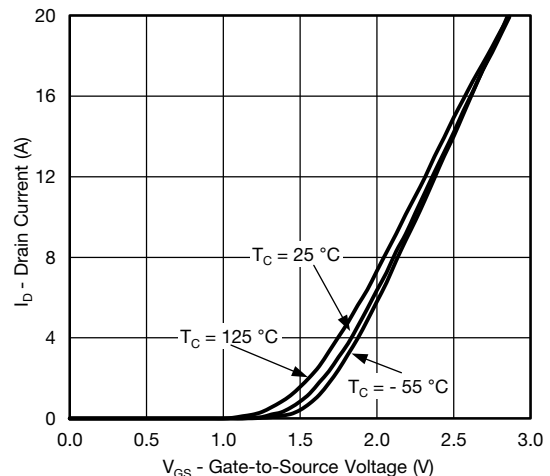
Gate Current vs. Gate-Source Voltage



Gate Current vs. Gate-Source Voltage

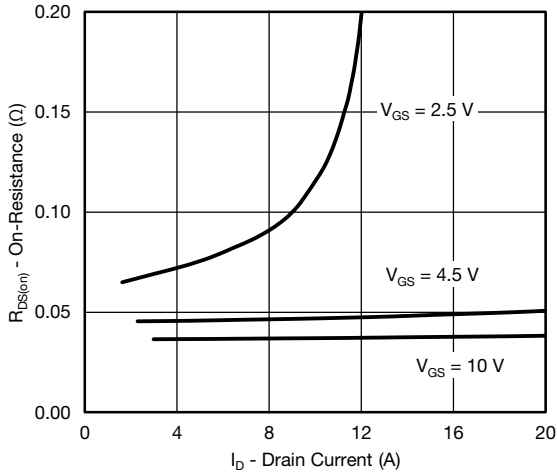


Output Characteristics

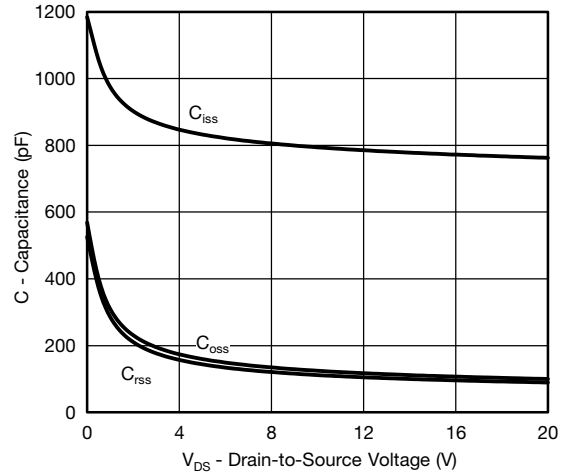


Transfer Characteristics

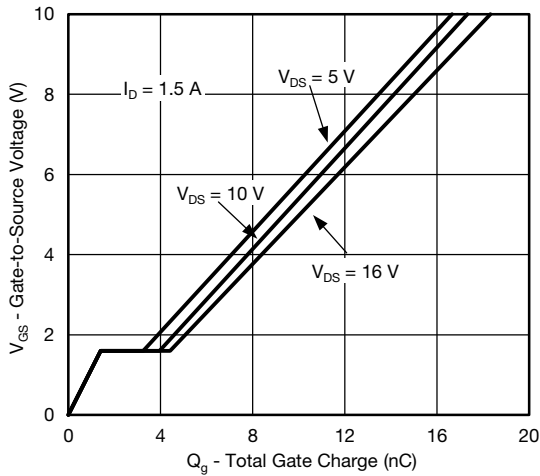
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



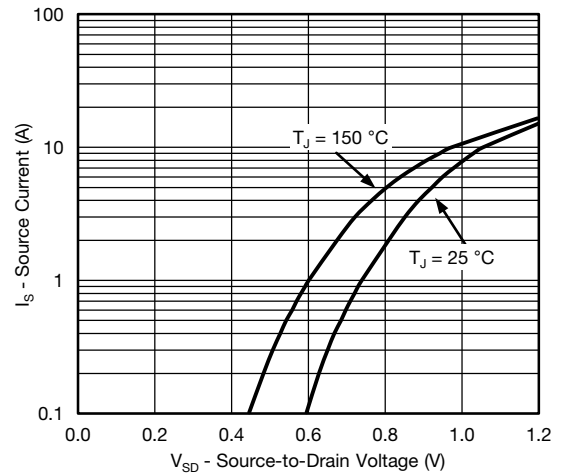
**On-Resistance vs. Drain Current and Gate Voltage**



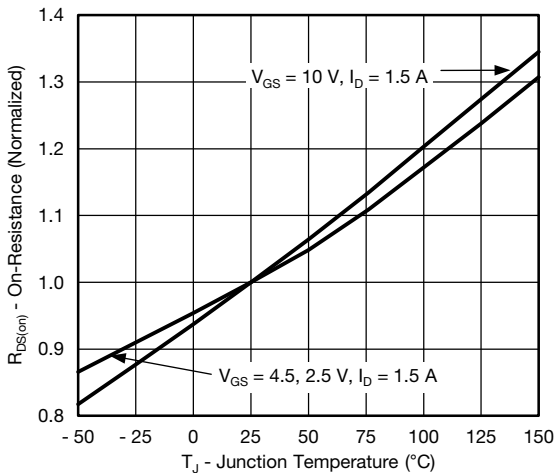
**Capacitance**



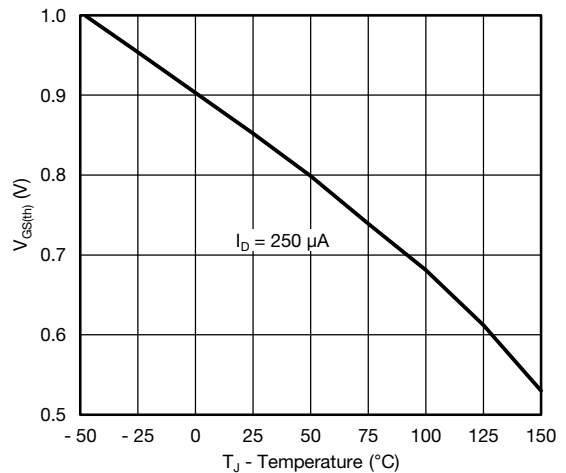
**Gate Charge**



**Source-Drain Diode Forward Voltage**

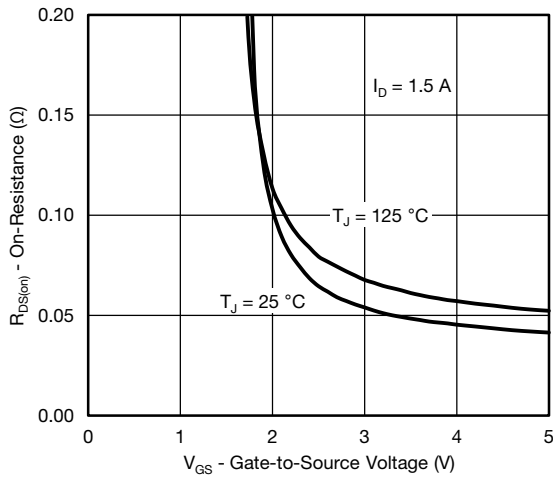


**On-Resistance vs. Junction Temperature**

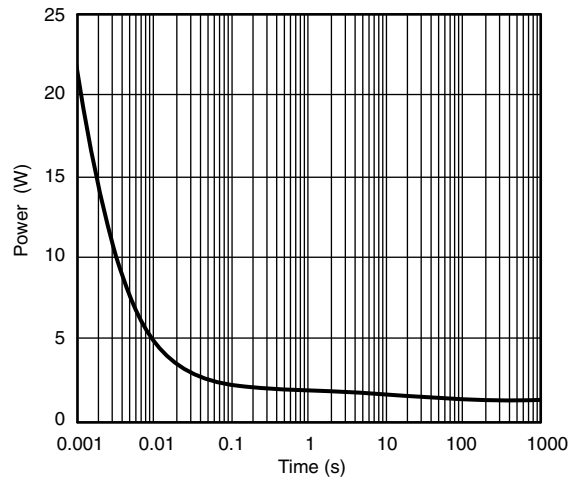


**Threshold Voltage**

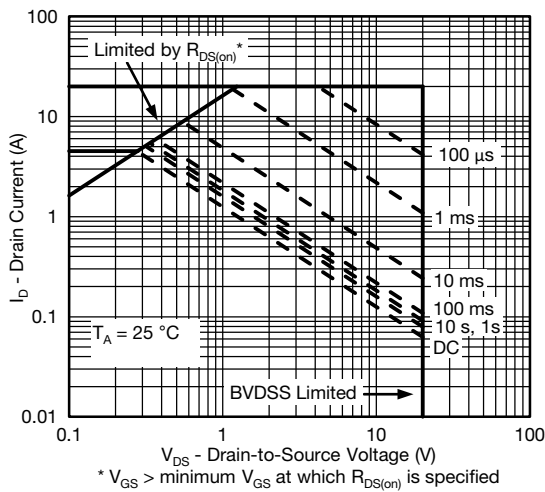
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



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



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



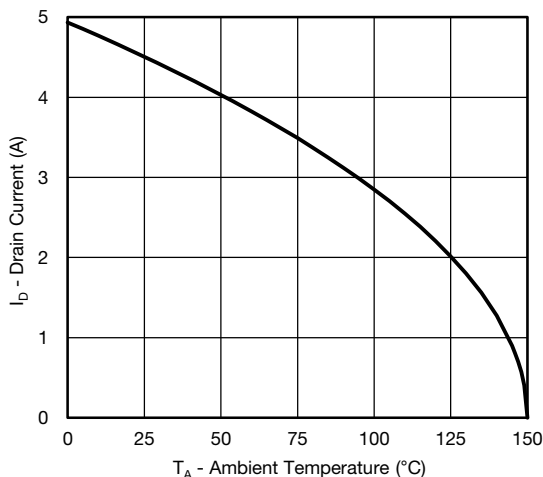
**Safe Operating Area, Junction-to-Ambient**

**Note**

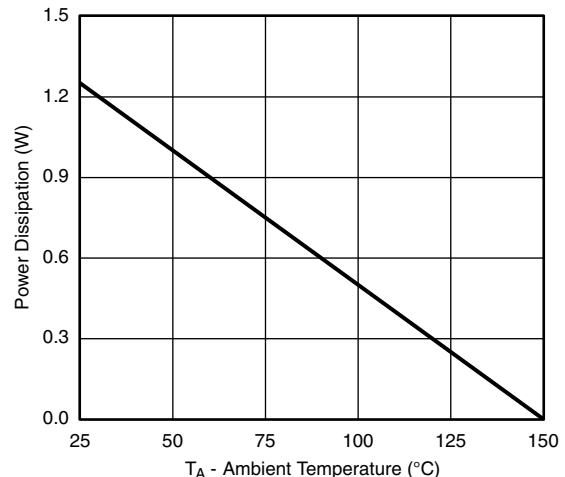
- When mounted on 1" x 1" FR4 with full copper.

**Note**

- 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.



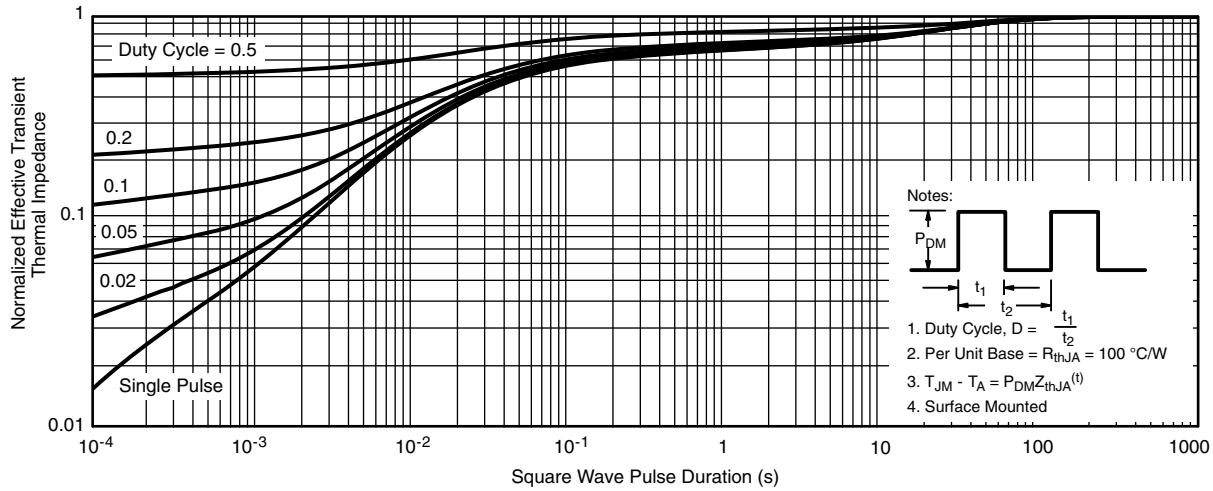
**Current Derating <sup>a</sup>**



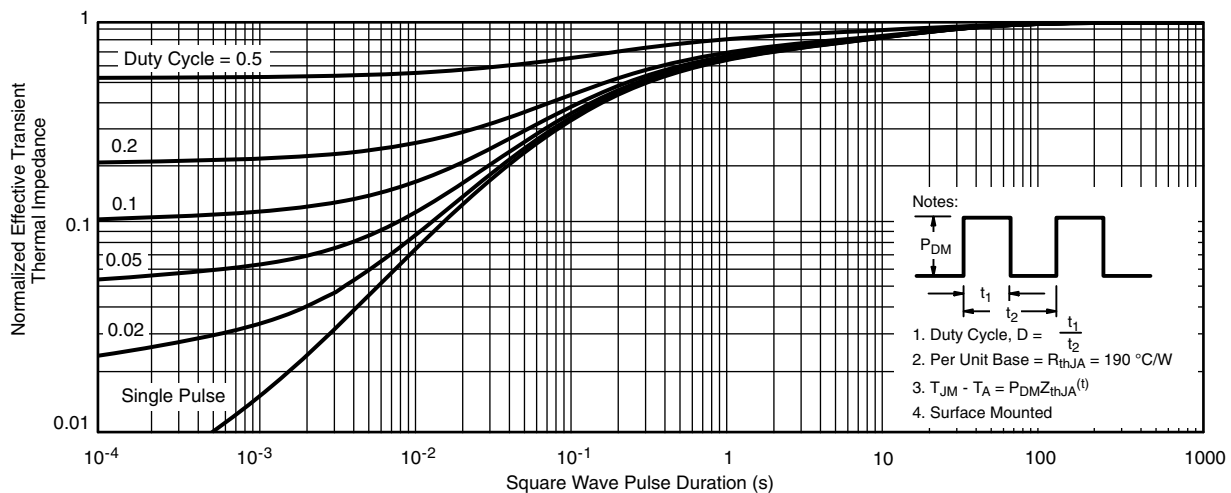
**Power Derating**



TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



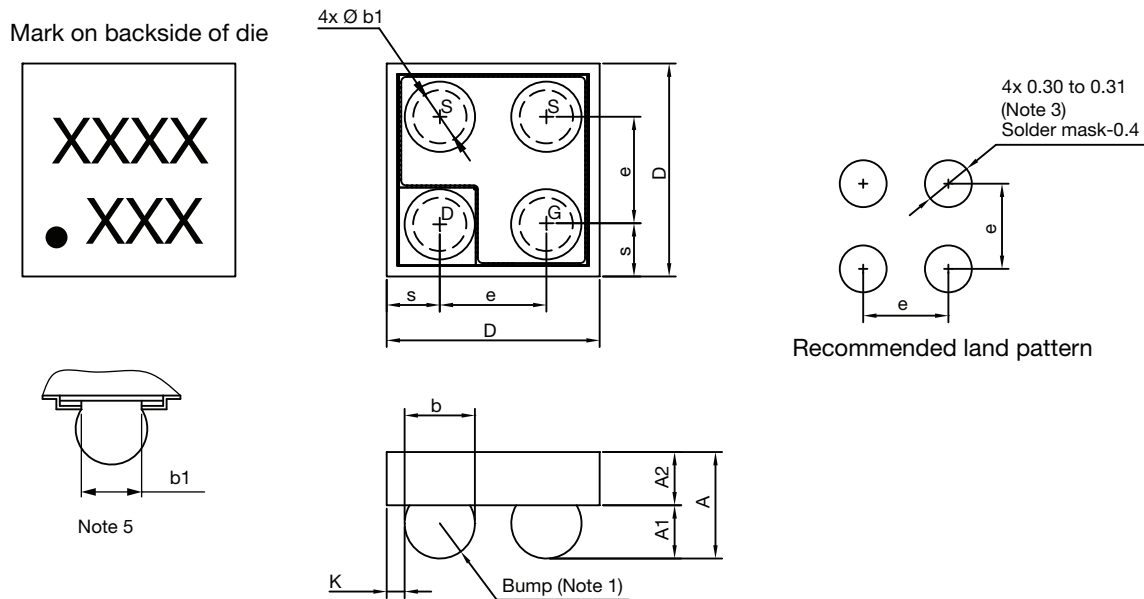
Normalized Thermal Transient Impedance, Junction-to-Ambient (1" x 1" FR4 Board with Full Copper)



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

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## MICRO FOOT®: 4-Bumps (1 mm x 1 mm, 0.5 mm Pitch, 0.286 mm Bump Height)



### Notes

1. 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 mark on the backside surface of die.
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	0.458	0.504	0.550	0.0180	0.0198	0.0217
A1	0.214	0.250	0.286	0.0084	0.0098	0.0113
A2	0.244	0.254	0.264	0.0096	0.0100	0.0104
b	0.297	0.330	0.363	0.0117	0.0130	0.0143
b1	0.250			0.0098		
e	0.500			0.0197		
s	0.210	0.230	0.250	0.0083	0.0091	0.0096
D	0.920	0.960	1.000	0.0362	0.0378	0.0394
K	0.029	0.065	0.102	0.0011	0.0026	0.0040

### Note

- Use millimeters as the primary measurement.

ECN: T15-0176-Rev. A, 27-Apr-15  
DWG: 6039



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