

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

## PRODUCT SUMMARY

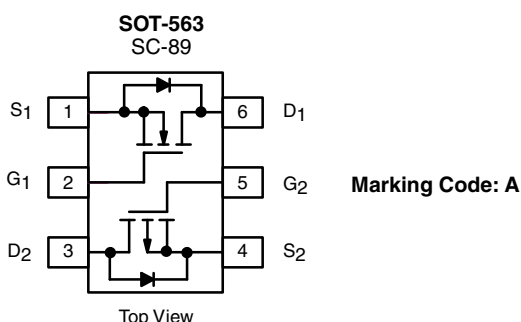
	V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω)	I <sub>D</sub> (mA)
N-Channel	20	0.70 at V <sub>GS</sub> = 4.5 V	600
		0.85 at V <sub>GS</sub> = 2.5 V	500
		1.25 at V <sub>GS</sub> = 1.8 V	350
P-Channel	- 20	1.2 at V <sub>GS</sub> = - 4.5 V	- 400
		1.6 at V <sub>GS</sub> = - 2.5 V	- 300
		2.7 at V <sub>GS</sub> = - 1.8 V	- 150

## FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- TrenchFET® Power MOSFETs
- 2000 V ESD Protection
- Very Small Footprint
- High-Side Switching
- Low On-Resistance:  
N-Channel, 0.7 Ω  
P-Channel, 1.2 Ω
- Low Threshold: ± 0.8 V (Typ.)
- Fast Switching Speed: 14 ns
- 1.8 V Operation
- Compliant to RoHS Directive 2002/95/EC



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



## BENEFITS

- Ease in Driving Switches
- Low Offset (Error) Voltage
- Low-Voltage Operation
- High-Speed Circuits
- Low Battery Voltage Operation

## APPLICATIONS

- Replace Digital Transistor, Level-Shifter
- Battery Operated Systems
- Power Supply Converter Circuits

**Ordering Information:** Si1016X-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
			5 s	Steady State	5 s	Steady State	
Drain-Source Voltage		V <sub>DS</sub>	20		- 20		V
Gate-Source Voltage		V <sub>GS</sub>	± 6				
Continuous Drain Current (T <sub>J</sub> = 150 °C) <sup>a</sup>	T <sub>A</sub> = 25 °C	I <sub>D</sub>	515	485	- 390	- 370	mA
	T <sub>A</sub> = 85 °C		370	350	- 280	- 265	
Pulsed Drain Current <sup>b</sup>		I <sub>DM</sub>	650		- 650		
Continuous Source Current (Diode Conduction) <sup>a</sup>		I <sub>S</sub>	450	380	- 450	- 380	mW
Maximum Power Dissipation <sup>a</sup>	T <sub>A</sub> = 25 °C	P <sub>D</sub>	280	250	280	250	
	T <sub>A</sub> = 85 °C		145	130	145	130	
Operating Junction and Storage Temperature Range		T <sub>J</sub> , T <sub>stg</sub>	- 55 to 150				°C
Gate-Source ESD Rating (HBM, Method 3015)		ESD	2000				V

Notes:

a. Surface mounted on FR4 board.

b. Pulse width limited by maximum junction temperature.

SPECIFICATIONS (T <sub>J</sub> = 25 °C, unless otherwise noted)							
Parameter	Symbol	Test Conditions		Min.	Typ.	Max.	Unit
Static							
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	N-Ch	0.45		1	V
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = - 250 μA	P-Ch	- 0.45		- 1	
Gate Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 4.5 V	N-Ch P-Ch		± 0.5 ± 1.0	± 1.0 ± 2.0	μA
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 16 V, V <sub>GS</sub> = 0 V	N-Ch		0.3	100	nA
		V <sub>DS</sub> = - 16 V, V <sub>GS</sub> = 0 V	P-Ch		- 0.3	- 100	
		V <sub>DS</sub> = 16 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 85 °C	N-Ch			5	μA
		V <sub>DS</sub> = - 16 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 85 °C	P-Ch			- 5	
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	N-Ch	700			mA
		V <sub>DS</sub> = - 5 V, V <sub>GS</sub> = - 4.5 V	P-Ch	- 700			
Drain-Source On-State Resistance <sup>a</sup>	R <sub>DS(on)</sub>	V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 600 mA	N-Ch		0.41	0.70	Ω
		V <sub>GS</sub> = - 4.5 V, I <sub>D</sub> = - 350 mA	P-Ch		0.80	1.2	
		V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 500 mA	N-Ch		0.53	0.85	
		V <sub>GS</sub> = - 2.5 V, I <sub>D</sub> = - 300 mA	P-Ch		1.20	1.6	
		V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 350 mA	N-Ch		0.70	1.25	
		V <sub>GS</sub> = - 1.8 V, I <sub>D</sub> = - 150 mA	P-Ch		1.80	2.7	
Forward Transconductance <sup>a</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 400 mA	N-Ch		1.0		S
		V <sub>DS</sub> = - 10 V, I <sub>D</sub> = - 250 mA	P-Ch		0.4		
Diode Forward Voltage <sup>a</sup>	V <sub>SD</sub>	I <sub>S</sub> = 150 mA, V <sub>GS</sub> = 0 V	N-Ch		0.8	1.2	V
		I <sub>S</sub> = - 150 mA, V <sub>GS</sub> = 0 V	P-Ch		- 0.8	- 1.2	
Dynamic <sup>b</sup>							
Total Gate Charge	Q <sub>g</sub>	N-Channel V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 250 mA P-Channel V <sub>DS</sub> = - 10 V, V <sub>GS</sub> = - 4.5 V, I <sub>D</sub> = - 250 mA	N-Ch P-Ch		750 1500		pC
Gate-Source Charge	Q <sub>gs</sub>		N-Ch P-Ch		75 150		
Gate-Drain Charge	Q <sub>gd</sub>		N-Ch P-Ch		225 450		
Turn-On Time	t <sub>ON</sub>	N-Channel V <sub>DD</sub> = 10 V, R <sub>L</sub> = 47 Ω I <sub>D</sub> ≅ 200 mA, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 10 Ω P-Channel V <sub>DD</sub> = - 10 V, R <sub>L</sub> = 47 Ω I <sub>D</sub> ≅ - 200 mA, V <sub>GEN</sub> = - 4.5 V, R <sub>g</sub> = 10 Ω	N-Ch P-Ch		5 5		ns
Turn-Off Time	t <sub>OFF</sub>		N-Ch P-Ch		25 35		

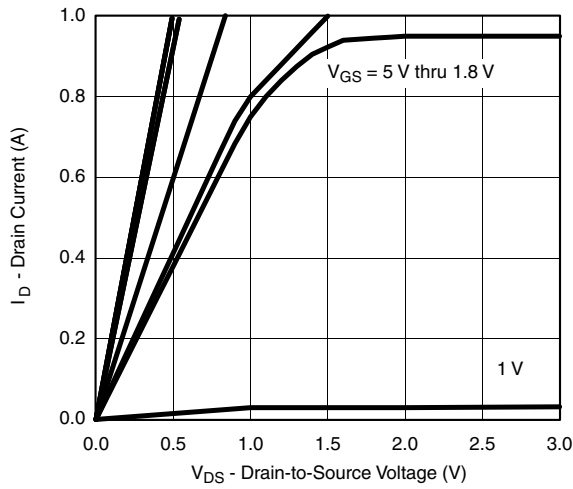
Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

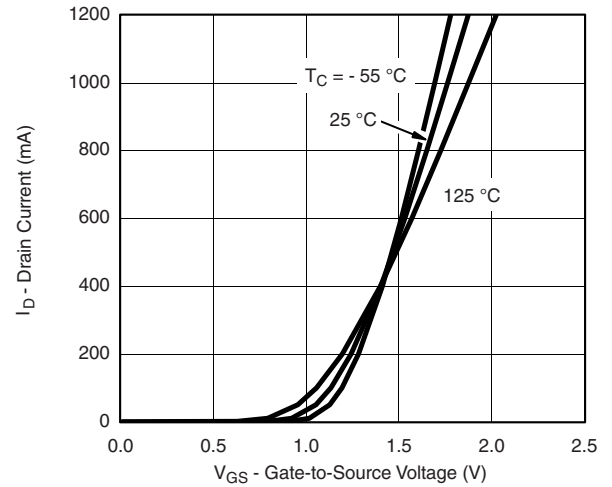
b. Guaranteed by design, not subject to production testing.

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.

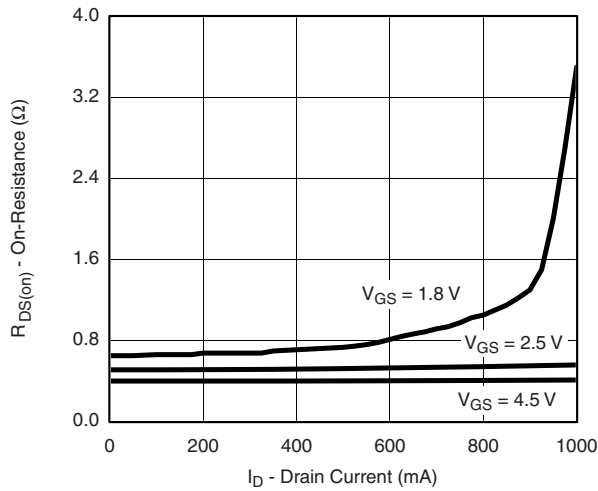
## N-CHANNEL TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



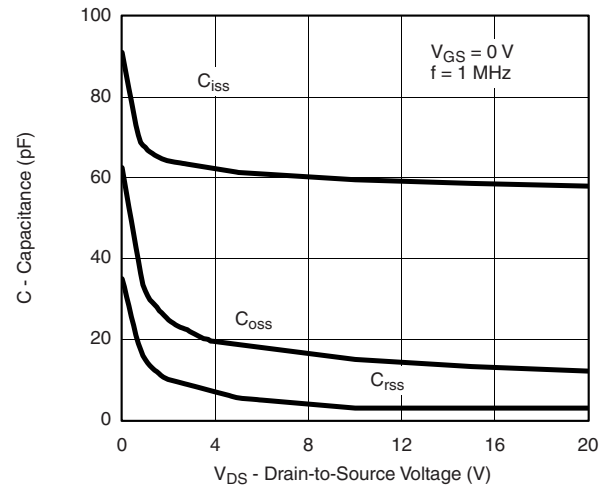
Output Characteristics



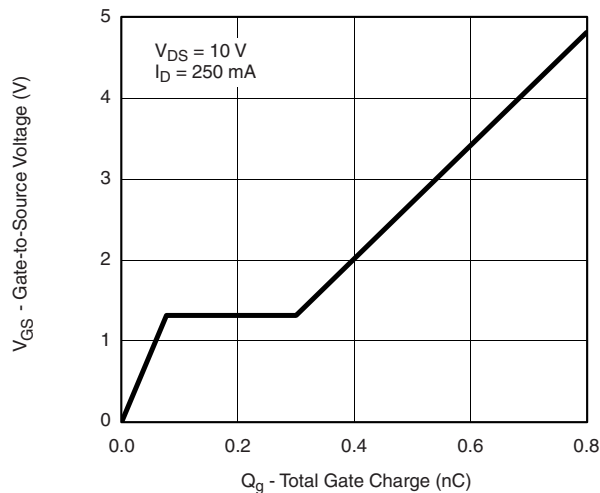
Transfer Characteristics



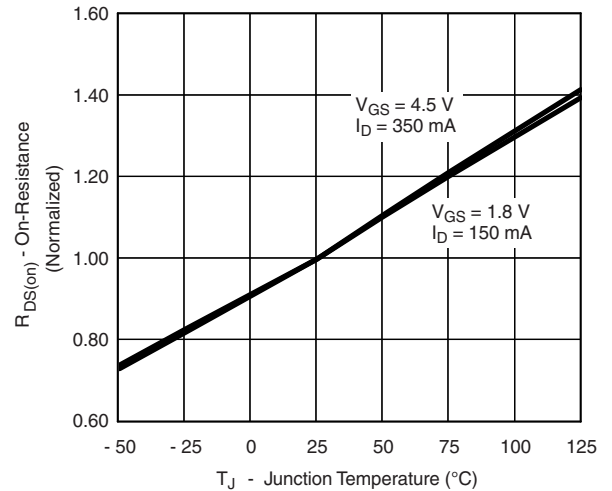
On-Resistance vs. Drain Current



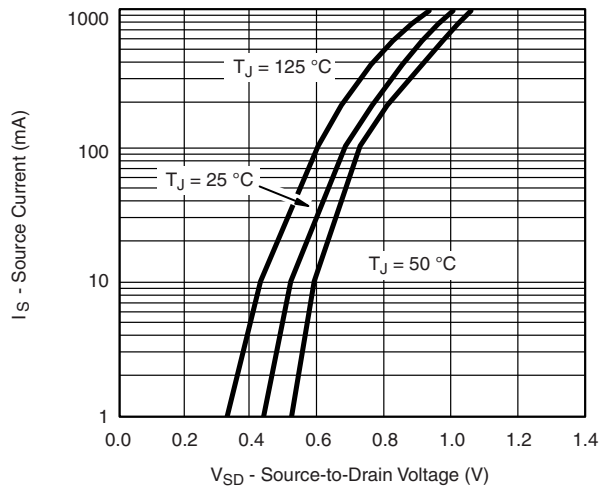
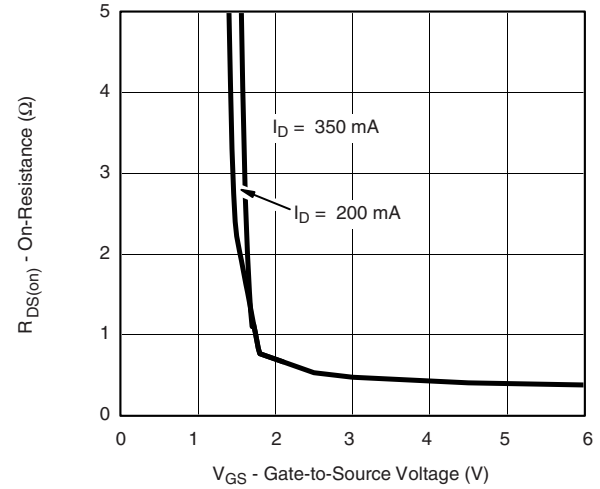
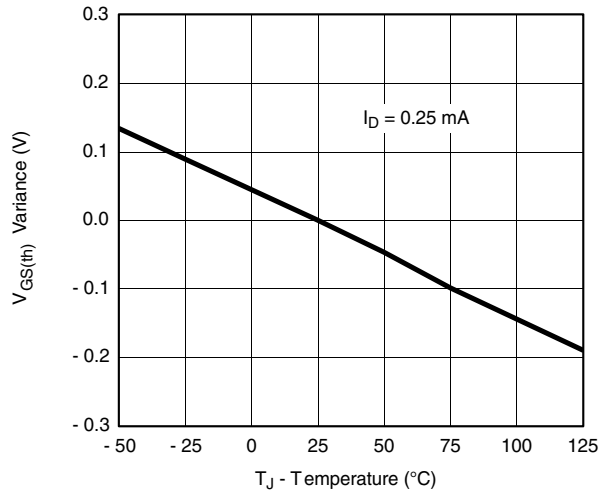
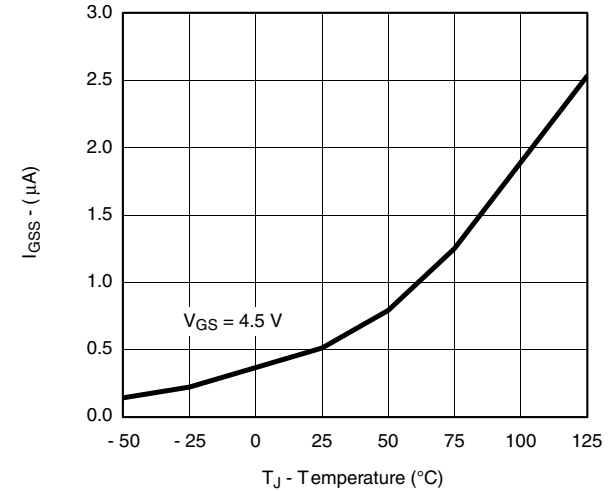
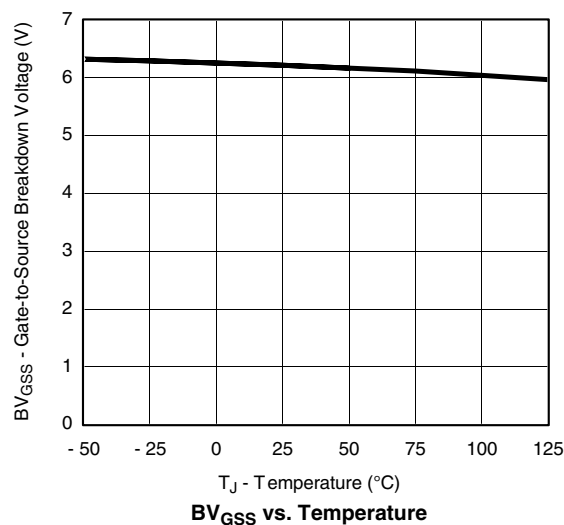
Capacitance



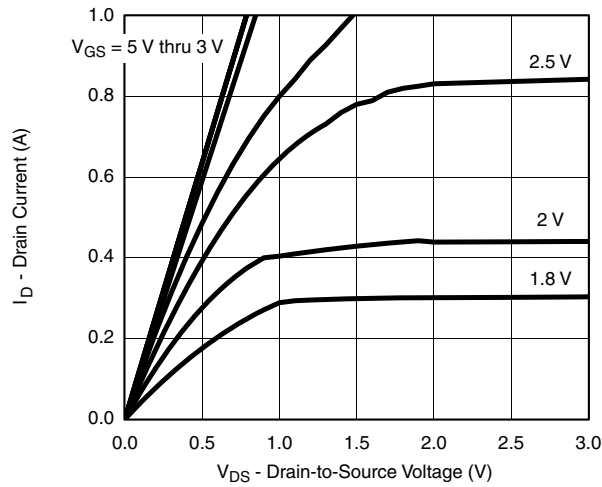
Gate Charge



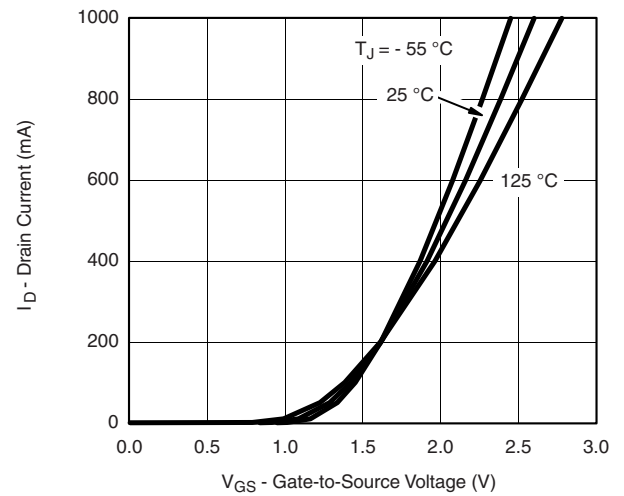
On-Resistance vs. Junction Temperature

**N-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)

**Source-Drain Diode Forward Voltage**

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

**Threshold Voltage Variance vs. Temperature**

 **$I_{GSS}$  vs. Temperature**

 **$BV_{GSS}$  vs. Temperature**

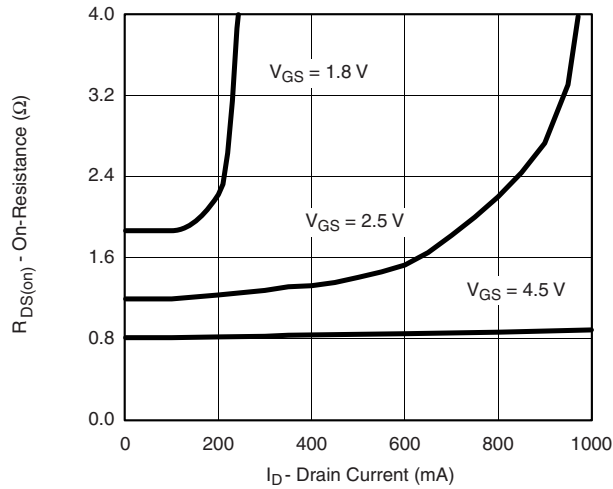
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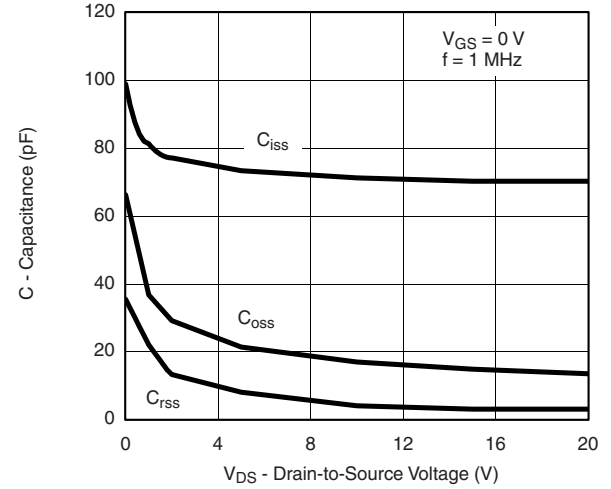
Output Characteristics



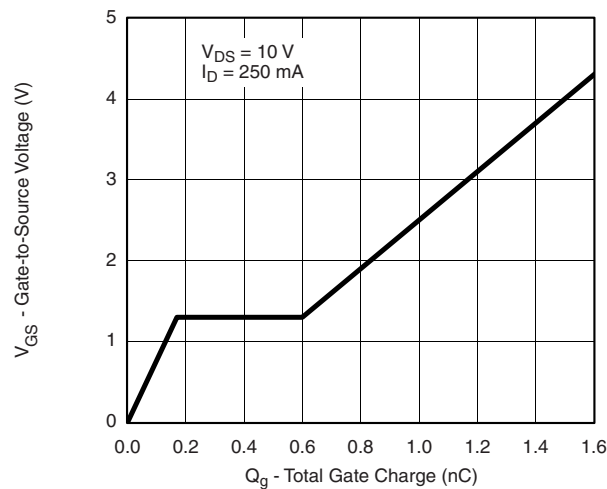
Transfer Characteristics



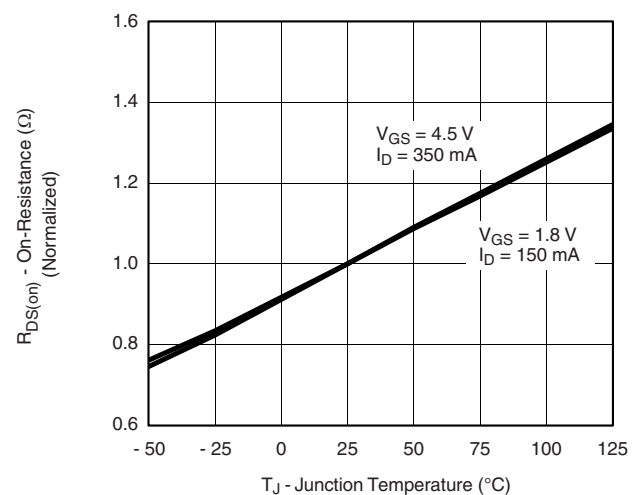
On-Resistance vs. Drain Current



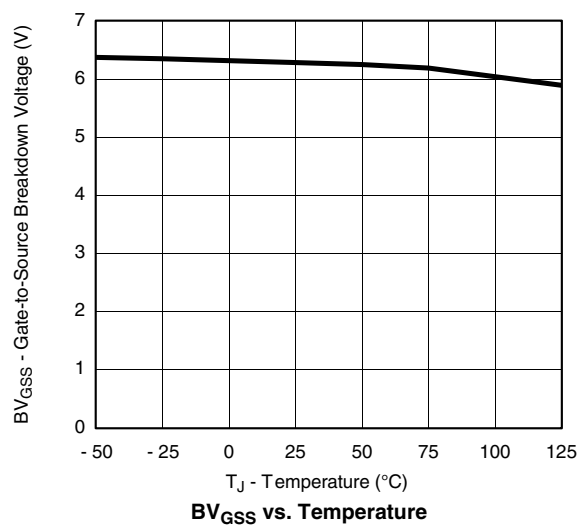
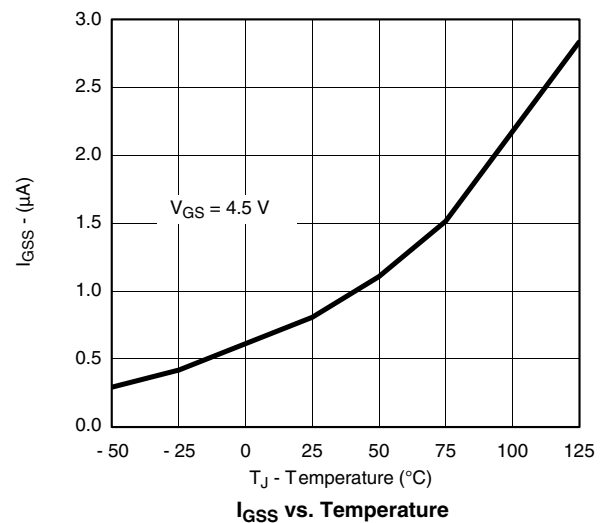
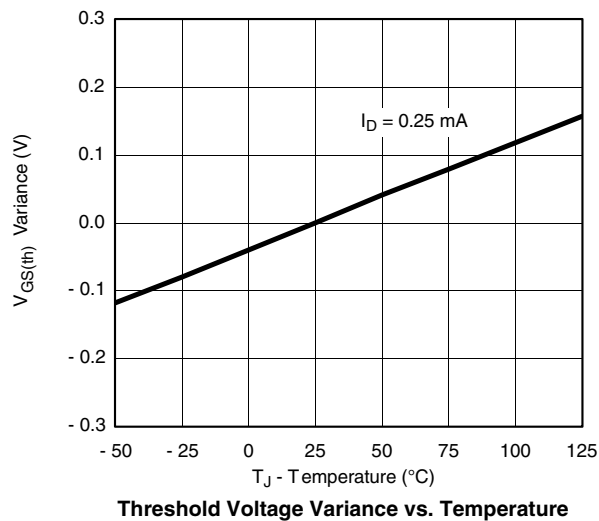
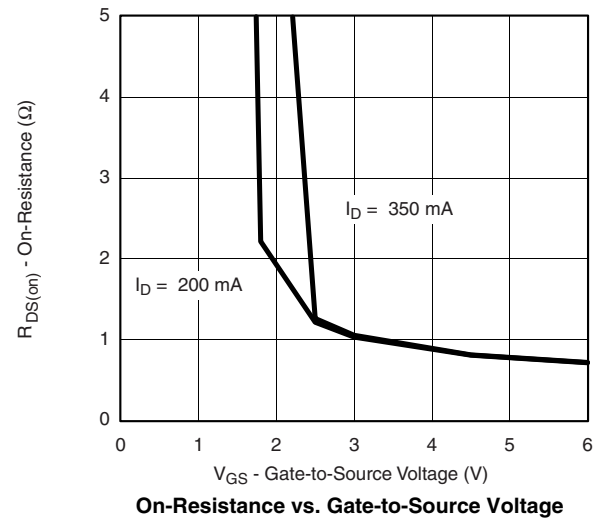
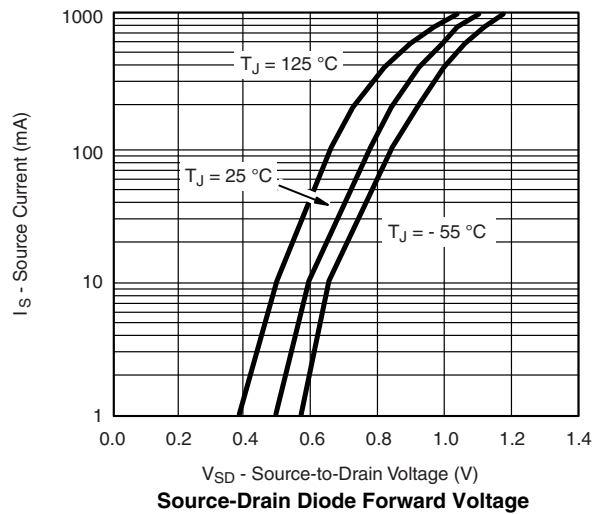
Capacitance



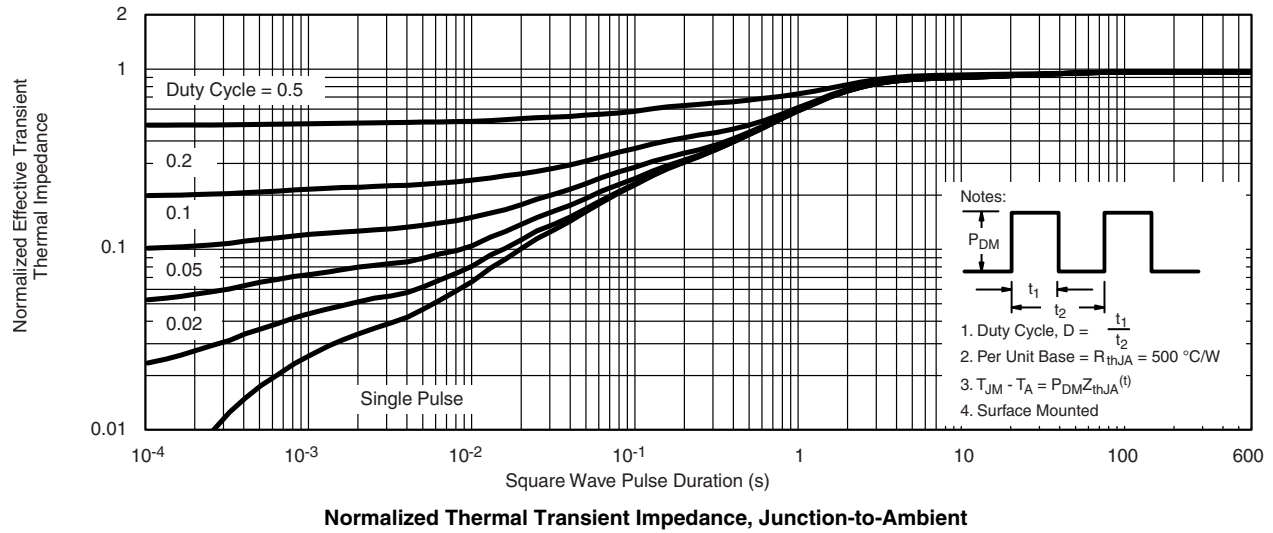
Gate Charge



On-Resistance vs. Junction Temperature

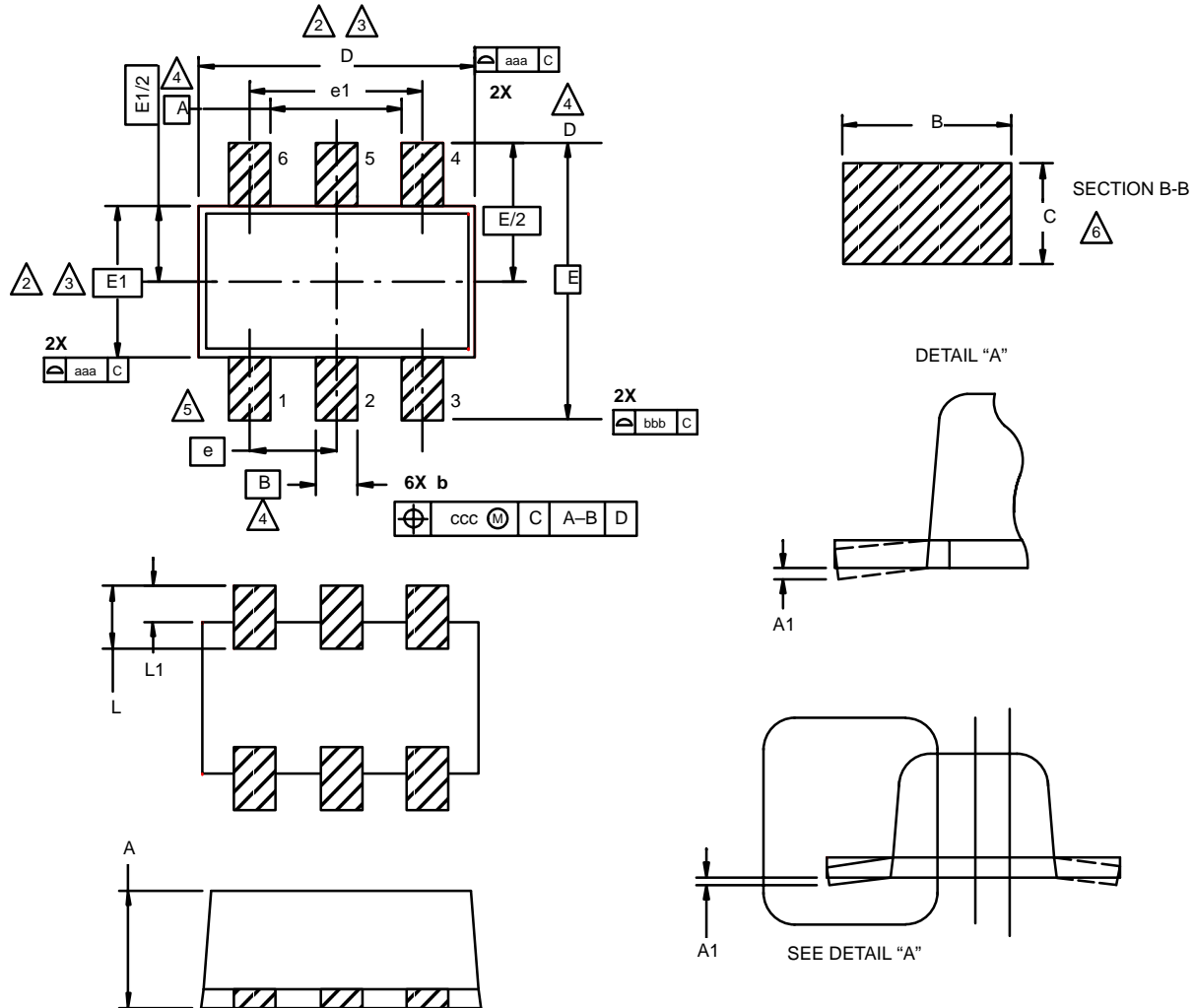
**P-CHANNEL TYPICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)

## N- OR P-CHANNEL TYPICAL CHARACTERISTICS ( $T_A = 25\text{ }^{\circ}\text{C}$ , unless otherwise noted)



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### SC89: 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.

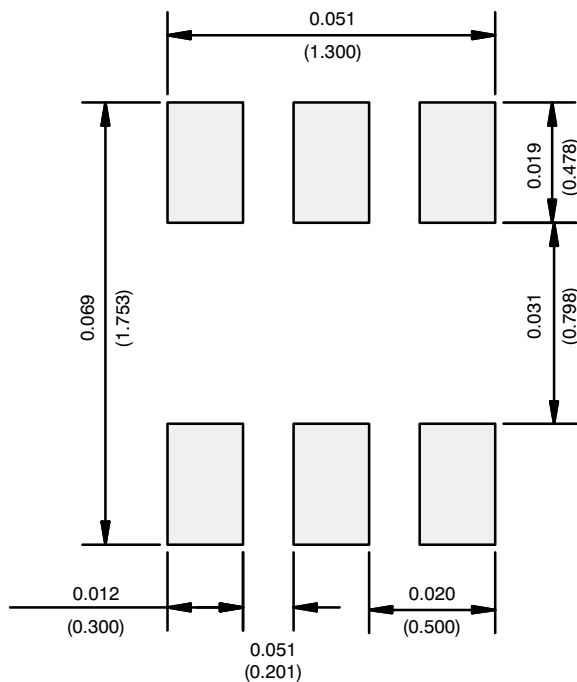
**4** Datums A, B and D to be determined 0.10 mm from the lead tip.

**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.



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



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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