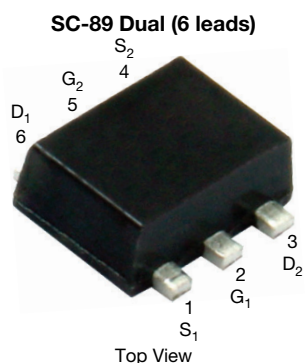


# Complementary N- and P-Channel 20 V (D-S) MOSFET

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	



**Marking Code:** 5

**Ordering Information:**

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

## FEATURES

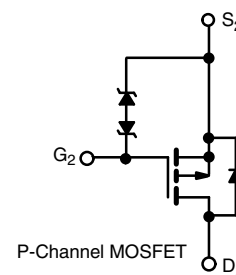
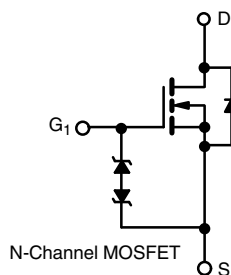
- TrenchFET® power MOSFETs
- High-side switching
- Ease in driving switches
- Low offset (error) voltage
- Low-voltage operation
- High-speed circuits
- Typical ESD protection:  
n-channel 900 V, p-channel 900 V (HBM)
- 100 % R<sub>g</sub> tested
- Material categorization: for definitions of compliance 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



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)	T <sub>A</sub> = 25 °C	I <sub>D</sub>	0.6 a, b	-0.6 a, b	A
	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	
Source Drain Current Diode Current	T <sub>A</sub> = 25 °C	I <sub>S</sub>	0.18 a, b	-0.18 a, b	
Maximum Power Dissipation	T <sub>A</sub> = 25 °C	P <sub>D</sub>	0.22 a, b	0.22 a, b	W
	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 <sup>a, c</sup>	t ≤ 5 s	R <sub>thJA</sub>	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
Static							
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	-	
		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	
		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	
		V <sub>GS</sub> = -1.5 V, I <sub>D</sub> = -0.05 A	P-Ch	-	1.600	2.400	
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	-	
			P-Ch	-	15	-	
Reverse Transfer Capacitance	C <sub>rss</sub>	P-Channel V <sub>DS</sub> = -10 V, V <sub>GS</sub> = 0 V, f = 1 MHz	N-Ch	-	8	-	
			P-Ch	-	10	-	
Dynamic <sup>a</sup>							
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
Dynamic <sup>a</sup>							
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
Rise Time	t <sub>r</sub>		P-Ch	-	9	18	
			N-Ch	-	16	24	
Turn-Off Delay Time	t <sub>d(off)</sub>		P-Ch	-	10	20	
		N-Ch	-	26	39		
Fall Time	t <sub>f</sub>	P-Ch	-	10	20		
		N-Ch	-	11	20		
Turn-On Delay Time	t <sub>d(on)</sub>	P-Ch	-	8	16		
		N-Ch	-	2	4		
Rise Time	t <sub>r</sub>	P-Ch	-	1	2		
		N-Ch	-	13	20		
Turn-Off Delay Time	t <sub>d(off)</sub>	P-Ch	-	8	16		
		N-Ch	-	7	14		
Fall Time	t <sub>f</sub>	P-Ch	-	9	18		
		N-Ch	-	5	10		
		P-Ch	-	5	10		
Drain-Source Body Diode Characteristics							
Pulse Diode Forward Current <sup>a</sup>	I <sub>SM</sub>	I <sub>S</sub> = 0.5 A, V <sub>GS</sub> = 0 V	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>		N-Ch	-	2	4	nC
			P-Ch	-	8	20	
Reverse Recovery Fall Time	t <sub>a</sub>	P-Channel I <sub>F</sub> = -0.3 A, dI/dt = -100 A/μs, T <sub>J</sub> = 25 °C	N-Ch	-	5	-	ns
			P-Ch	-	11	-	
Reverse Recovery Rise Time	t <sub>b</sub>		N-Ch	-	5	-	
			P-Ch	-	5	-	

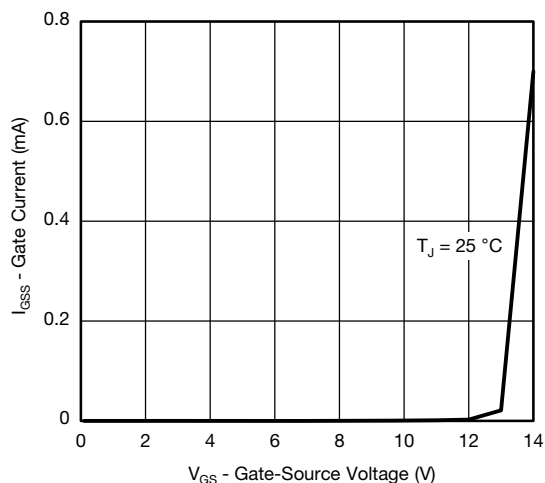
**Notes**

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

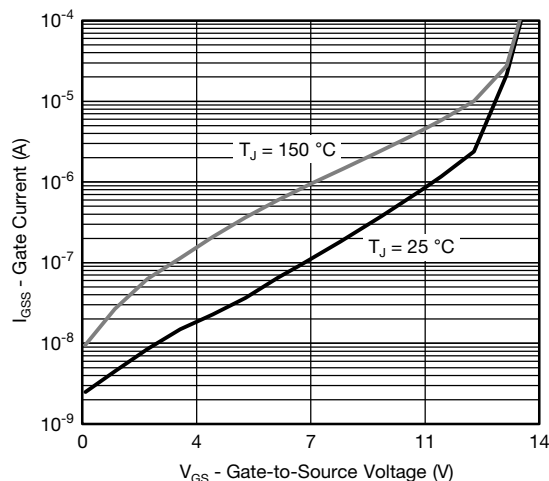
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



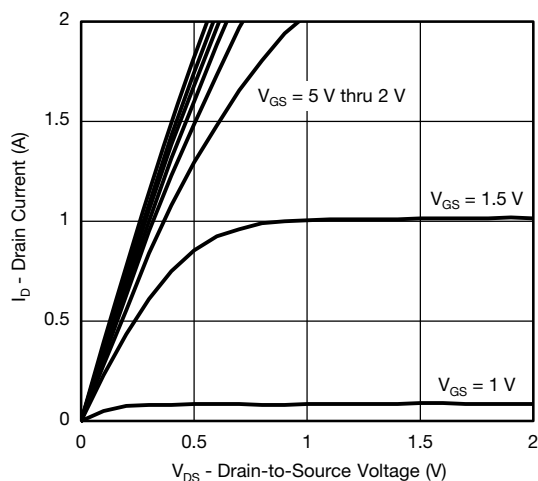
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



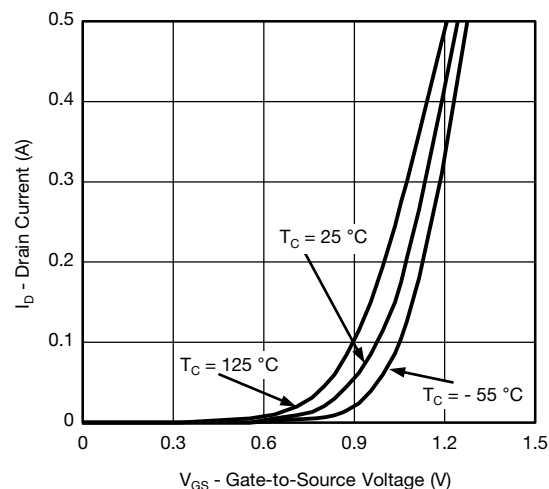
**Gate Current vs. Gate-Source Voltage**



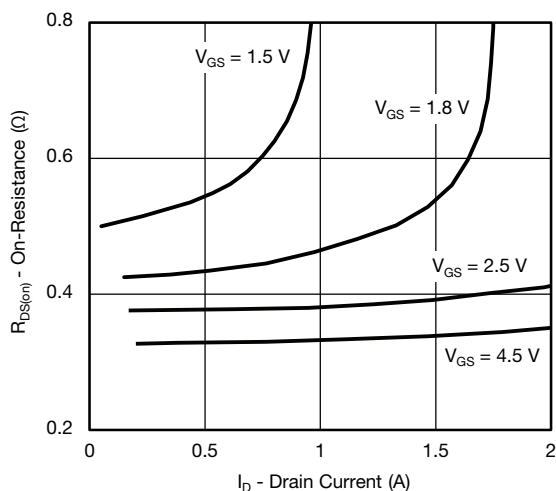
**Gate Current vs. Gate-Source Voltage**



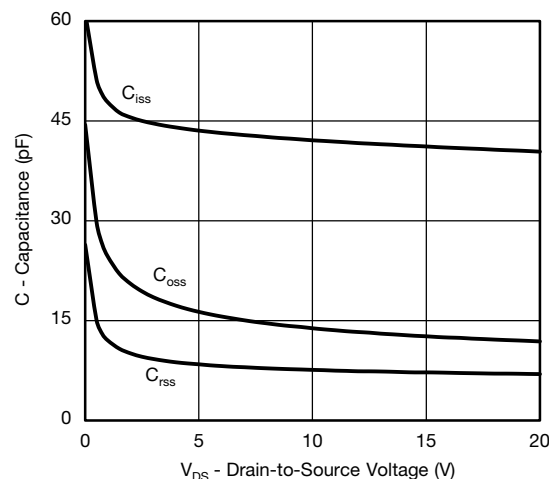
**Output Characteristics**



**Transfer Characteristics**



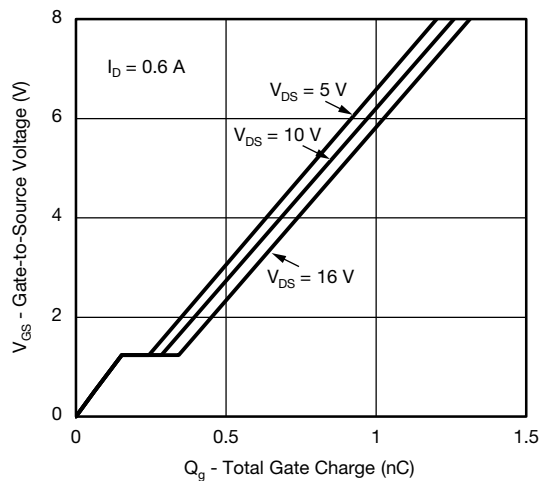
**On-Resistance vs. Drain Current**



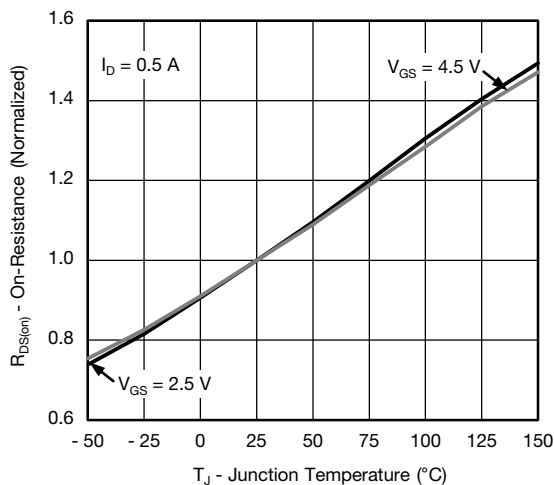
**Capacitance**



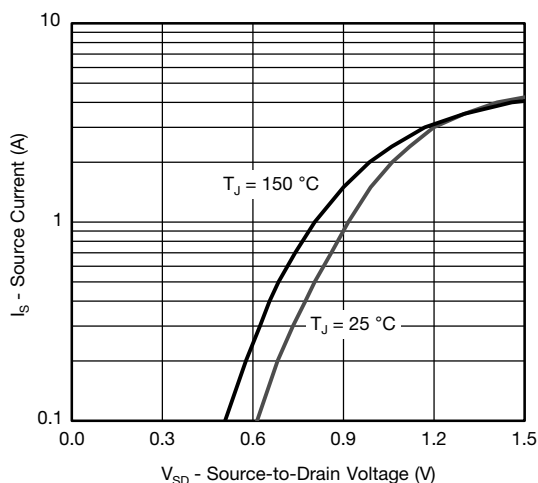
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



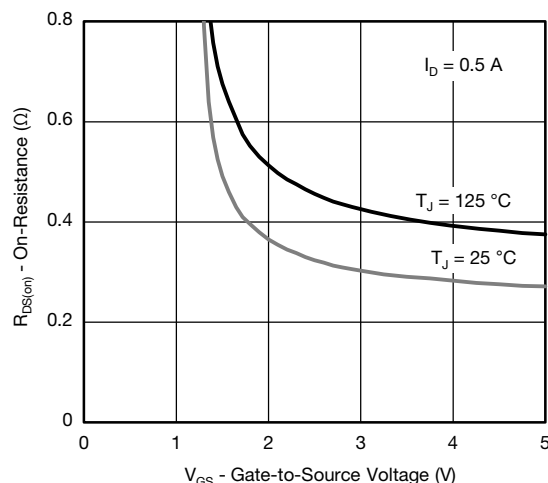
**Gate Charge**



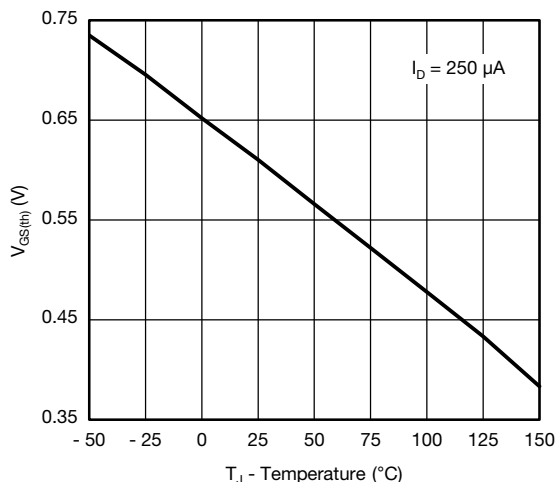
**On-Resistance vs. Junction Temperature**



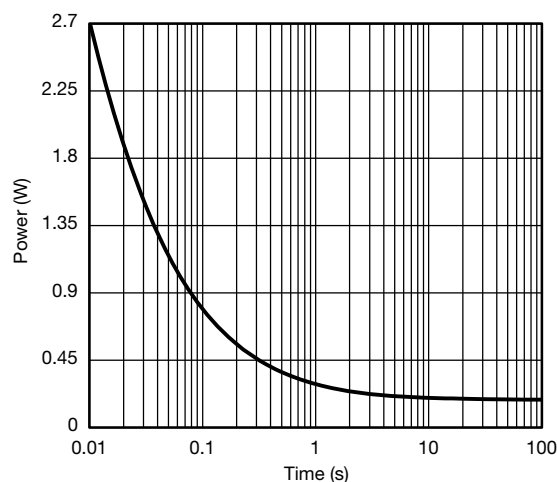
**Source-Drain Diode Forward Voltage**



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



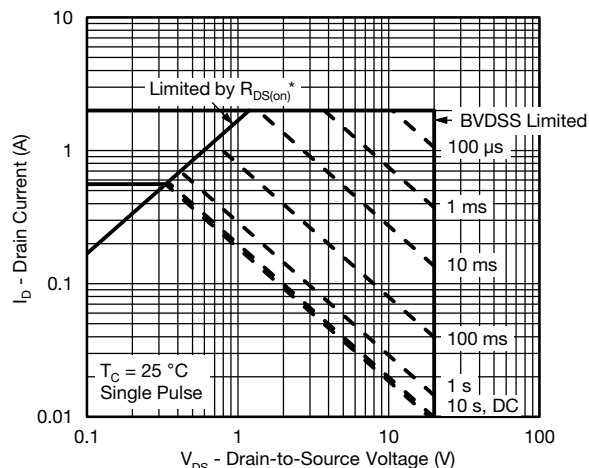
**Threshold Voltage**



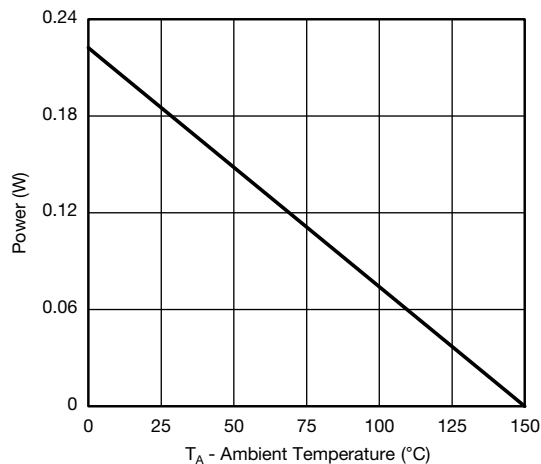
**Single Pulse Power, Junction-to-Ambient**



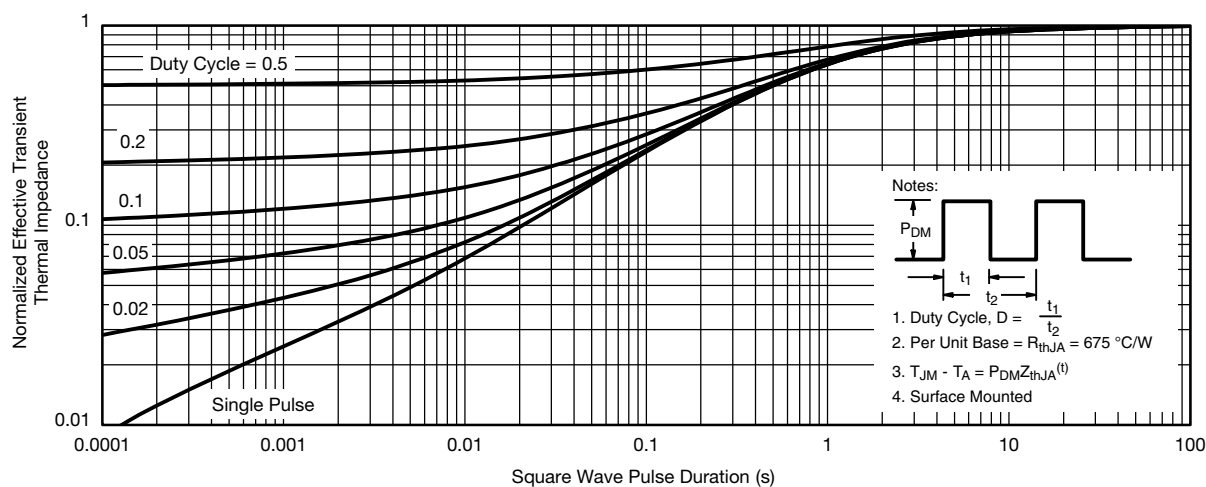
**N-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



Safe Operating Area, Junction-to-Ambient



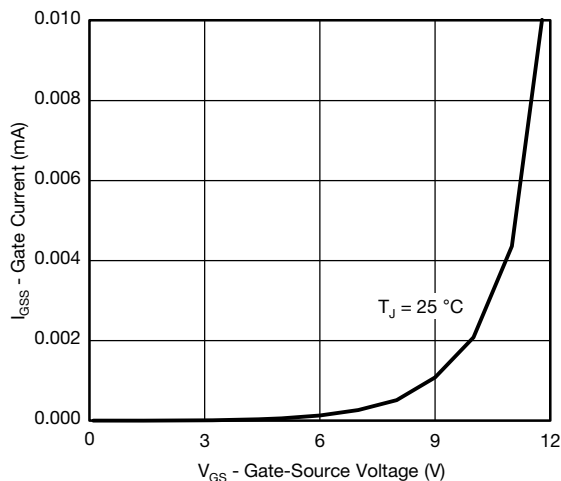
Power Derating, Junction-to-Ambient



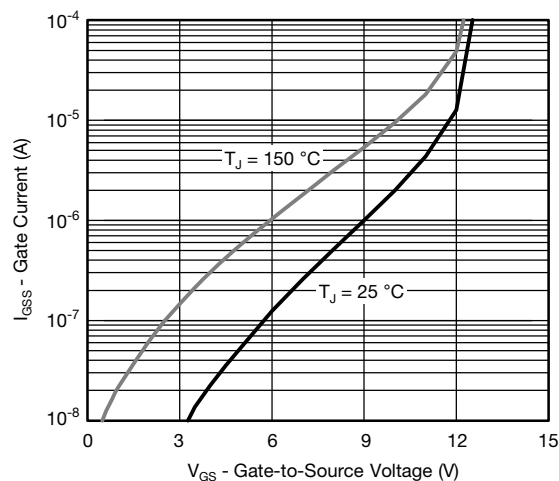
Normalized Thermal Transient Impedance, Junction-to-Ambient



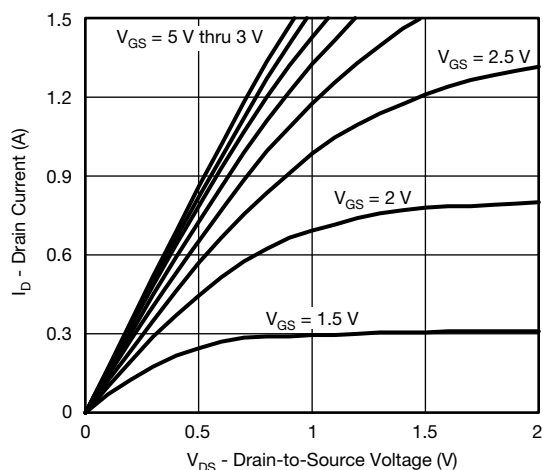
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



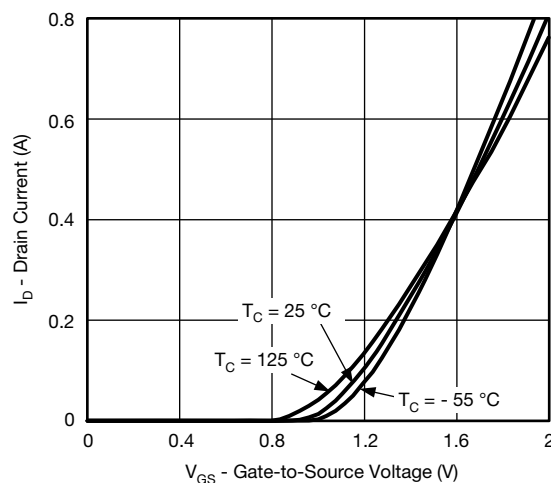
**Gate Current vs. Gate-Source Voltage**



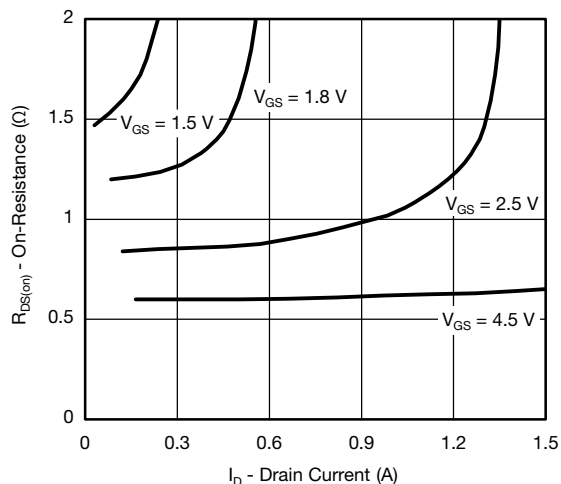
**Gate Current vs. Gate-Source Voltage**



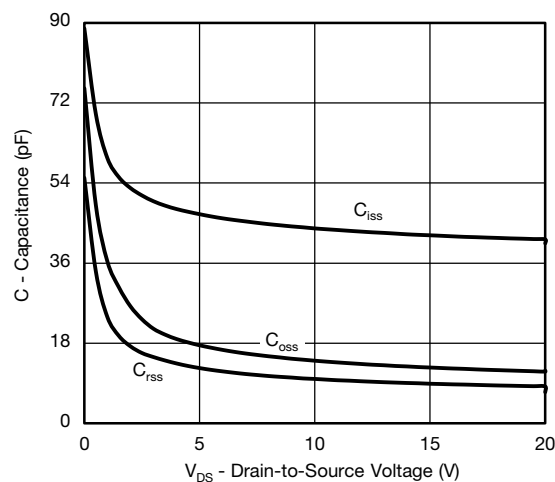
**Output Characteristics**



**Transfer Characteristics**



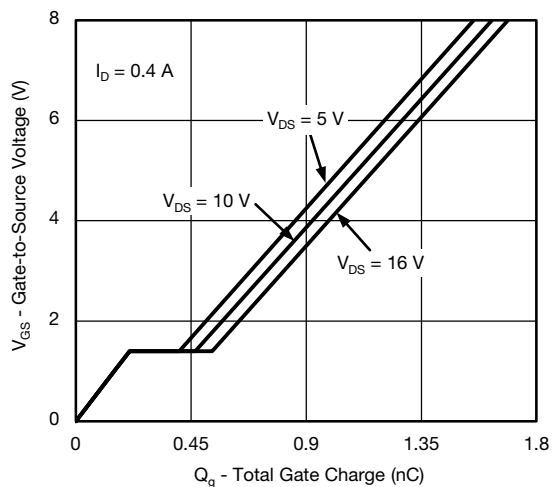
**On-Resistance vs. Drain Current**



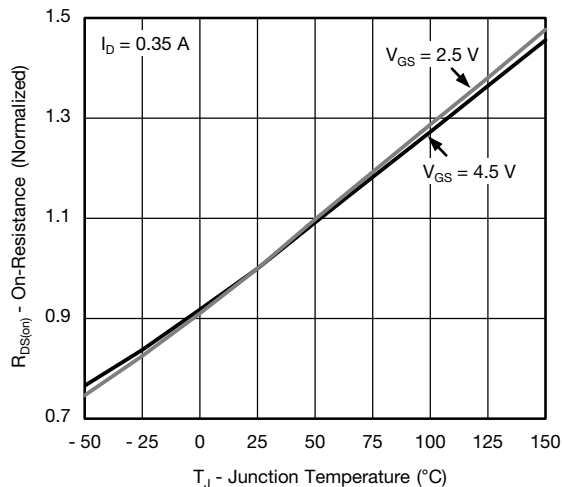
**Capacitance**



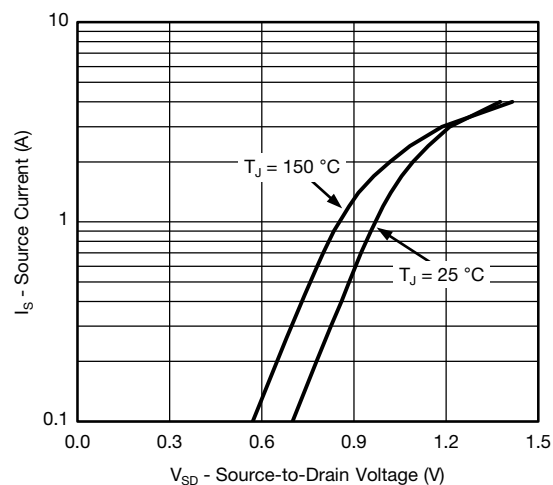
**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



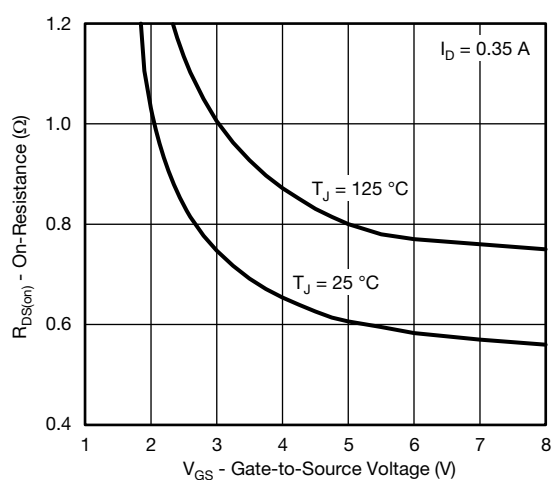
**Gate Charge**



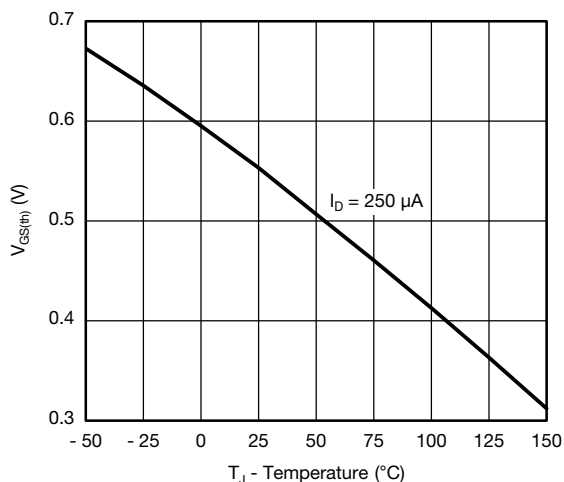
**On-Resistance vs. Junction Temperature**



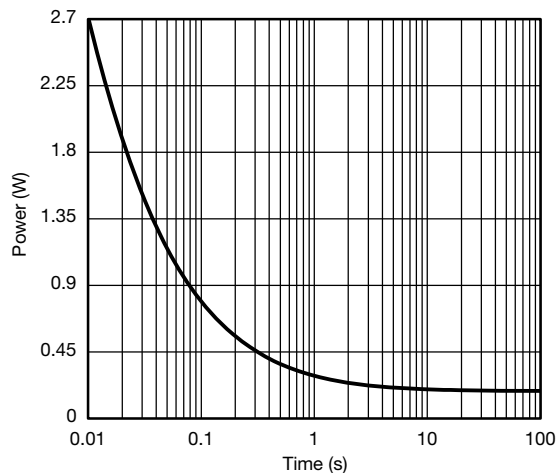
**Source-Drain Diode Forward Voltage**



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



**Threshold Voltage**

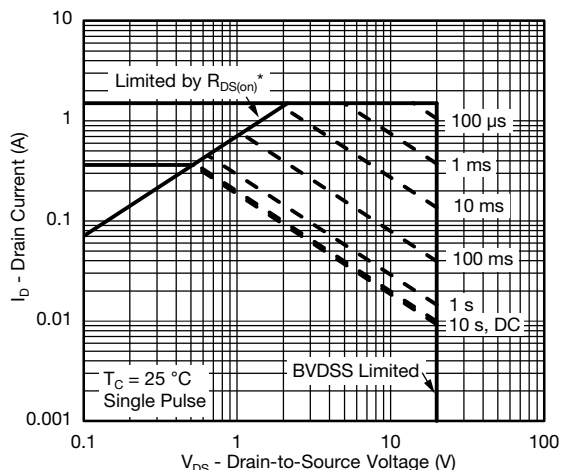


**Single Pulse Power, Junction-to-Ambient**



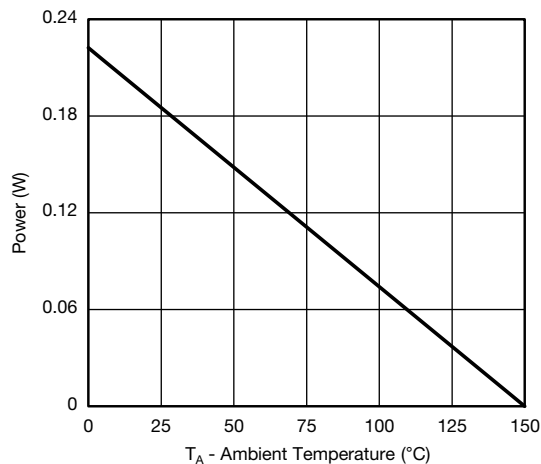


**P-CHANNEL TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)

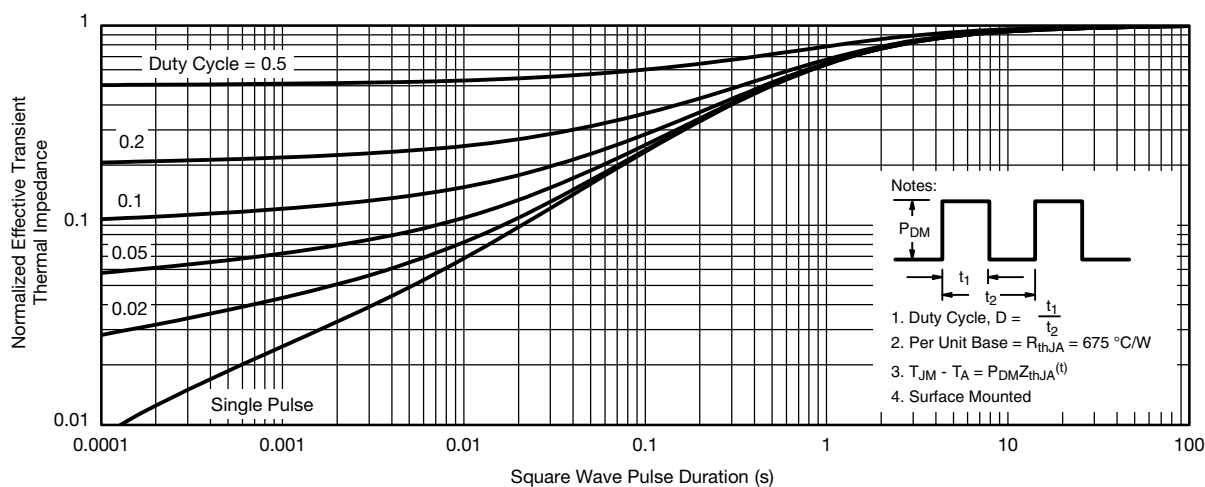


\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

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



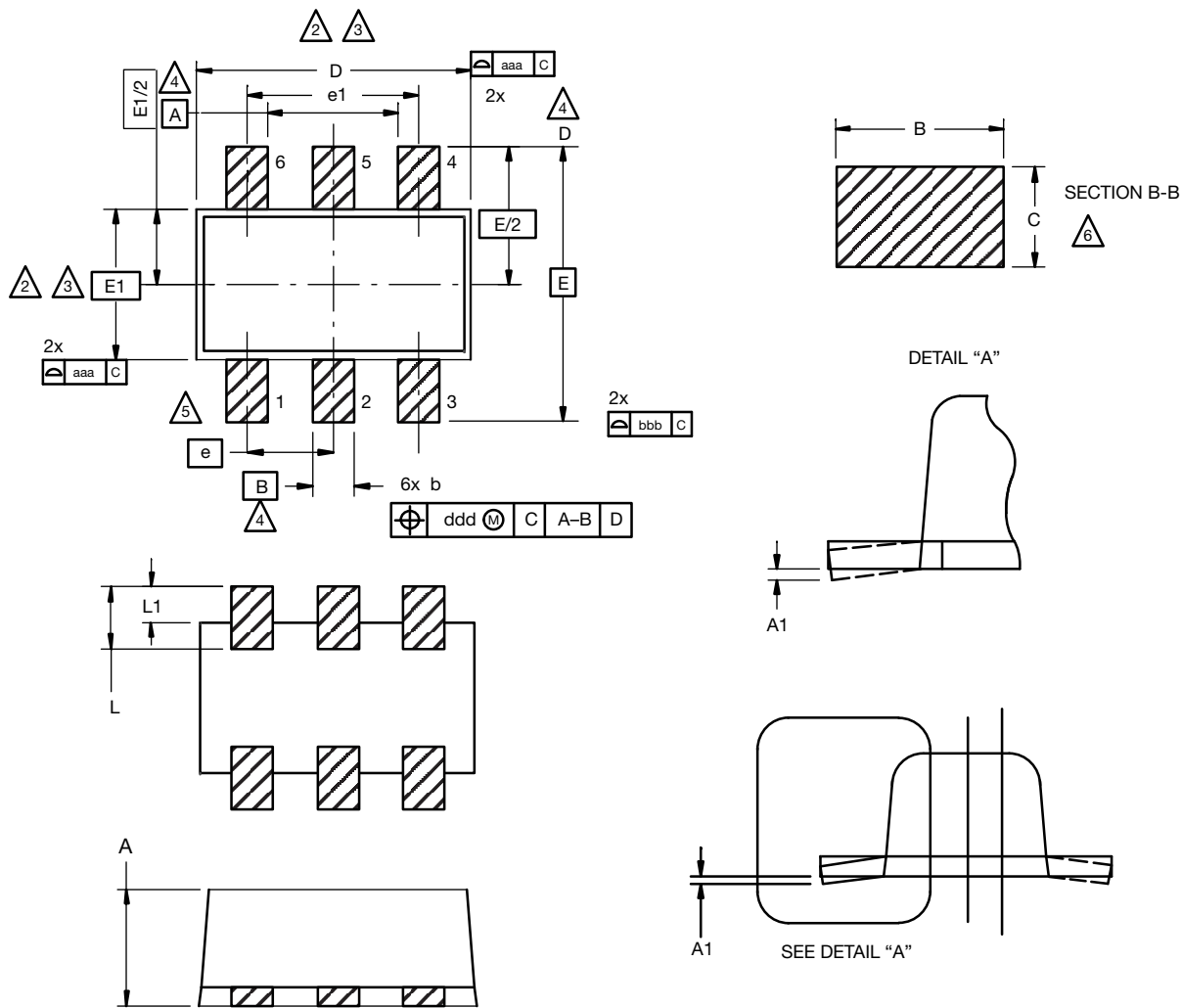
**Power Derating, Junction-to-Ambient**



**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)



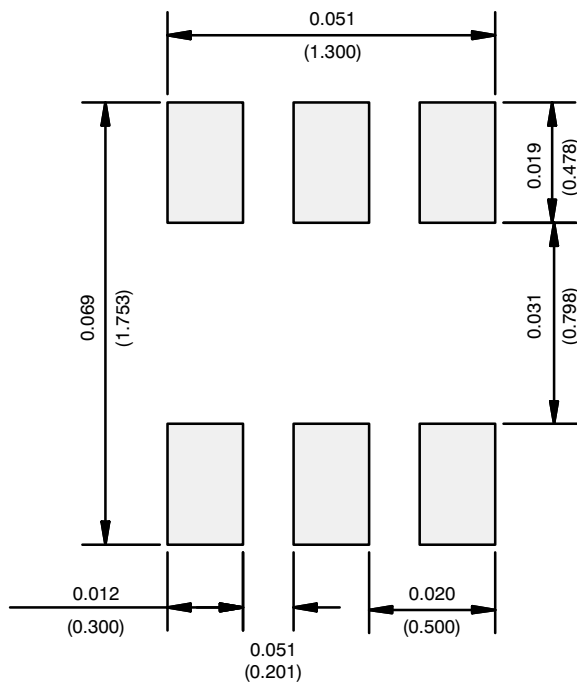
## Notes

1. Dimensions in millimeters.
2. 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.
3. 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.
4. Datums A, B and D to be determined 0.10 mm from the lead tip.
5. Terminal numbers are shown for reference only.
6. 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

C14-0439-Rev. C, 11-Aug-14  
DWG: 5880

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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



## Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

## Material Category Policy

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**