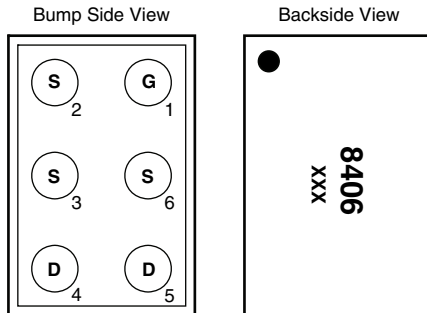


## N-Channel 20 V (D-S) MOSFET

### 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	

### MICRO FOOT



Device Marking: 8406  
xxx = Date/Lot Traceability Code

Ordering Information:  
Si8406DB-T2-E1 (Lead (Pb)-free and Halogen-free)

### FEATURES

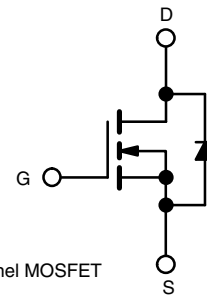
- TrenchFET® Power MOSFET
- Ultra-small 1.5 mm x 1 mm Maximum Outline
- Ultra-thin 0.59 mm Maximum Height
- Material categorization:  
For definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### APPLICATIONS

- Load Switch
- Battery Management
- Boost Converter



N-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>	± 8	
Continuous Drain Current (T <sub>J</sub> = 150 °C)	I <sub>D</sub>	T <sub>C</sub> = 25 °C	A
		T <sub>C</sub> = 70 °C	
		T <sub>A</sub> = 25 °C	
		T <sub>A</sub> = 70 °C	
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	W
		T <sub>C</sub> = 70 °C	
		T <sub>A</sub> = 25 °C	
		T <sub>A</sub> = 70 °C	
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>	$R_{thJA}$	37	45	°C/W
Maximum Junction-to-Case (Drain) <sup>c</sup>	Steady State $R_{thJC}$	7	9.5	

Notes:

a. Surface mounted on 1" x 1" FR4 board.

b. Maximum under steady state conditions is 85 °C/W.

c. Case is defined as top surface of the package.

**SPECIFICATIONS** ( $T_J = 25\text{ °C}$ , unless otherwise noted)

Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0, I_D = 250\text{ }\mu\text{A}$	20			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = 250\text{ }\mu\text{A}$		18		mV/°C
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$			- 3		
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$	0.4		0.85	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	$\mu\text{A}$
		$V_{DS} = 20\text{ V}, V_{GS} = 0\text{ V}, T_J = 70\text{ °C}$			10	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \geq 5\text{ V}, V_{GS} = 4.5\text{ V}$	5			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = 4.5\text{ V}, I_D = 1\text{ A}$		0.026	0.033	$\Omega$
		$V_{GS} = 2.5\text{ V}, I_D = 1\text{ A}$		0.028	0.037	
		$V_{GS} = 1.8\text{ V}, I_D = 1\text{ A}$		0.030	0.042	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = 10\text{ V}, I_D = 1\text{ A}$		20		S
<b>Dynamic<sup>b</sup></b>						
Input Capacitance	$C_{iss}$	$V_{DS} = 10\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		830		pF
Output Capacitance	$C_{oss}$			146		
Reverse Transfer Capacitance	$C_{rss}$			61		
Total Gate Charge	$Q_g$	$V_{DS} = 10\text{ V}, V_{GS} = 8\text{ V}, I_D = 1\text{ A}$		13	20	nC
Gate-Source Charge	$Q_{gs}$	$V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}, I_D = 1\text{ A}$		7.5	12	
Gate-Drain Charge	$Q_{gd}$			1.1		
Gate Resistance	$R_g$	$V_{GS} = 0.1\text{ V}, f = 1\text{ MHz}$		0.8		$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 10\text{ V}, R_L = 10\text{ }\Omega$ $I_D \cong 1\text{ A}, V_{GEN} = 4.5\text{ V}, R_g = 1\text{ }\Omega$		7	15	ns
Rise Time	$t_r$			18	40	
Turn-Off Delay Time	$t_{d(off)}$			30	60	
Fall Time	$t_f$			10	20	
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = 10\text{ V}, R_L = 10\text{ }\Omega$ $I_D = 1\text{ A}, V_{GEN} = 8\text{ V}, R_g = 1\text{ }\Omega$		5	10	ns
Rise Time	$t_r$			17	35	
Turn-Off Delay Time	$t_{d(off)}$			25	50	
Fall Time	$t_f$			10	20	

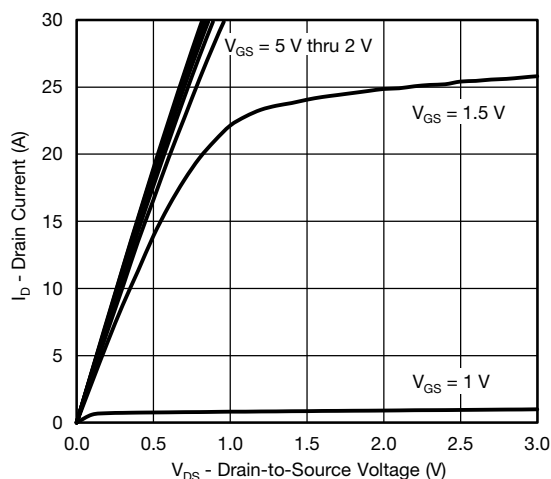
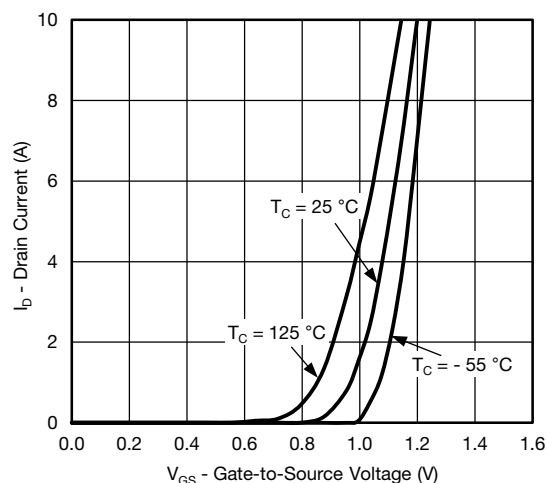
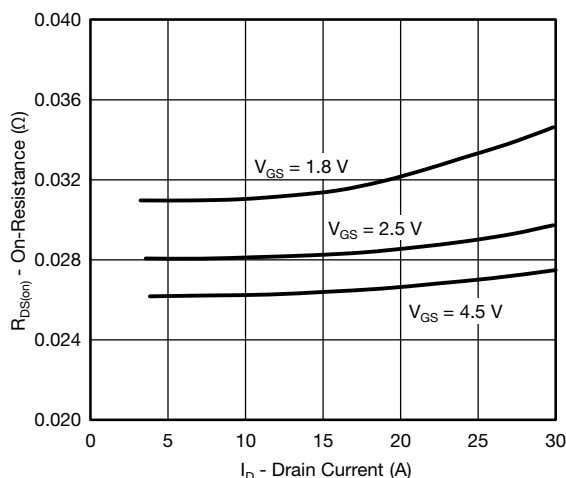
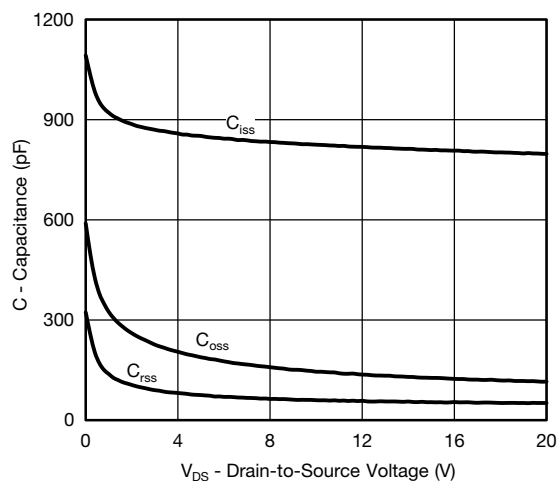
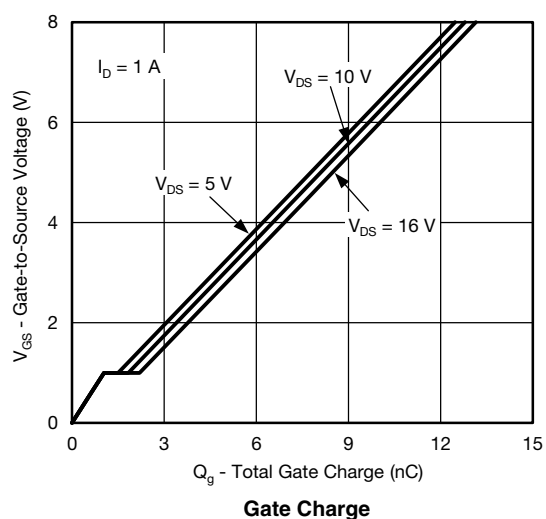
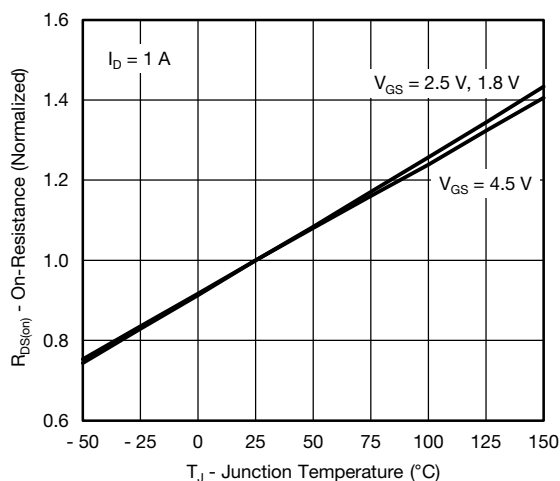


<b>SPECIFICATIONS</b> ( $T_J = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^{\circ}\text{C}$			20	A
Pulse Diode Forward Current	$I_{SM}$				30	
Body Diode Voltage	$V_{SD}$	$I_S = 1\text{ A}$ , $V_{GS} = 0$		0.7	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	$Q_{rr}$			5	10	nC
Reverse Recovery Fall Time	$t_a$			8		ns
Reverse Recovery Rise Time	$t_b$			7		

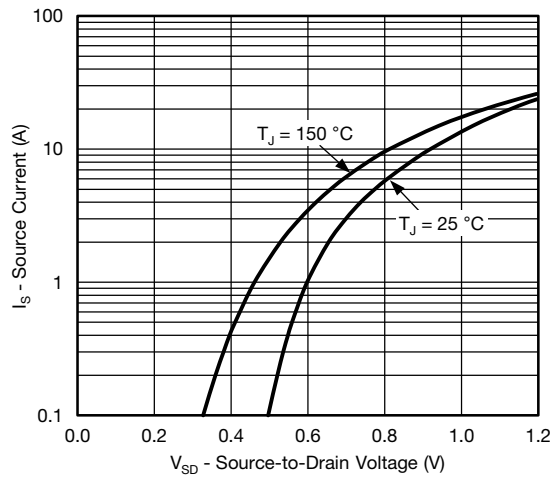
Notes:

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

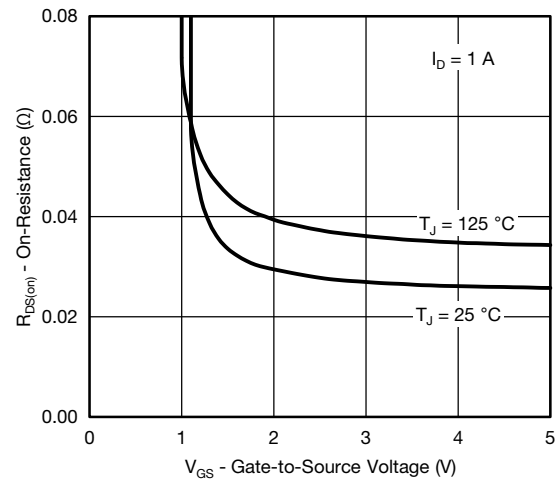
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

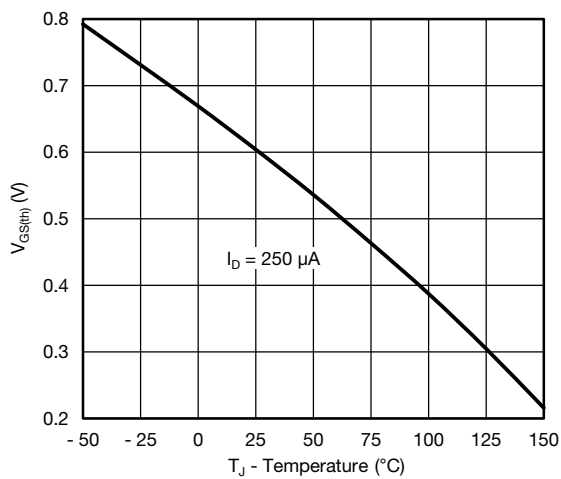
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



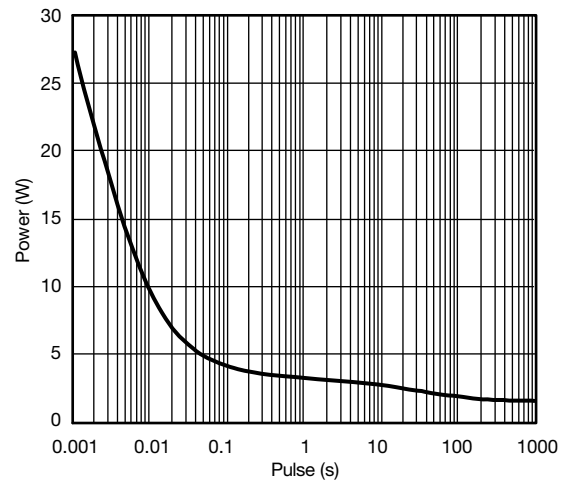
Source-Drain Diode Forward Voltage



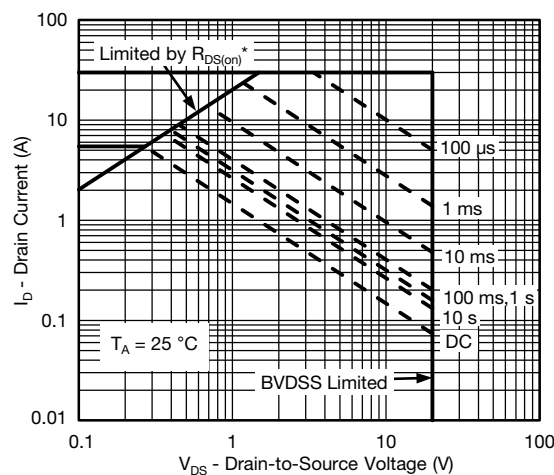
On-Resistance vs. Gate-to-Source Voltage



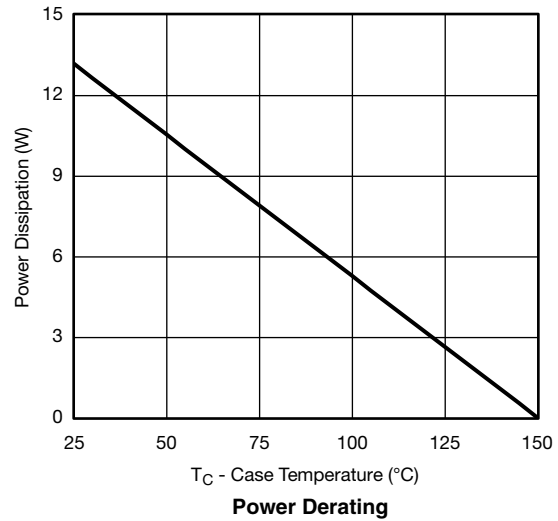
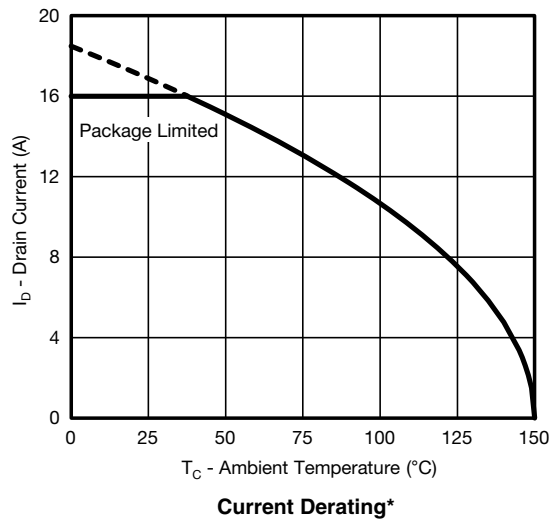
Threshold Voltage



Single Pulse Power, Junction-to-Ambient

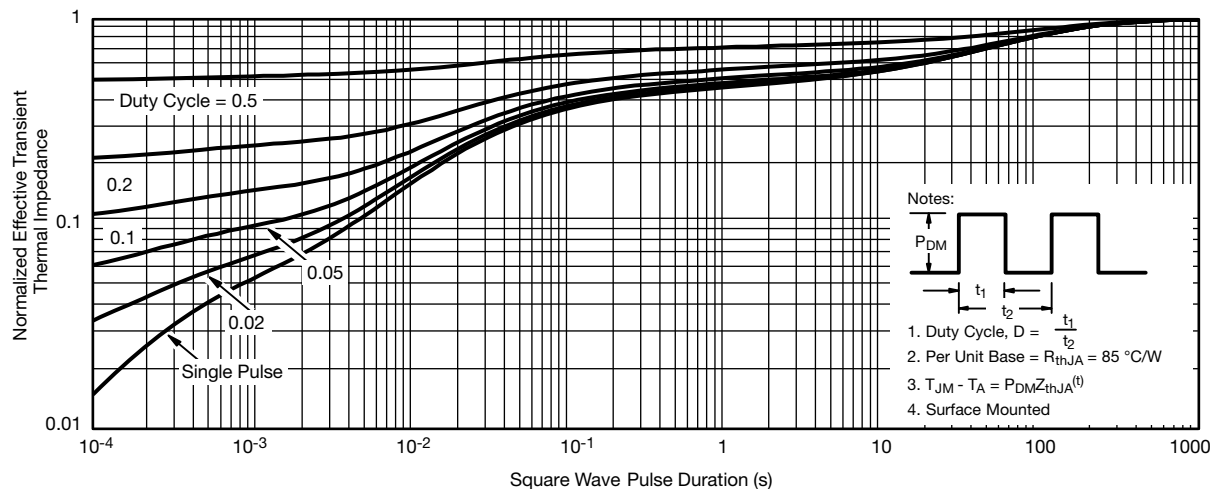


Safe Operating Area, Junction-to-Ambient

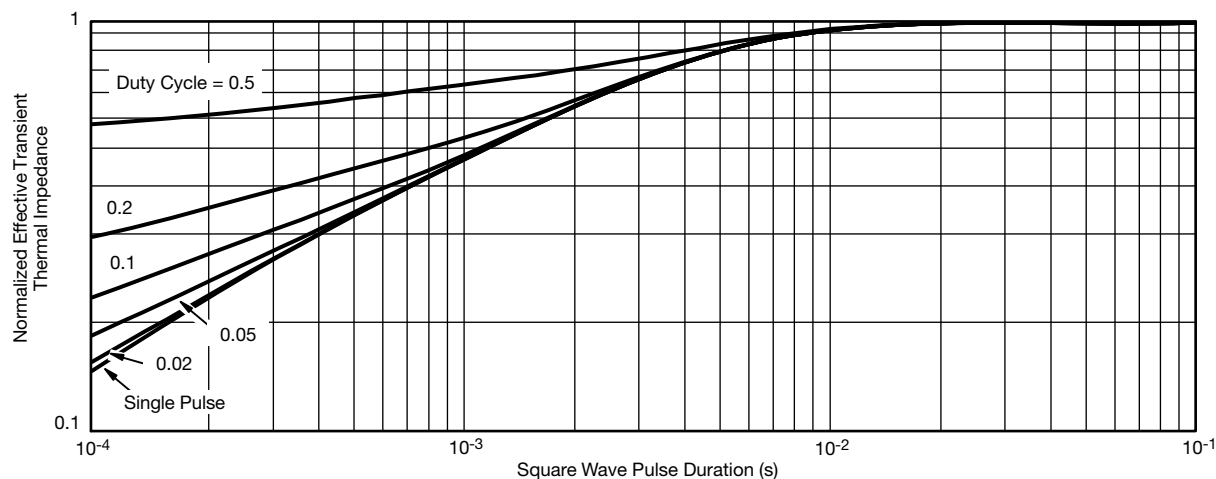
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

\* 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)



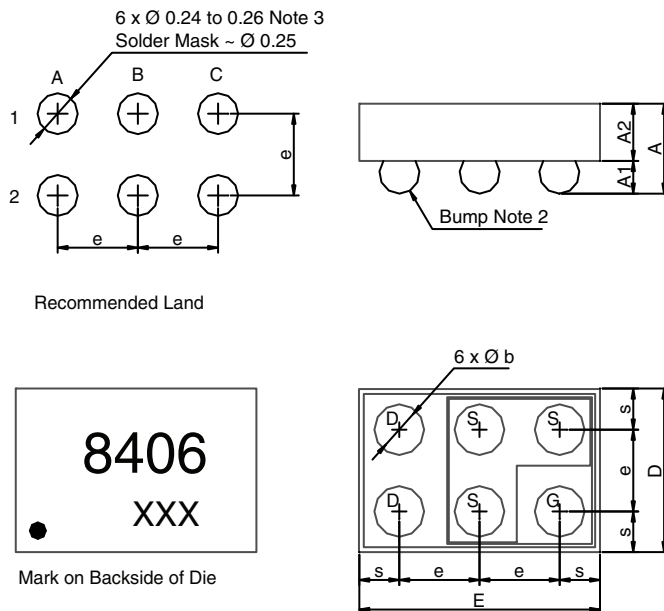
Normalized Thermal Transient Impedance, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Case

## PACKAGE OUTLINE

### MICRO FOOT: 6-BUMP (0.5 mm PITCH)



Notes (unless otherwise specified):

1. All dimensions are in millimeters.
2. Six (6) 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	0.510	0.575	0.590	0.0201	0.0224	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	0.300	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
E	1.420	1.460	1.500	0.0559	0.0575	0.0591

Note:

- a. Use millimeters as the primary measurement.

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