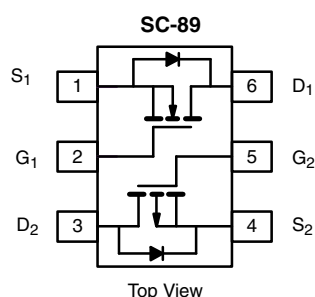


# Complementary N- and P-Channel 60 V (D-S) MOSFET

## PRODUCT SUMMARY

	V <sub>DS</sub> (V)	R <sub>DS(on)</sub> (Ω)	I <sub>D</sub> (mA)
N-Channel	60	1.40 at V <sub>GS</sub> = 10 V	500
		3 at V <sub>GS</sub> = 4.5 V	200
P-Channel	- 60	4 at V <sub>GS</sub> = - 10 V	- 500
		8 at V <sub>GS</sub> = - 4.5 V	- 25



Marking Code: H

**Ordering Information:** Si1029X-T1-GE3 (Lead (Pb)-free and Halogen-free)

## FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- TrenchFET® Power MOSFETs
- Very Small Footprint
- High-Side Switching
- Low On-Resistance:  
N-Channel, 1.40 Ω  
P-Channel, 4 Ω
- Low Threshold: ± 2 V (typ.)
- Fast Switching Speed: 15 ns (typ.)
- Gate-Source ESD Protected: 2000 V
- 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

## APPLICATIONS

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

## 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>	60		- 60		V
Gate-Source Voltage		V <sub>GS</sub>	± 20				
Continuous Drain Current (T <sub>J</sub> = 150 °C) <sup>a</sup>	T <sub>A</sub> = 25 °C	I <sub>D</sub>	320	305	- 200	- 190	mA
	T <sub>A</sub> = 85 °C		230	220	- 145	- 135	
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	
Maximum Power Dissipation <sup>a</sup>	T <sub>A</sub> = 25 °C	P <sub>D</sub>	280	250	280	250	mW
	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								
Drain-Source Breakdown Voltage	V <sub>DS</sub>	V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA	N-Ch	60			V	
		V <sub>GS</sub> = 0 V, I <sub>D</sub> = - 10 μA	P-Ch	- 60				
Gate Threshold Voltage	V <sub>GS(th)</sub>	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA	N-Ch	1		2.5		
		V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = - 250 μA	P-Ch	- 1		- 3.0		
Gate-Body Leakage	I <sub>GSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 5 V	N-Ch			± 50	nA	
			P-Ch			± 100		
Zero Gate Voltage Drain Current	I <sub>DSS</sub>	V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 10 V	N-Ch			± 150		
			P-Ch			± 200		
		V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0 V	N-Ch			10		
		V <sub>DS</sub> = - 50 V, V <sub>GS</sub> = 0 V	P-Ch			- 25		
On-State Drain Current <sup>a</sup>	I <sub>D(on)</sub>	V <sub>DS</sub> = 50 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 85 °C	N-Ch			100		
		V <sub>DS</sub> = - 50 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 85 °C	P-Ch			- 250		
		V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V	N-Ch	500				mA
		V <sub>DS</sub> = - 10 V, V <sub>GS</sub> = - 4.5 V	P-Ch	- 50				
Drain-Source On-State Resistance <sup>a</sup>	R <sub>DS(on)</sub>	V <sub>DS</sub> = 7.5 V, V <sub>GS</sub> = - 4.5 V	N-Ch	800				
		V <sub>DS</sub> = - 10 V, V <sub>GS</sub> = - 10 V	P-Ch	- 600				
		V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 200 mA	N-Ch			3	Ω	
		V <sub>GS</sub> = - 4.5 V, I <sub>D</sub> = - 25 mA	P-Ch			8		
V <sub>GS</sub> = 10 V, I <sub>D</sub> = 500 mA	N-Ch			1.40				
V <sub>GS</sub> = - 10 V, I <sub>D</sub> = - 500 mA	P-Ch			4				
V <sub>GS</sub> = 10 V, I <sub>D</sub> = 500 mA, T <sub>J</sub> = 125 °C	N-Ch			2.50				
V <sub>GS</sub> = - 10 V, I <sub>D</sub> = - 500 mA, T <sub>J</sub> = 125 °C	P-Ch			6				
Forward Transconductance <sup>a</sup>	g <sub>fs</sub>	V <sub>DS</sub> = 10 V, I <sub>D</sub> = 200 mA	N-Ch		200		ms	
		V <sub>DS</sub> = - 10 V, I <sub>D</sub> = - 100 mA	P-Ch		100			
Diode Forward Voltage <sup>a</sup>	V <sub>SD</sub>	I <sub>S</sub> = 200 mA, V <sub>GS</sub> = 0 V	N-Ch			1.4	V	
		I <sub>S</sub> = - 200 mA, V <sub>GS</sub> = 0 V	P-Ch			- 1.4		
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	N-Ch		750		pC	
Gate-Source Charge	Q <sub>gs</sub>		P-Ch		1700			
Gate-Drain Charge	Q <sub>gd</sub>	P-Channel V <sub>DS</sub> = - 30 V, V <sub>GS</sub> = - 15 V, I <sub>D</sub> = - 500 mA	N-Ch		75			
			P-Ch		260			
Input Capacitance	C <sub>iss</sub>	N-Channel V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz	N-Ch		225		pF	
			P-Ch		460			
Output Capacitance	C <sub>oss</sub>	P-Channel V <sub>DS</sub> = - 25 V, V <sub>GS</sub> = 0 V, f = 1 MHz	N-Ch		30			
			P-Ch		23			
Reverse Transfer Capacitance	C <sub>rss</sub>		N-Ch		6			
			P-Ch		10			
Turn-On Time <sup>c</sup>	t <sub>ON</sub>	N-Channel V <sub>DD</sub> = 30 V, R <sub>L</sub> = 150 Ω I <sub>D</sub> ≅ 200 mA, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 10 Ω	N-Ch		3		ns	
			P-Ch		5			
Turn-Off Time <sup>c</sup>	t <sub>OFF</sub>	P-Channel V <sub>DD</sub> = - 25 V, R <sub>L</sub> = 150 Ω I <sub>D</sub> ≅ - 165 mA, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 10 Ω	N-Ch		20			
			P-Ch		35			

Notes:

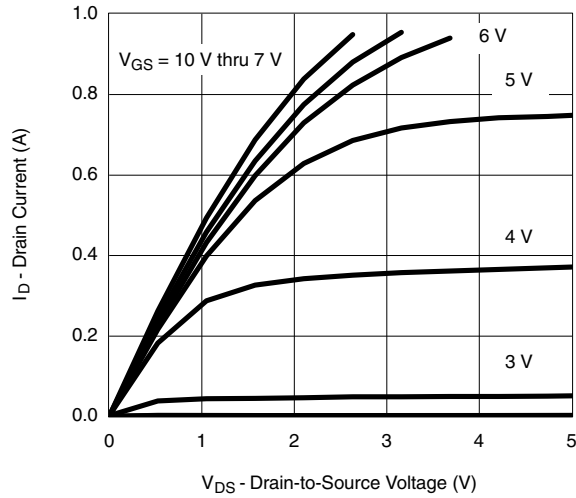
a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

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

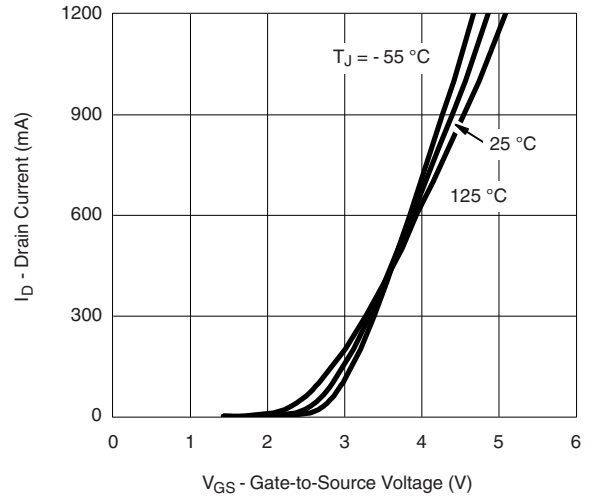
c. Switching time is essentially independent of operating temperature.

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.

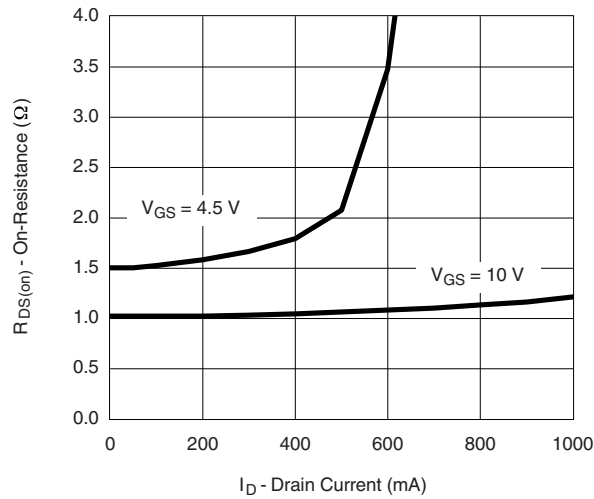
## N-CHANNEL TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



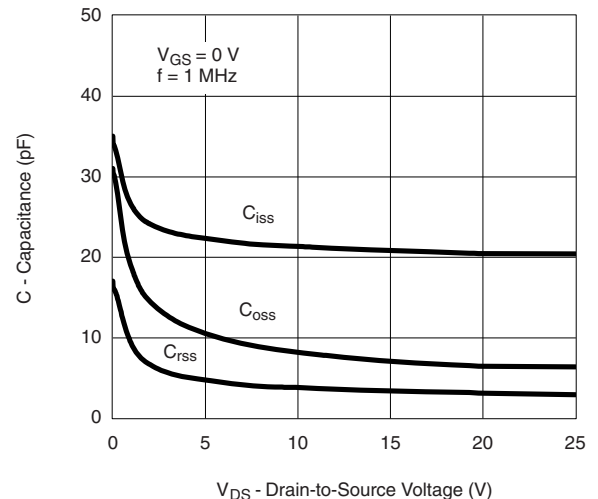
Output Characteristics



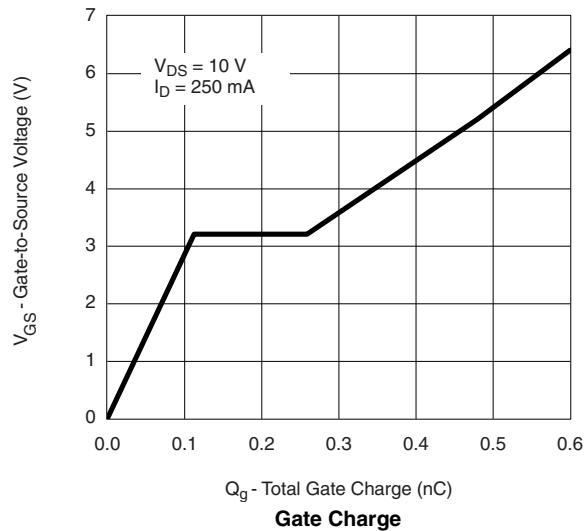
Transfer Characteristics



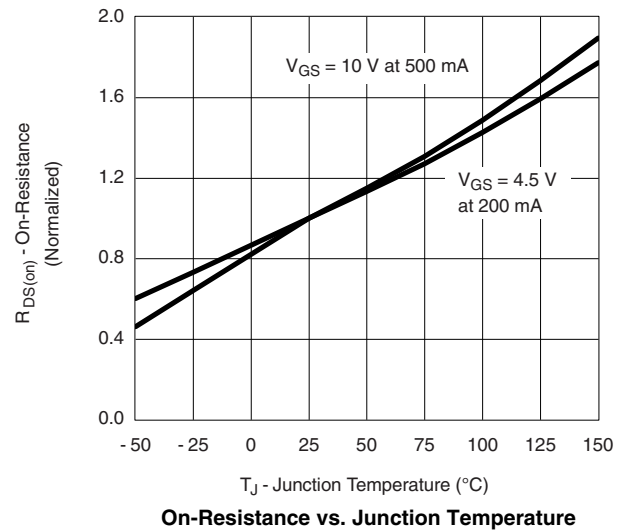
On-Resistance vs. Drain Current



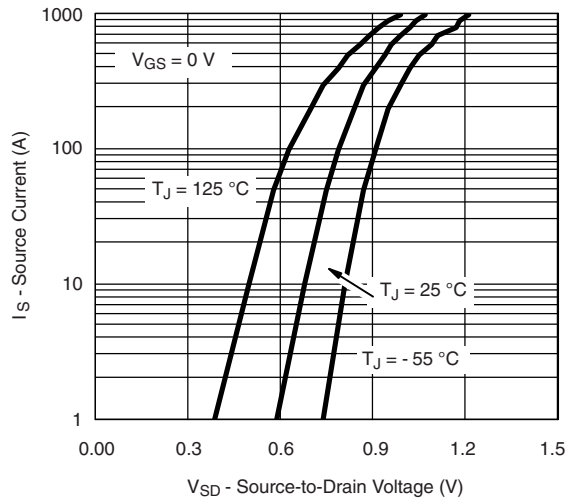
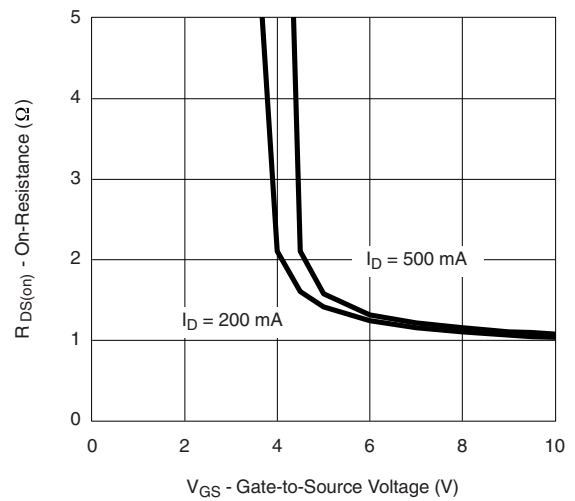
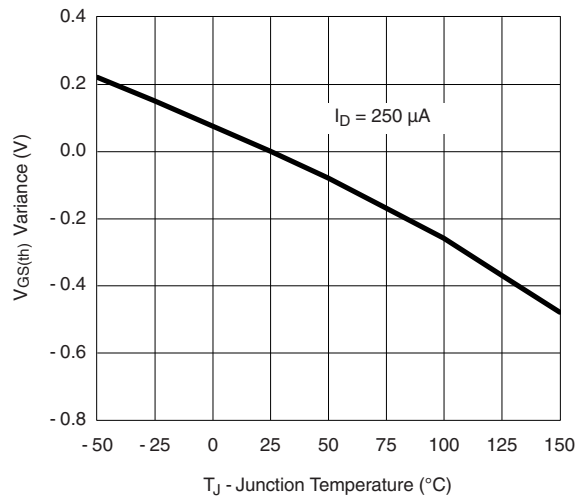
Capacitance



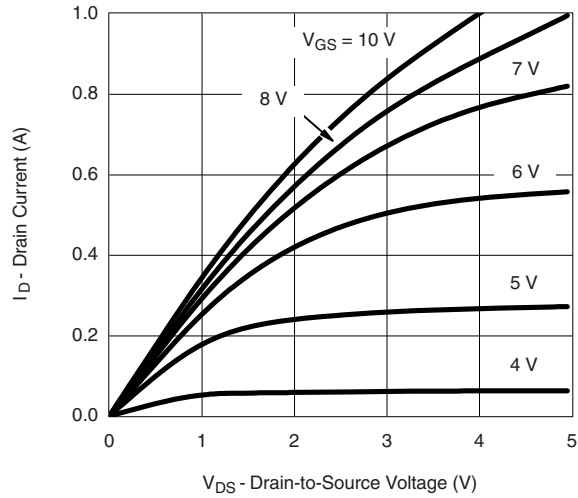
Gate Charge



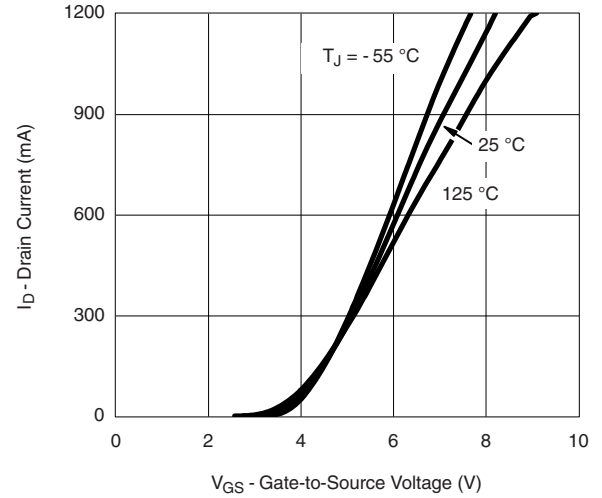
On-Resistance vs. Junction Temperature

**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 Over Temperature**

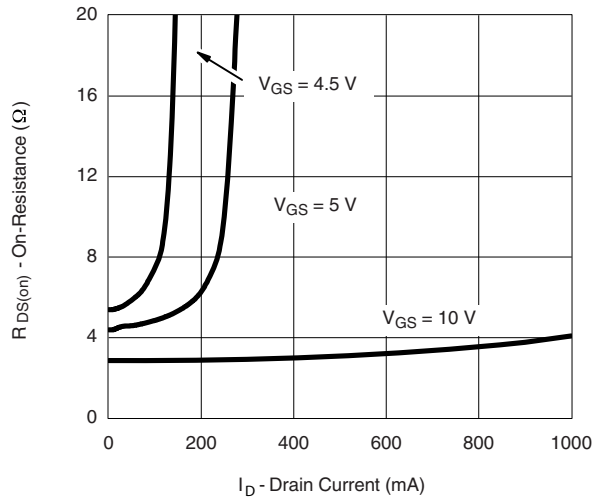
## P-CHANNEL TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



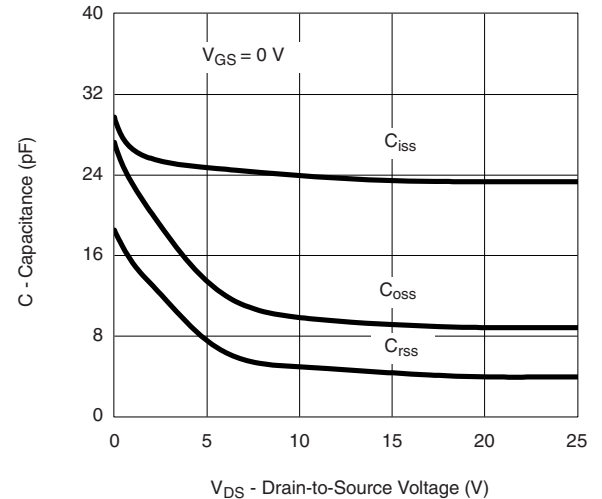
**Output Characteristics**



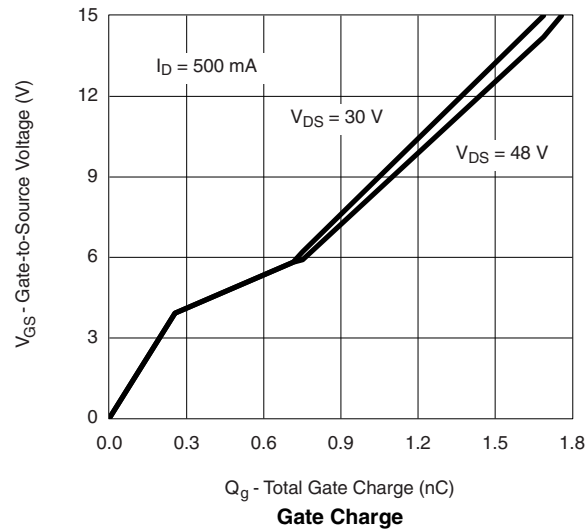
**Transfer Characteristics**



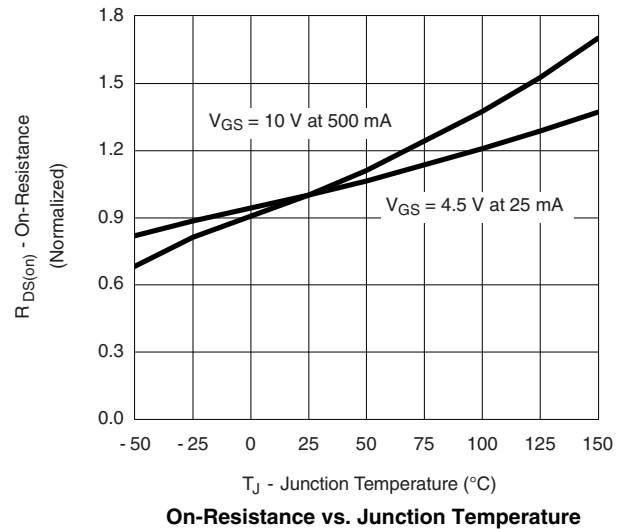
**On-Resistance vs. Drain Current**



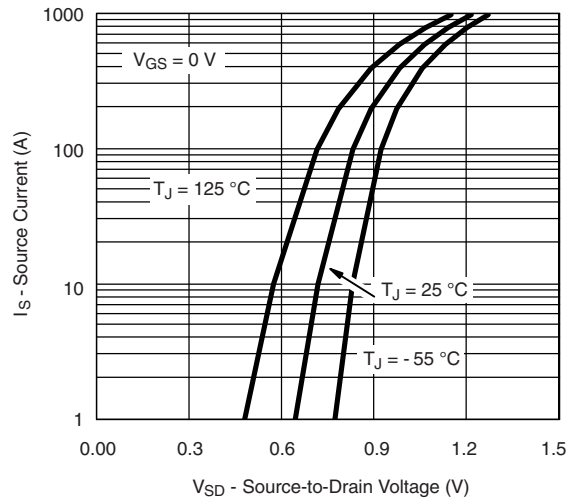
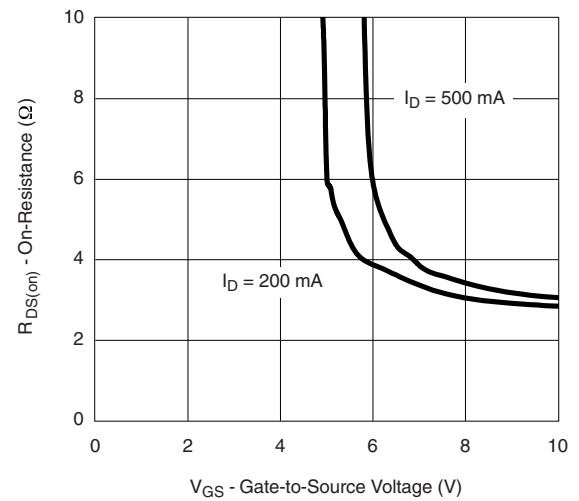
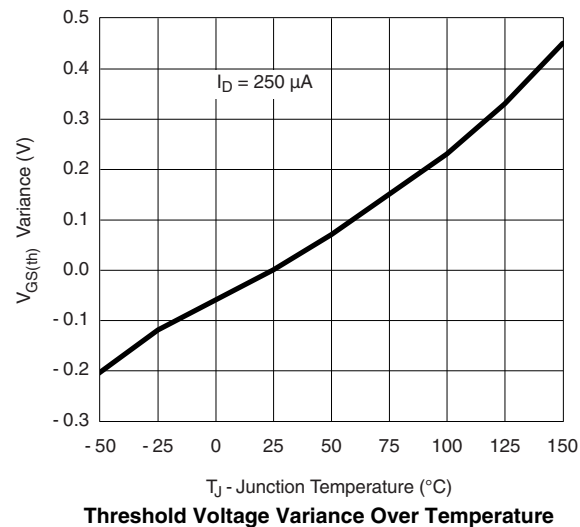
**Capacitance**



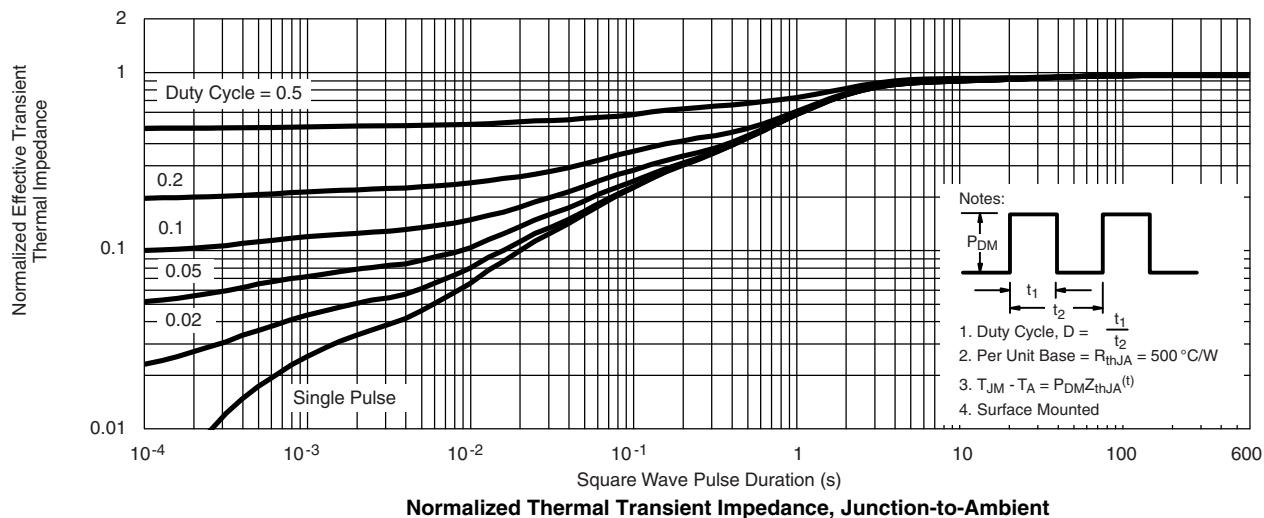
**Gate Charge**



**On-Resistance vs. Junction Temperature**

**P-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 Over Temperature**

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

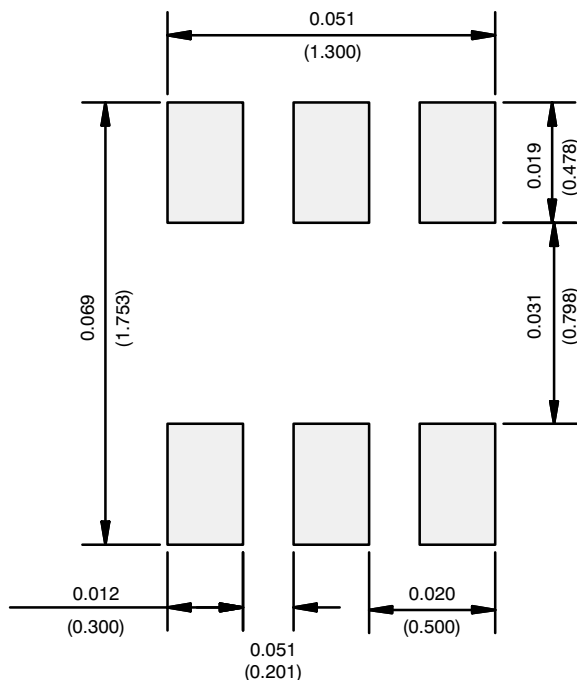


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## RECOMMENDED MINIMUM PADS FOR SC-89: 6-Lead



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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