

## Complementary N- and P-Channel 20 V (D-S) MOSFET

PRODUCT SUMMARY				
	V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω)	I <sub>D</sub> (A)	Q <sub>g</sub> (TYP.)
N-Channel	20	0.396 at V <sub>GS</sub> = 4.5 V	0.50	0.75 nC
		0.456 at V <sub>GS</sub> = 2.5 V	0.20	
		0.546 at V <sub>GS</sub> = 1.8 V	0.20	
		0.760 at V <sub>GS</sub> = 1.5 V	0.05	
P-Channel	-20	0.756 at V <sub>GS</sub> = -4.5 V	-0.35	1 nC
		1.038 at V <sub>GS</sub> = -2.5 V	-0.35	
		1.440 at V <sub>GS</sub> = -1.8 V	-0.10	
		2.400 at V <sub>GS</sub> = -1.5 V	-0.05	

### FEATURES

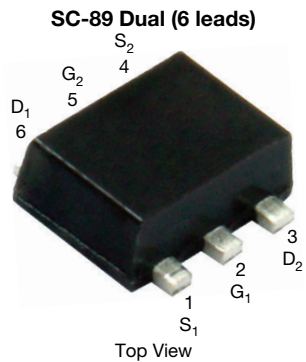
- TrenchFET® power MOSFETs
- High-side switching
- Ease in driving switches
- Low offset (error) voltage
- Low-voltage operation
- High-speed circuits
- Typical ESD protection:  
n-channel 900 V, p-channel 900 V (HBM)
- 100 % R<sub>g</sub> tested
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



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

### APPLICATIONS

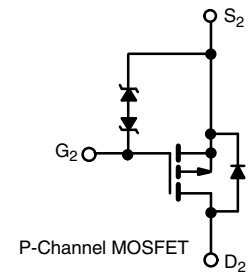
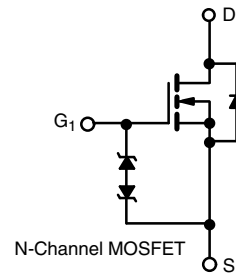
- Load switch, small signal switches and level-shift switches
  - Battery operated systems
  - Portable



**Marking Code:** 5

**Ordering Information:**

Si1016CX-T1-GE3 (Lead (Pb)-free and Halogen-free)



ABSOLUTE MAXIMUM RATINGS (T <sub>A</sub> = 25 °C, unless otherwise noted)					
PARAMETER	SYMBOL	N-CHANNEL	P-CHANNEL	UNIT	
Drain-Source Voltage	V <sub>DS</sub>	20	-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>A</sub> = 25 °C	0.6 a, b	-0.6 a, b	
		T <sub>A</sub> = 70 °C	0.49 a, b	-0.49 a, b	
Pulsed Drain Current (t = 300 μs)	I <sub>DM</sub>	2	-1.5	A	
Source Drain Current Diode Current	I <sub>S</sub>	0.18 a, b	-0.18 a, b	W	
Maximum Power Dissipation	P <sub>D</sub>	T <sub>A</sub> = 25 °C	0.22 a, b		0.22 a, b
		T <sub>A</sub> = 70 °C	0.14 a, b		0.14 a, b
Operating Junction and Storage Temperature Range	T <sub>J</sub> , T <sub>stg</sub>	-55 to 150		°C	

THERMAL RESISTANCE RATINGS						
PARAMETER	SYMBOL	N-CHANNEL		P-CHANNEL		UNIT
		TYP.	MAX.	TYP.	MAX.	
Maximum Junction-to-Ambient a, c	t ≤ 5 s	470	565	470	565	°C/W
	Steady State	560	675	560	675	

#### Notes

- Surface mounted on 1" x 1" FR4 board.
- t = 5 s.
- Maximum under steady state conditions is 675 °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	N-Ch	20	-	-	V
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = -250 μA	P-Ch	-20	-	-	
V <sub>DS</sub> Temperature Coefficient	ΔV <sub>DS</sub> /T <sub>J</sub>	I <sub>D</sub> = 250 μA	N-Ch	-	17	-	mV/°C
		I <sub>D</sub> = -250 μA	P-Ch	-	-12	-	
V <sub>GS(th)</sub> Temperature Coefficient	ΔV <sub>GS(th)</sub> /T <sub>J</sub>	I <sub>D</sub> = 250 μA	N-Ch	-	-1.8	-	mV/°C
		I <sub>D</sub> = -250 μA	P-Ch	-	1.8	-	
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	N-Ch	0.4	-	1	V
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = -250 μA	P-Ch	-0.4	-	-1	
Gate-Source Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 4.5 V	N-Ch	-	-	± 1	μA
			P-Ch	-	-	± 1	
		V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 V	N-Ch	-	-	± 30	
			P-Ch	-	-	± 30	
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V	N-Ch	-	-	1	μA
		V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V	P-Ch	-	-	-1	
		V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55 °C	N-Ch	-	-	10	
		V <sub>DS</sub> = -20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55 °C	P-Ch	-	-	-10	
On-State Drain Current <sup>b</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> ≥ 5 V, V <sub>GS</sub> = 4.5 V	N-Ch	2	-	-	A
		V <sub>DS</sub> ≤ -5 V, V <sub>GS</sub> = -4.5 V	P-Ch	-1.5	-	-	
Drain-Source On-State Resistance <sup>b</sup>	R <sub>DS(on)</sub>	V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 0.5 A	N-Ch	-	0.330	0.396	Ω
		V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -0.35 A	P-Ch	-	0.630	0.756	
		V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 0.2 A	N-Ch	-	0.380	0.456	
		V <sub>GS</sub> = -2.5 V, I <sub>D</sub> = -0.35 A	P-Ch	-	0.865	1.038	
		V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 0.2 A	N-Ch	-	0.420	0.546	
		V <sub>GS</sub> = -1.8 V, I <sub>D</sub> = -0.1 A	P-Ch	-	1.200	1.440	
		V <sub>GS</sub> = 1.5 V, I <sub>D</sub> = 0.05 A	N-Ch	-	0.505	0.760	
Forward Transconductance <sup>b</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 0.5 A	N-Ch	-	2	-	S
		V <sub>DS</sub> = -10 V, I <sub>D</sub> = -3.6 A	P-Ch	-	1	-	
Input Capacitance	C <sub>iss</sub>	N-Channel V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1 MHz	N-Ch	-	43	-	pF
Output Capacitance	C <sub>oss</sub>		P-Ch	-	45	-	
			N-Ch	-	14	-	
Reverse Transfer Capacitance	C <sub>rss</sub>		P-Channel V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V, f = 1 MHz	P-Ch	-	15	
		N-Ch	-	8	-		
<b>Dynamic <sup>a</sup></b>							
Total Gate Charge	Q <sub>g</sub>	V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 0.6 A	N-Ch	-	1.3	2	nC
		V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -4.5 V, I <sub>D</sub> = -0.4 A	P-Ch	-	1.65	2.50	
		N-Channel V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 0.6 A	N-Ch	-	0.75	1.2	
			P-Ch	-	1	2	
Gate-Source Charge	Q <sub>gs</sub>	P-Channel V <sub>DS</sub> = -10 V, V <sub>GS</sub> = -2.5 V, I <sub>D</sub> = -0.4 A	N-Ch	-	0.15	-	
			P-Ch	-	0.2	-	
Gate-Drain Charge	Q <sub>gd</sub>		N-Ch	-	0.13	-	
			P-Ch	-	0.26	-	
Gate Resistance	R <sub>g</sub>	f = 1 MHz	N-Ch	2.4	12.2	24.4	Ω
			P-Ch	2.4	12	24	



SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
<b>Dynamic <sup>a</sup></b>							
Turn-On Delay Time	t <sub>d(on)</sub>	N-Channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 20 Ω I <sub>D</sub> ≅ 0.5 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	11	20	ns
			P-Ch	-	9	18	
Rise Time	t <sub>r</sub>	P-Channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 33.3 Ω I <sub>D</sub> ≅ -0.3 A, V <sub>GEN</sub> = -4.5 V, R <sub>g</sub> = 1 Ω	N-Ch	-	16	24	
			P-Ch	-	10	20	
Turn-Off Delay Time	t <sub>d(off)</sub>		N-Ch	-	26	39	
			P-Ch	-	10	20	
Fall Time	t <sub>f</sub>		N-Ch	-	11	20	
			P-Ch	-	8	16	
Turn-On Delay Time	t <sub>d(on)</sub>	N-Channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 20 Ω I <sub>D</sub> ≅ 0.5 A, V <sub>GEN</sub> = 8 V, R <sub>g</sub> = 1 Ω	N-Ch	-	2	4	
			P-Ch	-	1	2	
Rise Time	t <sub>r</sub>	P-Channel V <sub>DD</sub> = -10 V, R <sub>L</sub> = 33.3 Ω I <sub>D</sub> ≅ -0.3 A, V <sub>GEN</sub> = -8 V, R <sub>g</sub> = 1 Ω	N-Ch	-	13	20	
			P-Ch	-	8	16	
Turn-Off Delay Time	t <sub>d(off)</sub>		N-Ch	-	7	14	
			P-Ch	-	9	18	
Fall Time	t <sub>f</sub>		N-Ch	-	5	10	
			P-Ch	-	5	10	
<b>Drain-Source Body Diode Characteristics</b>							
Pulse Diode Forward Current <sup>a</sup>	I <sub>SM</sub>		N-Ch	-	-	2	A
			P-Ch	-	-	-1.5	
Body Diode Voltage	V <sub>SD</sub>	I <sub>S</sub> = 0.5 A, V <sub>GS</sub> = 0 V	N-Ch	-	0.85	1.2	V
		I <sub>S</sub> = -0.3 A, V <sub>GS</sub> = 0 V	P-Ch	-	-0.87	-1.2	
Body Diode Reverse Recovery Time	t <sub>rr</sub>	N-Channel I <sub>F</sub> = 0.5 A, di/dt = 100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	10	20	ns
			P-Ch	-	16	24	
Body Diode Reverse Recovery Charge	Q <sub>rr</sub>	P-Channel I <sub>F</sub> = -0.3 A, di/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	2	4	nC
			P-Ch	-	8	20	
Reverse Recovery Fall Time	t <sub>a</sub>		N-Ch	-	5	-	ns
			P-Ch	-	11	-	
Reverse Recovery Rise Time	t <sub>b</sub>		N-Ch	-	5	-	
			P-Ch	-	5	-	

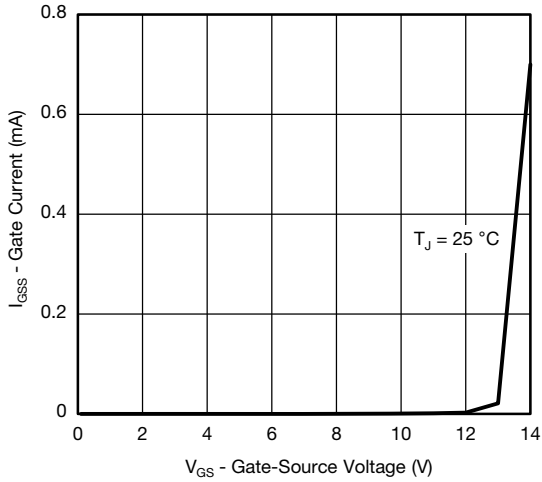
**Notes**

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

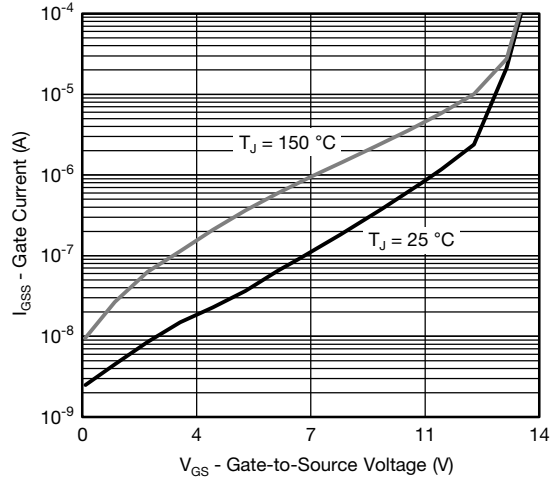
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



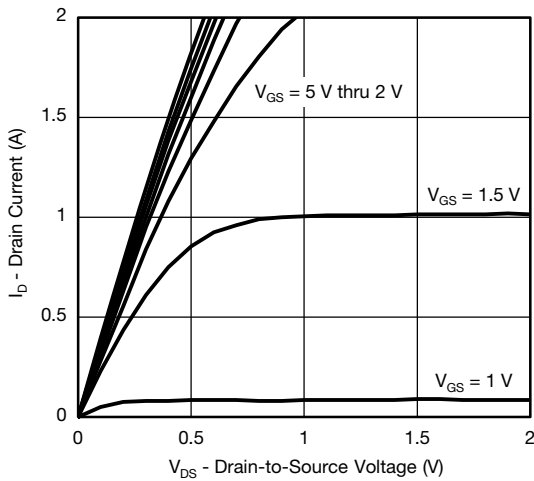
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



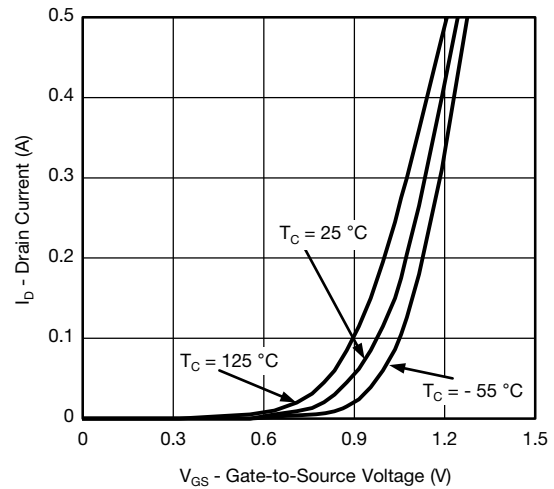
**Gate Current vs. Gate-Source Voltage**



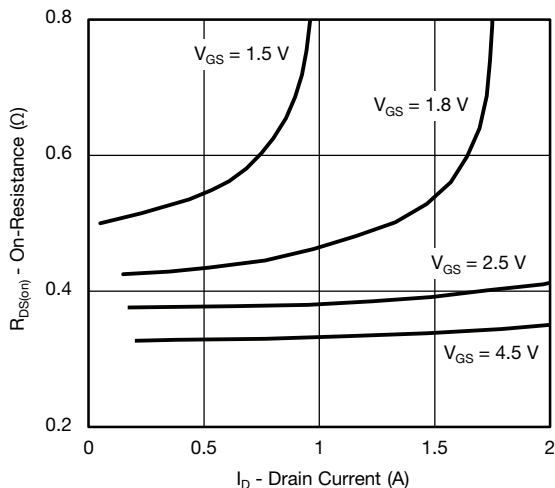
**Gate Current vs. Gate-Source Voltage**



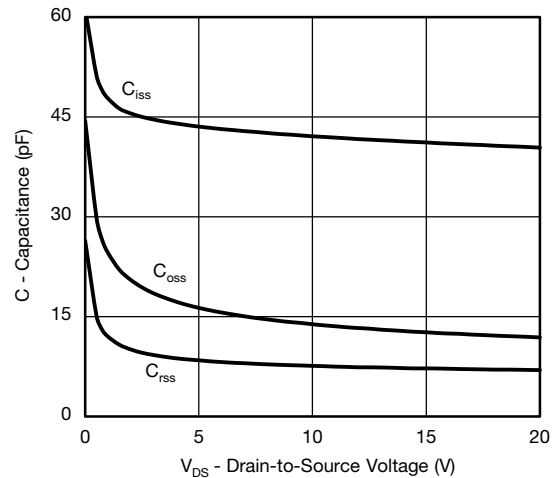
**Output Characteristics**



**Transfer Characteristics**



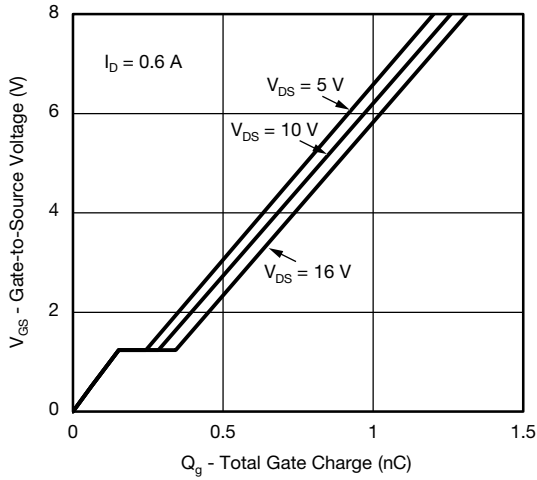
**On-Resistance vs. Drain Current**



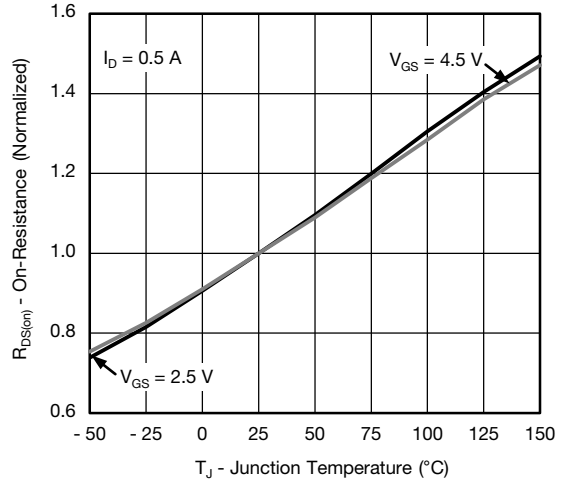
**Capacitance**



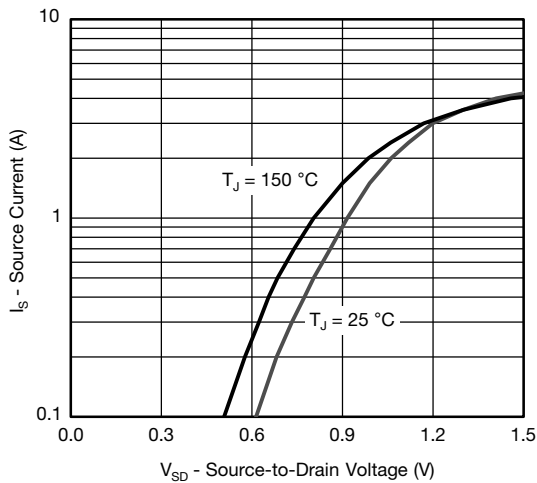
N-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



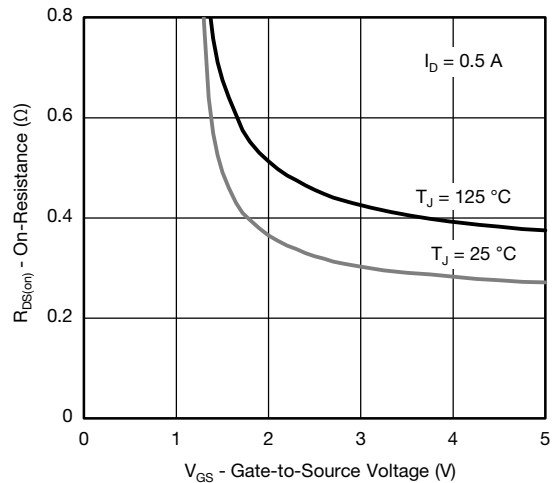
Gate Charge



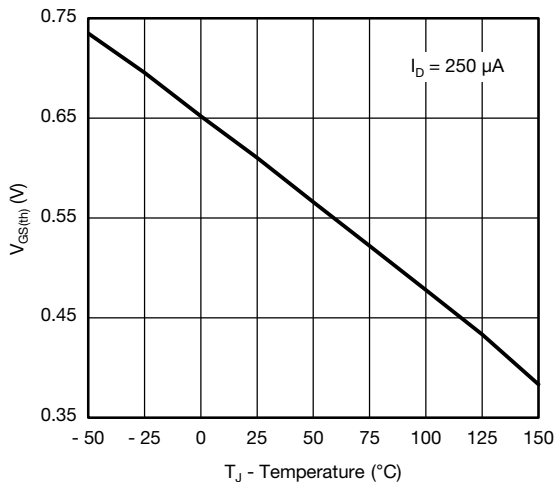
On-Resistance vs. Junction Temperature



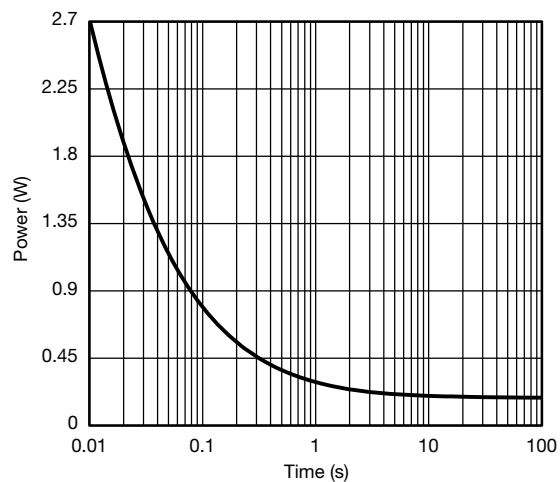
Source-Drain Diode Forward Voltage



On-Resistance vs. Gate-to-Source Voltage



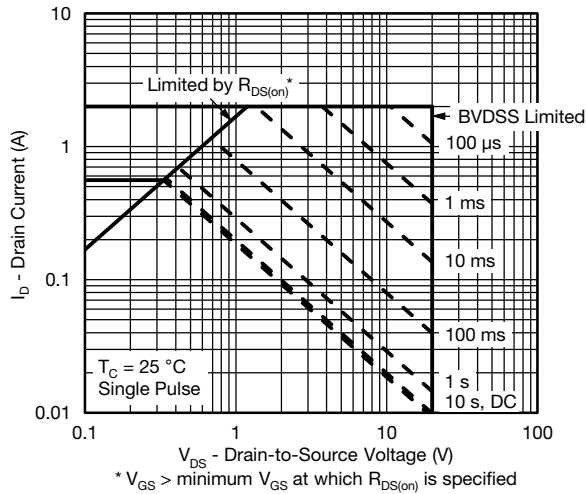
Threshold Voltage



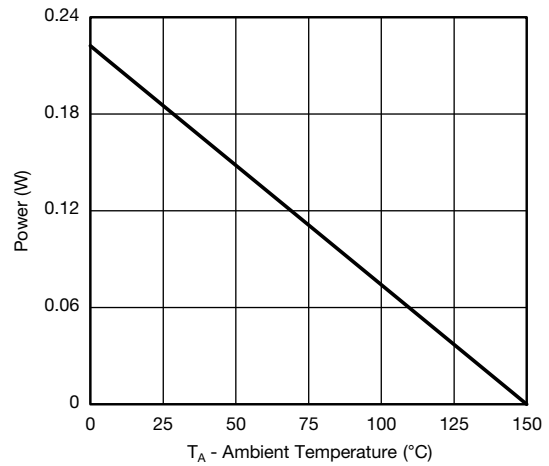
Single Pulse Power, Junction-to-Ambient



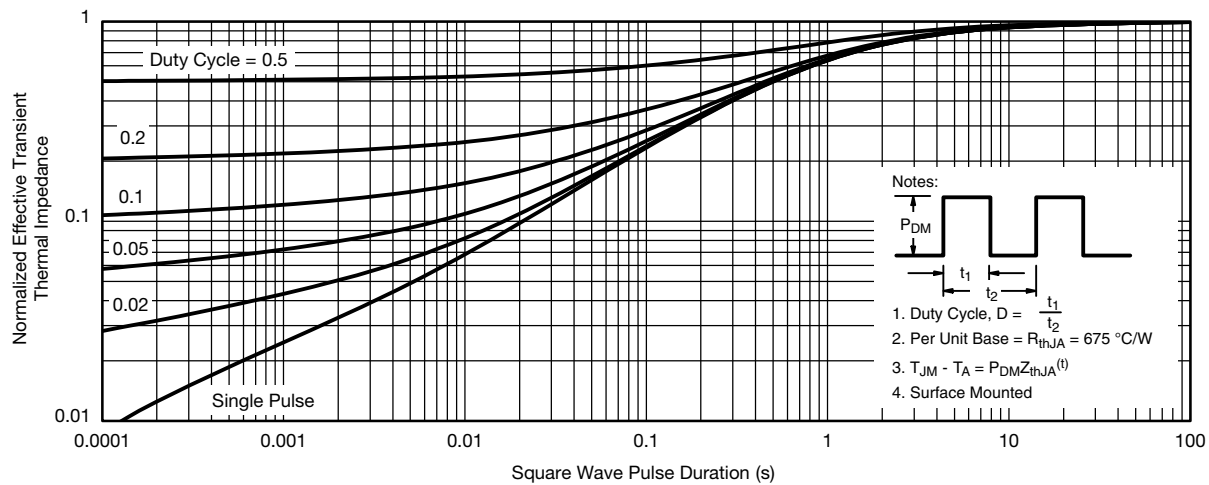
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



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



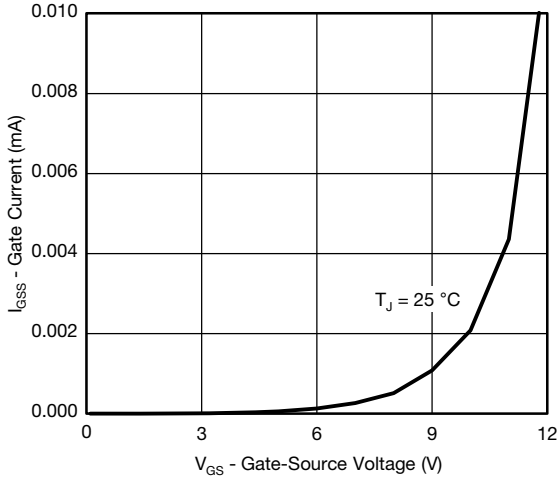
**Power Derating, Junction-to-Ambient**



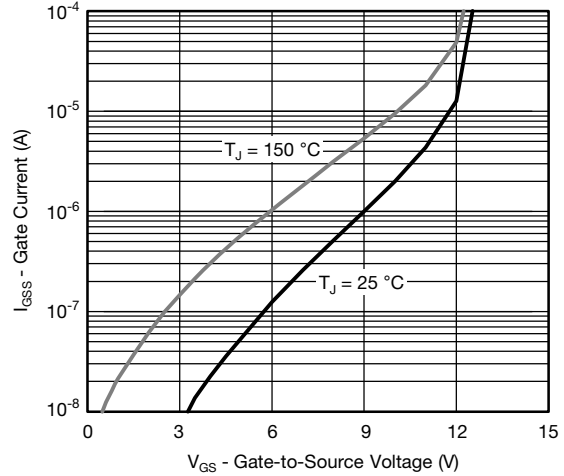
**Normalized Thermal Transient Impedance, Junction-to-Ambient**



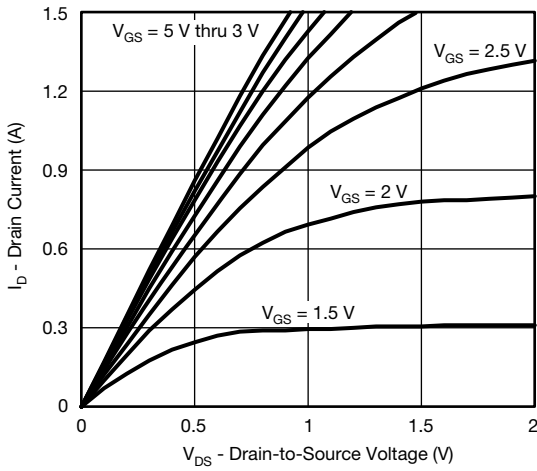
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



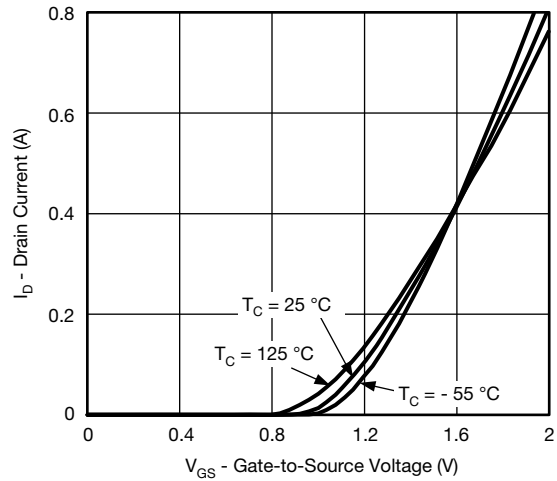
**Gate Current vs. Gate-Source Voltage**



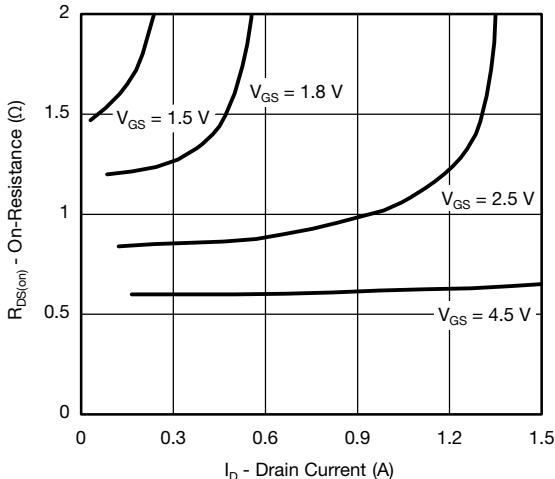
**Gate Current vs. Gate-Source Voltage**



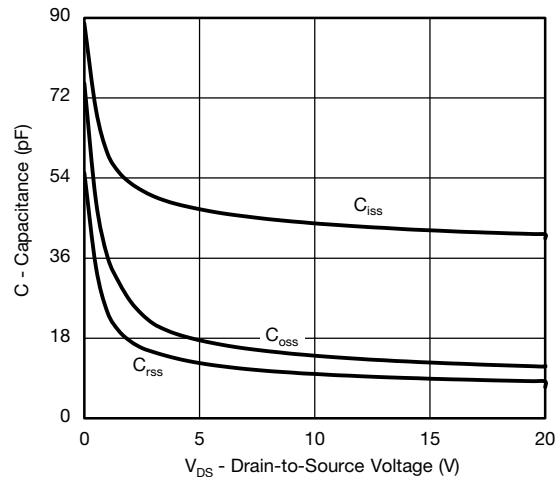
**Output Characteristics**



**Transfer Characteristics**



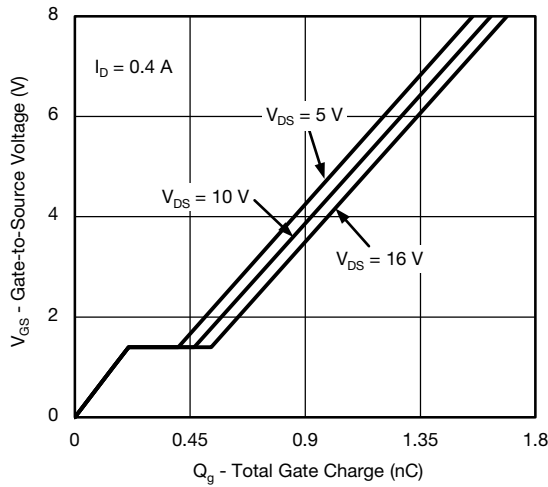
**On-Resistance vs. Drain Current**



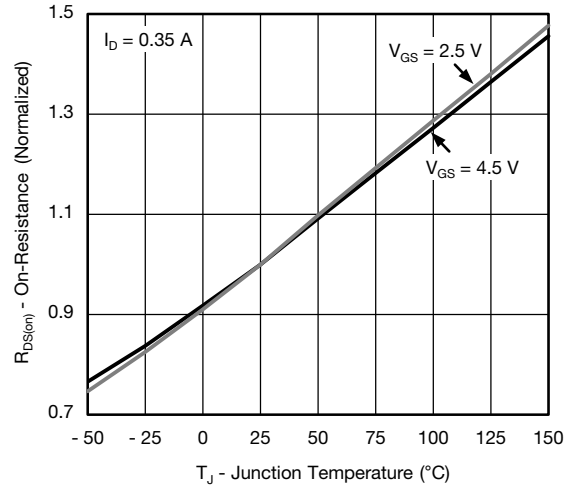
**Capacitance**



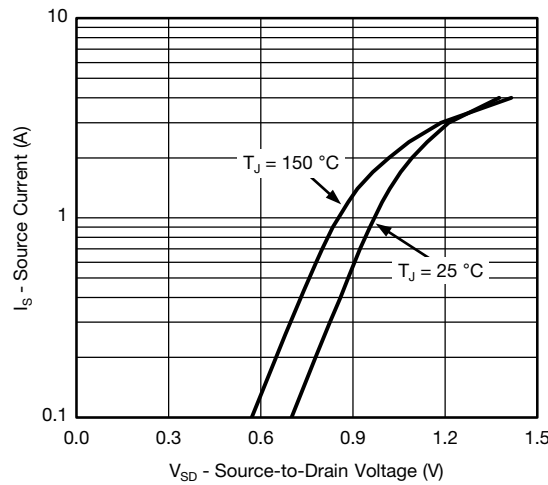
P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



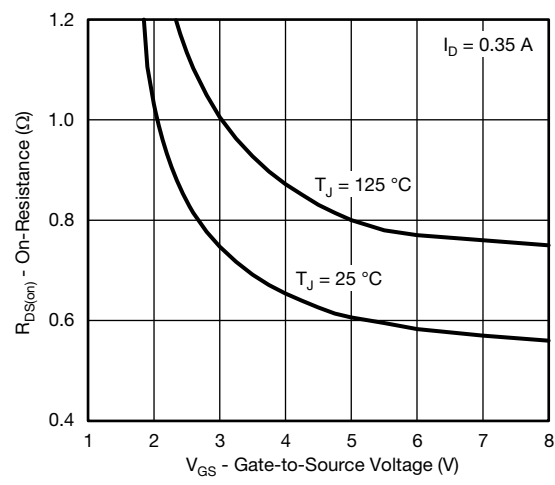
Gate Charge



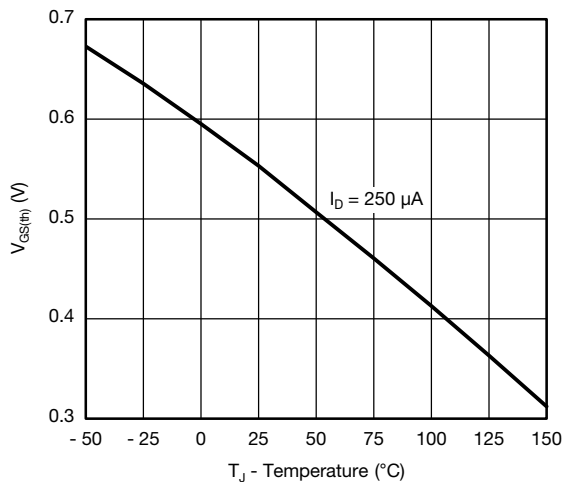
On-Resistance vs. Junction Temperature



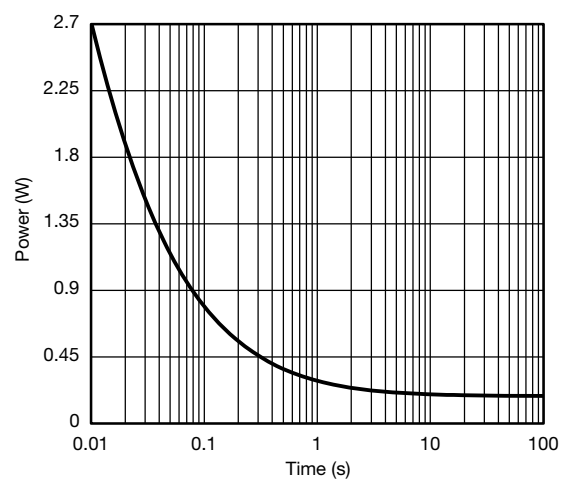
Source-Drain Diode Forward Voltage



On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage

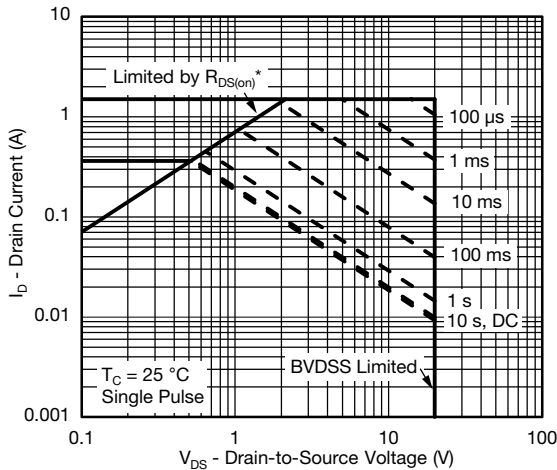


Single Pulse Power, Junction-to-Ambient

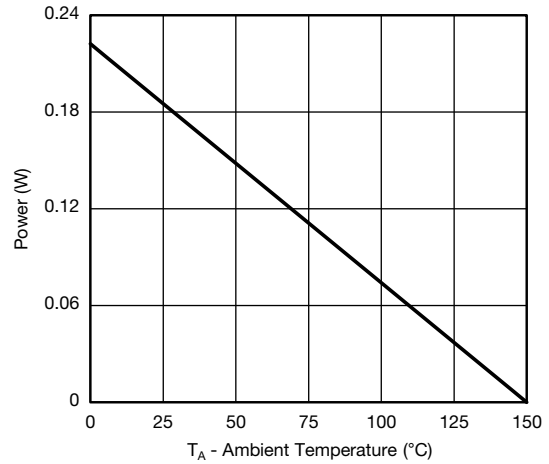




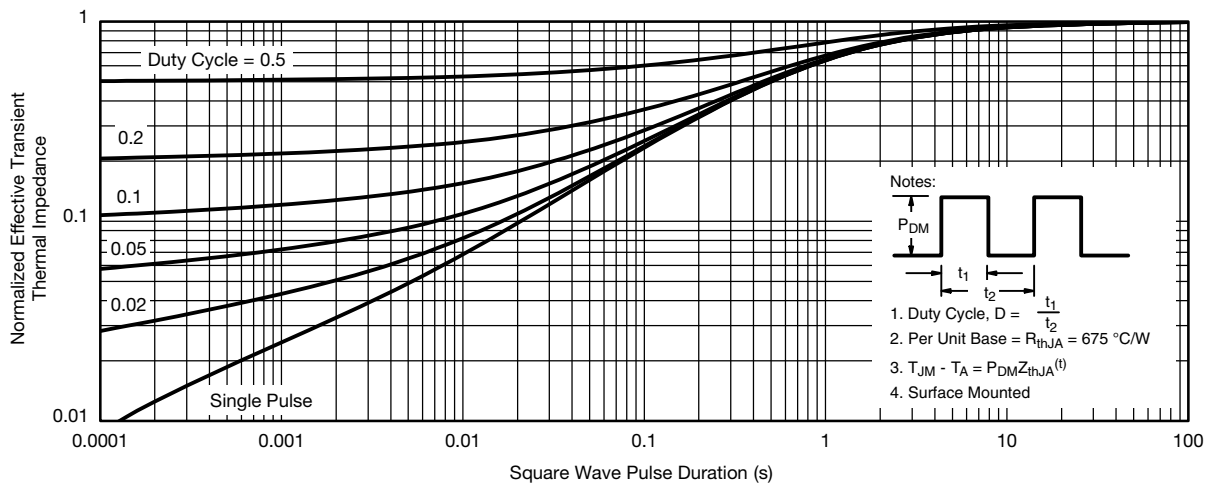
P-CHANNEL TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



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



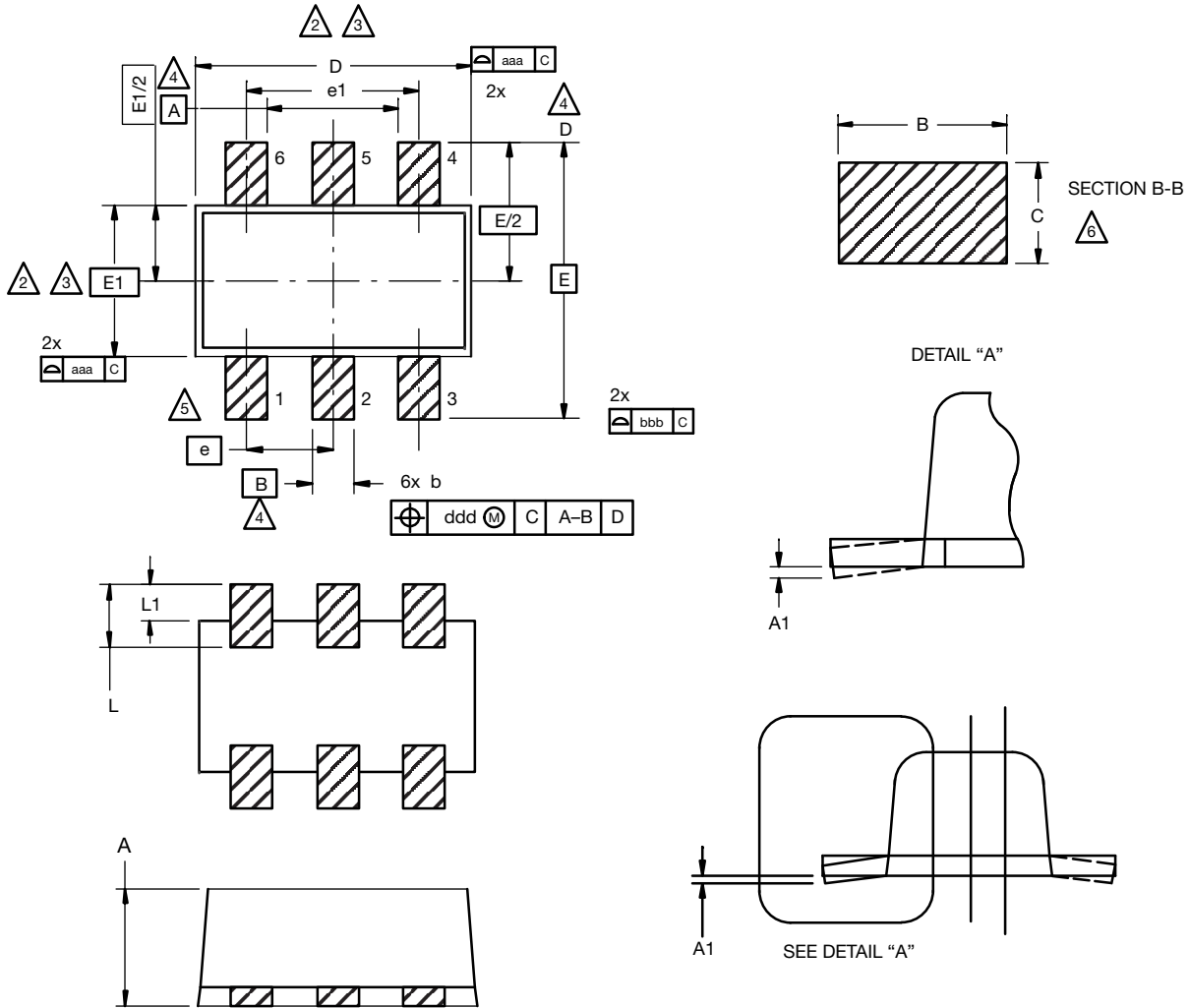
**Power Derating, Junction-to-Ambient**



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

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see [www.vishay.com/ppg267535](http://www.vishay.com/ppg267535).

### SC-89 6-Leads (SOT-563F)



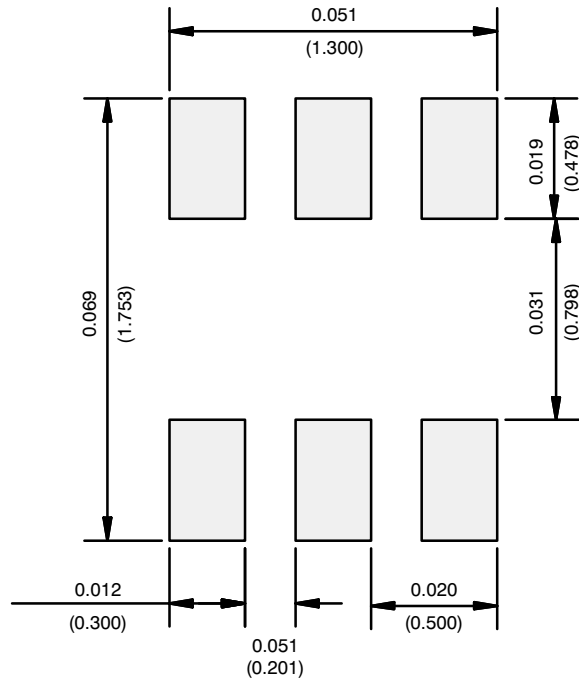
**Notes**

1. Dimensions in millimeters.
- ⚠ Dimension D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm per dimension E1 does not include interlead flash or protrusion, interlead flash or protrusion shall not exceed 0.15 mm per side.
- ⚠ Dimensions D and E1 are determined at the outmost extremes of the plastic body exclusive of mold flash, the bar burrs, gate burrs and interlead flash, but including any mismatch between the top and the bottom of the plastic body.
- ⚠ Datums A, B and D to be determined 0.10 mm from the lead tip.
- ⚠ Terminal numbers are shown for reference only.
- ⚠ These dimensions apply to the flat section of the lead between 0.08 mm and 0.15 mm from the lead tip.

DIM.	MILLIMETERS		
	MIN.	NOM.	MAX.
A	0.56	0.58	0.60
A1	0	0.02	0.10
b	0.15	0.22	0.30
c	0.10	0.14	0.18
D	1.50	1.60	1.70
E	1.50	1.60	1.70
E1	1.15	1.20	1.25
e	0.45	0.50	0.55
e1	0.95	1.00	1.05
L	0.25	0.35	0.50
L1	0.10	0.20	0.30

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## RECOMMENDED MINIMUM PADS FOR SC-89: 6-Lead



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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