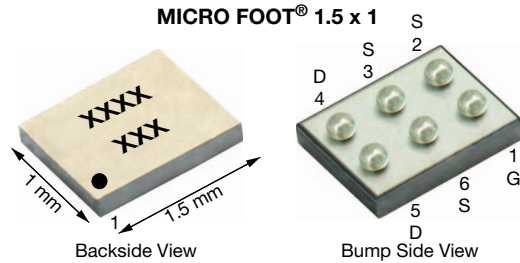


## N-Channel 20 V (D-S) MOSFET

PRODUCT SUMMARY			
V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω) MAX.	I <sub>D</sub> (A)	Q <sub>g</sub> (TYP.)
20	0.033 at V <sub>GS</sub> = 4.5 V	16 <sup>e</sup>	7.5 nC
	0.037 at V <sub>GS</sub> = 2.5 V	16 <sup>e</sup>	
	0.042 at V <sub>GS</sub> = 1.8 V	15	



Marking Code: xxxx = 8406

xxx = Date / lot traceability code

**Ordering Information:**

Si8406DB-T2-E1 (Lead (Pb)-free and halogen-free)

**FEATURES**

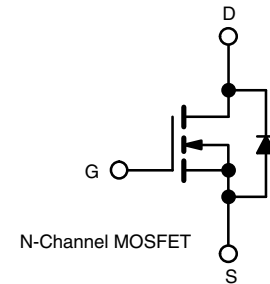
- TrenchFET® power MOSFET
- Ultra-small 1.5 mm x 1 mm maximum outline
- Ultra-thin 0.59 mm maximum height
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS COMPLIANT**  
 HALOGEN FREE Available

**APPLICATIONS**

- Load switch
- Battery management
- Boost converter



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>	± 8	
Continuous Drain Current (T <sub>J</sub> = 150 °C)	I <sub>D</sub>	T <sub>C</sub> = 25 °C	16 <sup>e</sup>
		T <sub>C</sub> = 70 °C	13.5
		T <sub>A</sub> = 25 °C	7.8 <sup>a,b</sup>
		T <sub>A</sub> = 70 °C	6.2 <sup>a,b</sup>
Pulsed Drain Current (t = 300 μs)	I <sub>DM</sub>	30	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	

**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 in defined as the top surface of the package.
- T<sub>C</sub> = 25 °C package limited.

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

**Notes**

- Surface mounted on 1" x 1" FR4 board.
- Maximum under steady state conditions is 85 °C/W.
- Case is defined as top surface of the package.



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	-	18	-	mV/°C
V <sub>GS(th)</sub> Temperature Coefficient	ΔV <sub>GS(th)</sub> /T <sub>J</sub>		-	-3	-	
Gate-Source Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	0.4	-	0.85	V
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 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 A	-	0.026	0.033	Ω
		V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 1 A	-	0.028	0.037	
		V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 1 A	-	0.030	0.042	
Forward Transconductance <sup>a</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 1 A	-	20	-	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	-	830	-	pF
Output Capacitance	C <sub>OSS</sub>		-	146	-	
Reverse Transfer Capacitance	C <sub>RSS</sub>		-	61	-	
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 8 V, I <sub>D</sub> = 1 A	-	13	20	nC
		V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 1 A	-	7.5	12	
Gate-Source Charge	Q <sub>gs</sub>		-	1.1	-	
Gate-Drain Charge	Q <sub>gd</sub>		-	0.8	-	
Gate Resistance	R <sub>g</sub>	V <sub>GS</sub> = 0.1 V, f = 1 MHz	-	3.6	-	Ω
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 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	-	7	15	ns
Rise Time	t <sub>r</sub>		-	18	40	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	30	60	
Fall Time	t <sub>f</sub>		-	10	20	
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 A, V <sub>GEN</sub> = 8 V, R <sub>g</sub> = 1 Ω	-	5	10	ns
Rise Time	t <sub>r</sub>		-	17	35	
Turn-Off Delay Time	t <sub>d(off)</sub>		-	25	50	
Fall Time	t <sub>f</sub>		-	10	20	
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	I <sub>S</sub>	T <sub>C</sub> = 25 °C	-	-	20	A
Pulse Diode Forward Current	I <sub>SM</sub>		-	-	30	
Body Diode Voltage	V <sub>SD</sub>	I <sub>S</sub> = 1 A, V <sub>GS</sub> = 0	-	0.7	1.2	V
Body Diode Reverse Recovery Time	t <sub>rr</sub>	I <sub>F</sub> = 1 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	-	15	30	ns
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>		-	5	10	nC
Reverse Recovery Fall Time	t <sub>a</sub>		-	8	-	ns
Reverse Recovery Rise Time	t <sub>b</sub>		-	7	-	

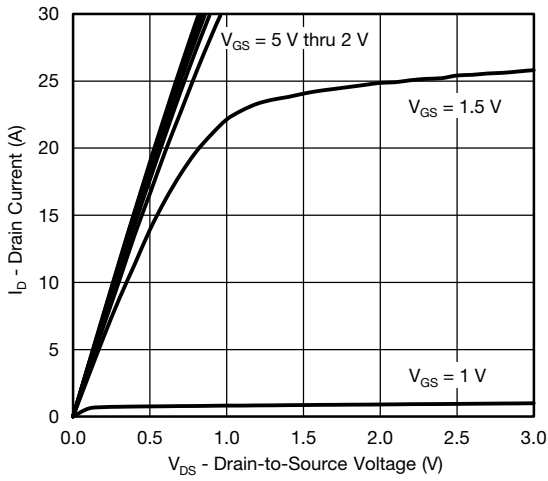
**Notes**

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

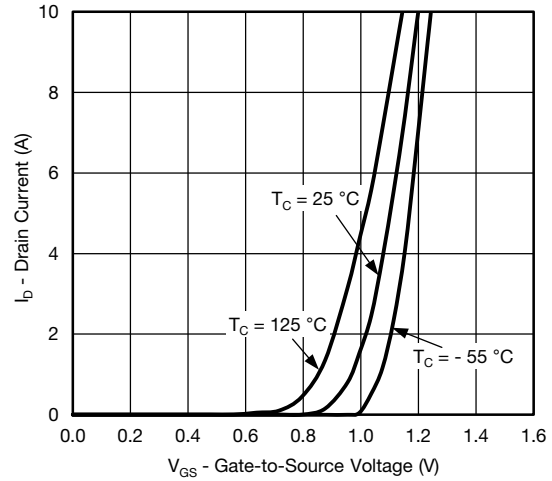
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



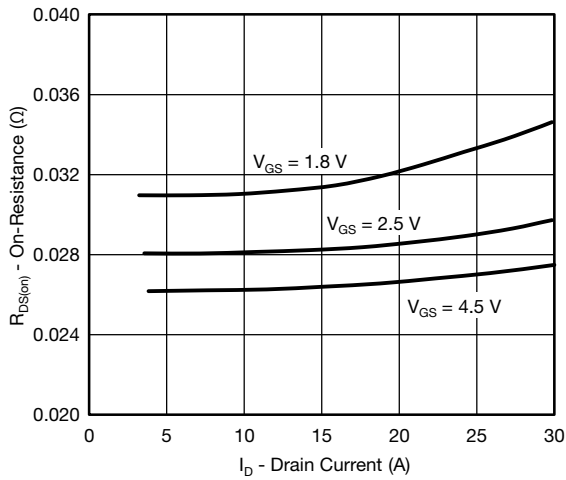
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



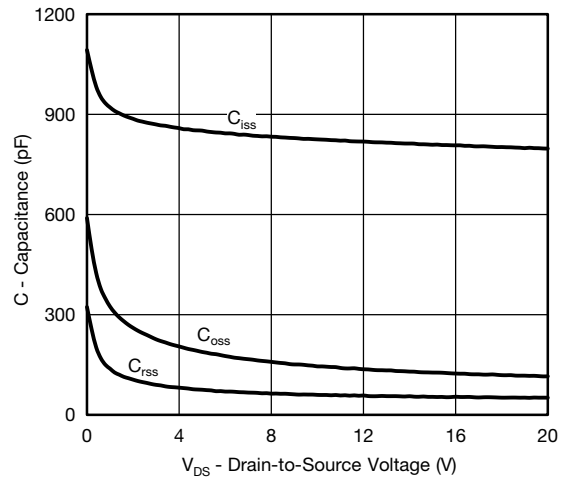
Output Characteristics



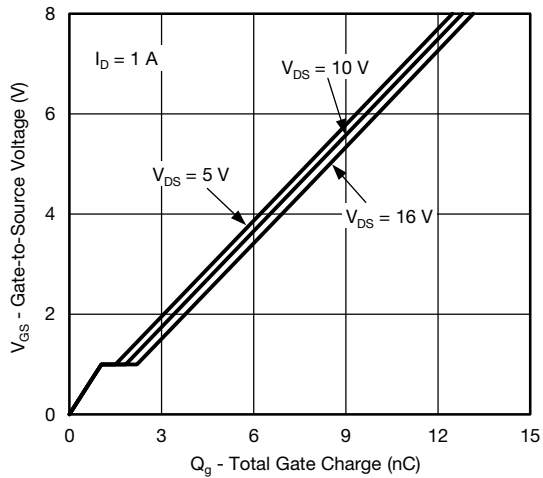
Transfer Characteristics



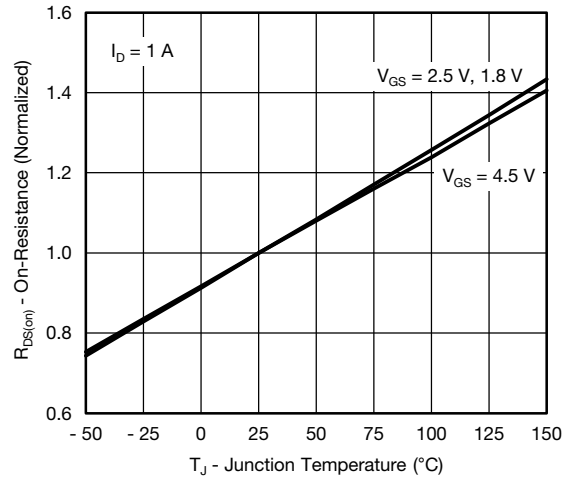
On-Resistance vs. Drain Current and Gate Voltage



Capacitance



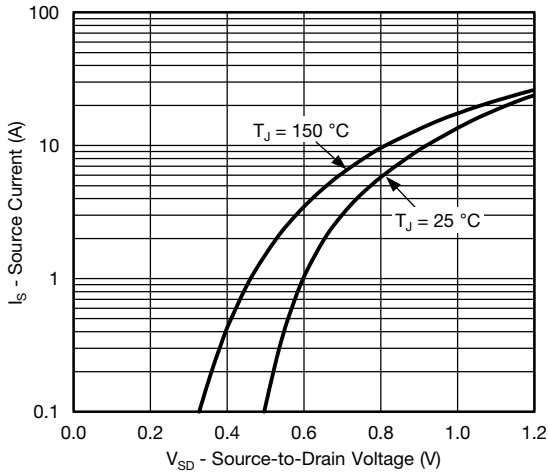
Gate Charge



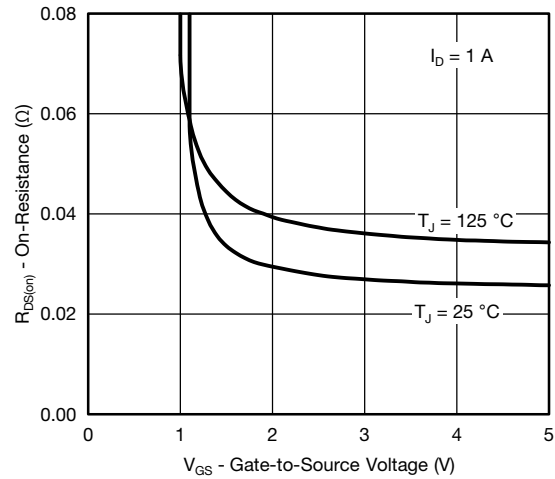
On-Resistance vs. Junction Temperature



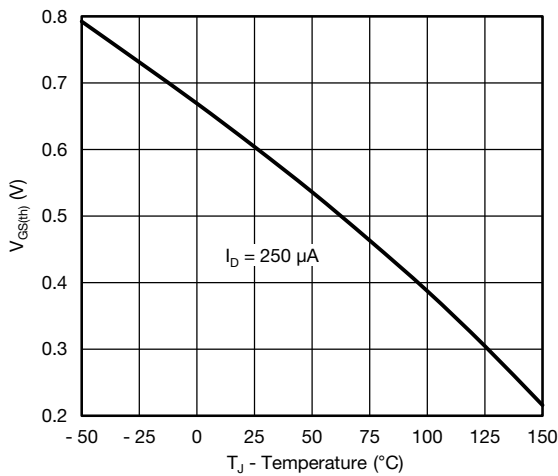
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



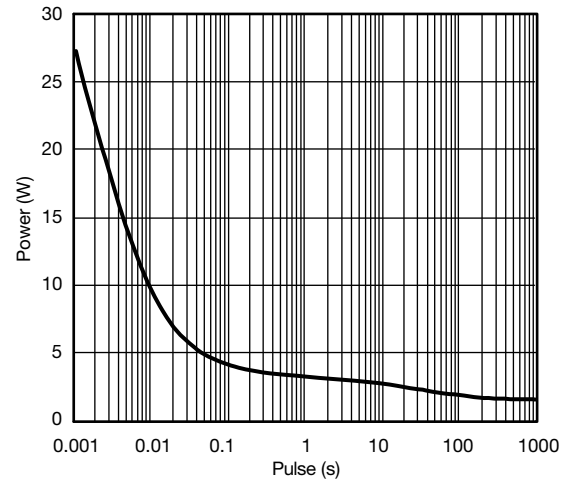
Source-Drain Diode Forward Voltage



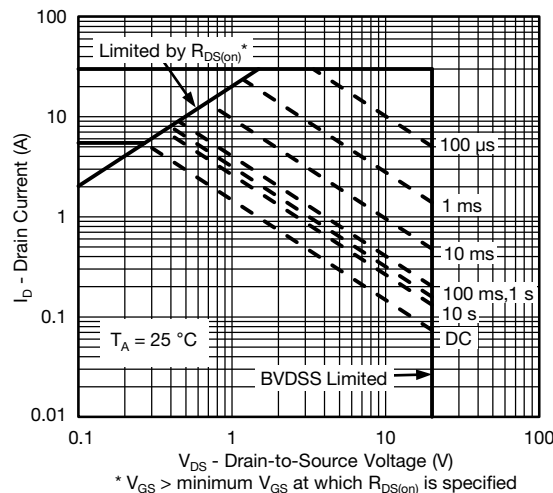
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



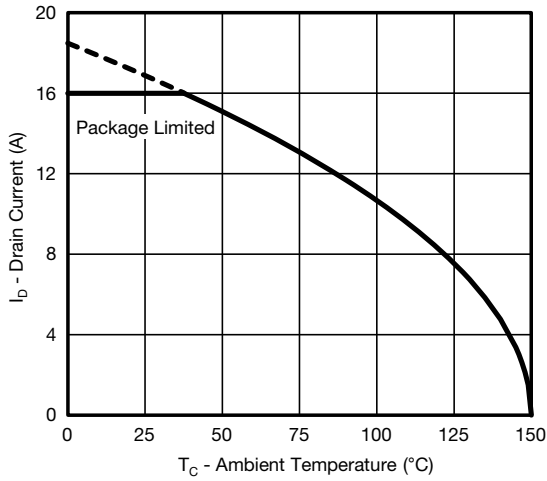
Single Pulse Power, Junction-to-Ambient



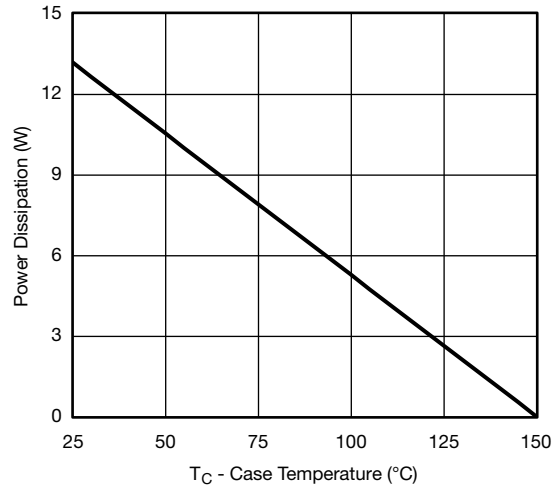
Safe Operating Area, Junction-to-Ambient



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



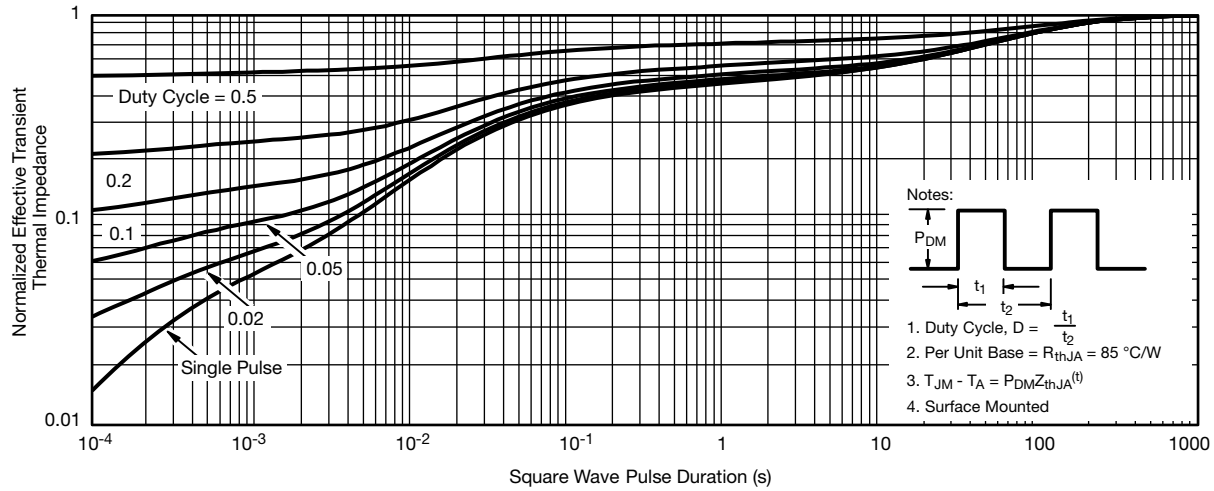
**Current Derating\***



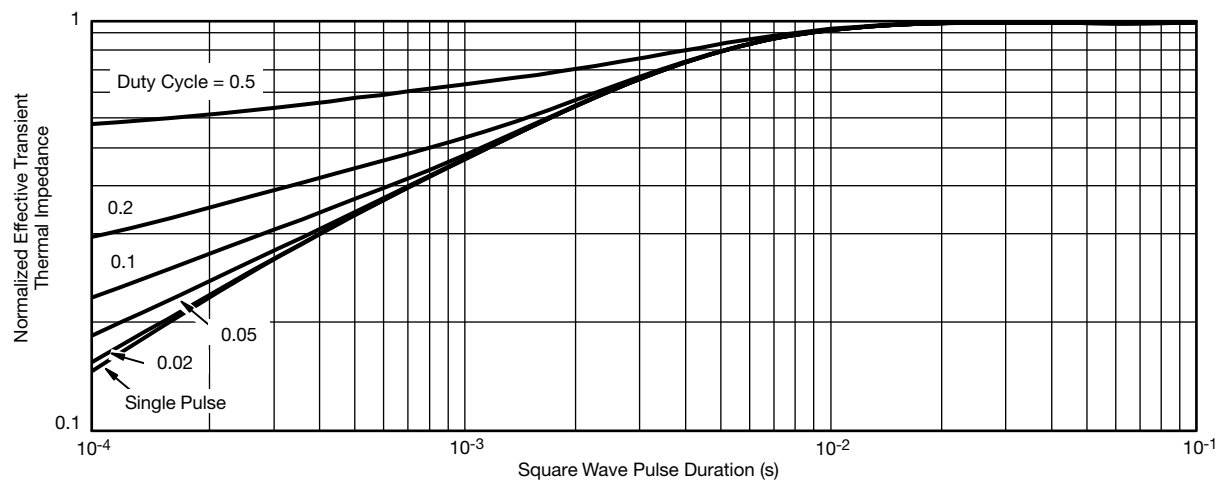
**Power Derating**

\* The power dissipation P<sub>D</sub> is based on T<sub>J (max.)</sub> = 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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