

## P-Channel 60-V (D-S) MOSFET

PRODUCT SUMMARY			
$V_{DS}$ (V)	$R_{DS(on)}$ ( $\Omega$ )	$I_D$ (A) <sup>d</sup>	$Q_g$ (Typ.)
- 60	0.345 at $V_{GS} = - 10$ V	- 1.6	2.7 nC
	0.450 at $V_{GS} = - 4.5$ V	- 1.4	

### FEATURES

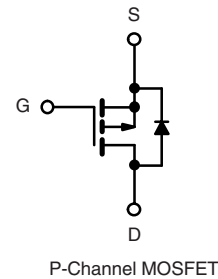
- Halogen-free Option Available
- TrenchFET<sup>®</sup> Power MOSFET



**RoHS**  
COMPLIANT

### APPLICATIONS

- Load Switch



Ordering Information: Si2309CDS-T1-E3 (Lead (Pb)-free)  
Si2309CDS-T1-GE3 (Lead (Pb)-free and Halogen-free)

ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °C, unless otherwise noted				
Parameter	Symbol	Limit	Unit	
Drain-Source Voltage	$V_{DS}$	- 60	V	
Gate-Source Voltage	$V_{GS}$	$\pm 20$		
Continuous Drain Current ( $T_J = 150$ °C) <sup>a, b</sup>	$I_D$	$T_C = 25$ °C	- 1.6	A
		$T_C = 70$ °C	- 1.3	
		$T_A = 25$ °C	- 1.2 <sup>a, b</sup>	
		$T_A = 70$ °C	- 1.0 <sup>a, b</sup>	
Pulsed Drain Current (10 $\mu$ s Pulse Width)	$I_{DM}$	- 8		
Single Pulse Avalanche Current	$L = 0.1$ mH $I_{AS}$	- 5		
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25$ °C	- 1.4	
		$T_A = 25$ °C	- 0.9 <sup>a, b</sup>	
Maximum Power Dissipation	$P_D$	$T_C = 25$ °C	1.7	W
		$T_C = 70$ °C	1.1	
		$T_A = 25$ °C	1.0 <sup>a, b</sup>	
		$T_A = 70$ °C	0.67 <sup>a, b</sup>	
Operating Junction and Storage Temperature Range	$T_J, T_{stg}$	- 55 to 150	°C	
Soldering Recommendations (Peak Temperature) <sup>c</sup>		260		

THERMAL RESISTANCE RATINGS					
Parameter	Symbol	Typical	Maximum	Unit	
Maximum Junction-to-Ambient <sup>a, c</sup>	$R_{thJA}$	92	120	°C/W	
Maximum Junction-to-Foot (Drain)	$R_{thJF}$	58	73		

Notes:

- Surface Mounted on 1" x 1" FR4 board.
- $t = 5$  s.
- Maximum under Steady State conditions is 166 °C/W.
- When  $T_C = 25$  °C.



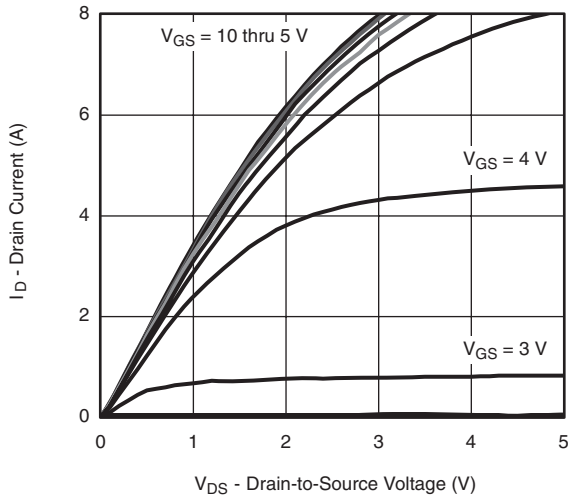
SPECIFICATIONS $T_J = 25\text{ }^\circ\text{C}$ , unless otherwise noted						
Parameter	Symbol	Test Conditions	Min.	Typ.	Max.	Unit
<b>Static</b>						
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	-60			V
$V_{DS}$ Temperature Coefficient	$\Delta V_{DS}/T_J$	$I_D = -250\text{ }\mu\text{A}$		-65		mV/°C
$V_{GS(th)}$ Temperature Coefficient	$\Delta V_{GS(th)}/T_J$		4.5			
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	-1		-3	V
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$			-100	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{DS} = -60\text{ V}, V_{GS} = 0\text{ V}$			-1	$\mu\text{A}$
		$V_{DS} = -60\text{ V}, V_{GS} = 0\text{ V}, T_J = 55\text{ }^\circ\text{C}$			-10	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{DS} \leq 5\text{ V}, V_{GS} = -10\text{ V}$	-6			A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -10\text{ V}, I_D = -1.25\text{ A}$		0.285	0.345	$\Omega$
		$V_{GS} = -4.5\text{ V}, I_D = -1.0\text{ A}$		0.360	0.450	
Forward Transconductance <sup>a</sup>	$g_{fs}$	$V_{DS} = -10\text{ V}, I_D = -1.0\text{ A}$		2.8		S
<b>Dynamic<sup>b</sup></b>						
Input Capacitance	$C_{iss}$	$V_{DS} = -30\text{ V}, V_{GS} = 0\text{ V}, f = 1\text{ MHz}$		210		pF
Output Capacitance	$C_{oss}$		28			
Reverse Transfer Capacitance	$C_{rss}$		20			
Total Gate Charge	$Q_g$	$V_{DS} = -30\text{ V}, V_{GS} = -4.5\text{ V}, I_D = -1.25\text{ A}$		2.7	4.1	nC
Gate-Source Charge	$Q_{gs}$		0.8			
Gate-Drain Charge	$Q_{gd}$		1.2			
Gate Resistance	$R_g$	$f = 1\text{ MHz}$		7		$\Omega$
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -30\text{ V}, R_L = 30\text{ }\Omega$ $I_D \cong -1\text{ A}, V_{GEN} = -4.5\text{ V}, R_g = 1\text{ }\Omega$		40	60	ns
Rise Time	$t_r$		35	55		
Turn-Off Delay Time	$t_{d(off)}$		15	25		
Fall Time	$t_f$		10	20		
Turn-On Delay Time	$t_{d(on)}$	$V_{DD} = -30\text{ V}, R_L = 30\text{ }\Omega$ $I_D \cong -1\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\text{ }\Omega$		5	10	
Rise Time	$t_r$		10	20		
Turn-Off Delay Time	$t_{d(off)}$		15	25		
Fall Time	$t_f$		10	20		
<b>Drain-Source Body Diode Characteristics</b>						
Continuous Source-Drain Diode Current	$I_S$	$T_C = 25\text{ }^\circ\text{C}$			-1.4	A
Pulse Diode Forward Current	$I_{SM}$				-8	
Body Diode Voltage	$V_{SD}$	$I_S = -0.75\text{ A}, V_{GS} = 0\text{ V}$		-0.8	-1.2	V
Body Diode Reverse Recovery Time	$t_{rr}$	$I_F = -1.25\text{ A}, dI/dt = 100\text{ A}/\mu\text{s}, T_J = 25\text{ }^\circ\text{C}$		30	60	ns
Body Diode Reverse Recovery Charge	$Q_{rr}$		33	60	nC	
Reverse Recovery Fall Time	$t_a$		18		ns	
Reverse Recovery Rise Time	$t_b$		12			

## Notes:

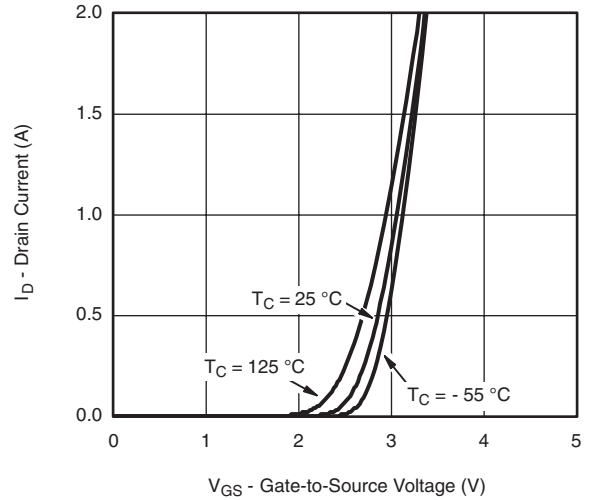
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .  
 b. Guaranteed by design, not subject to production testing.

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.

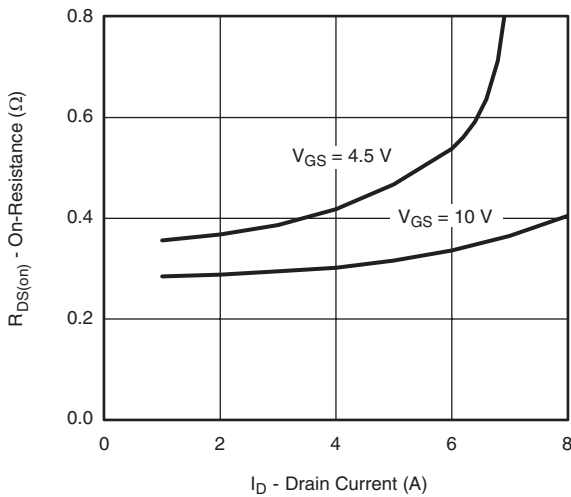
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



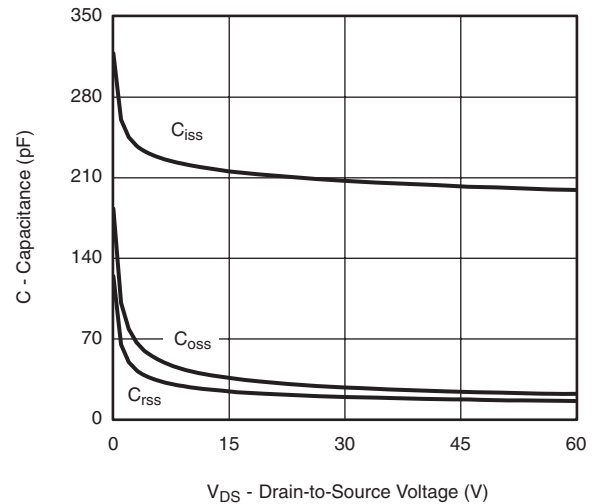
**Output Characteristics**



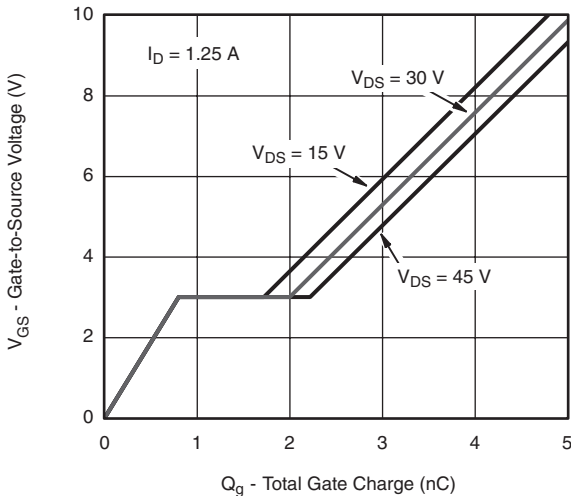
**Transfer Characteristics**



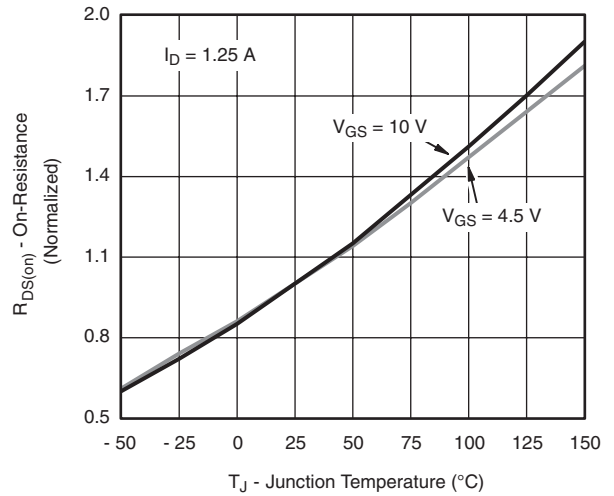
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



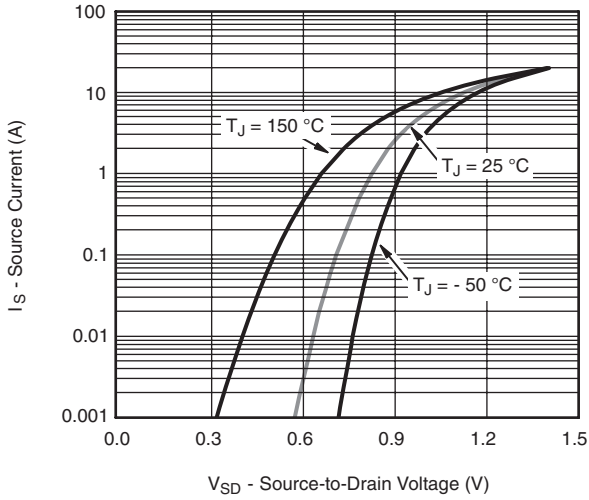
**Gate Charge**



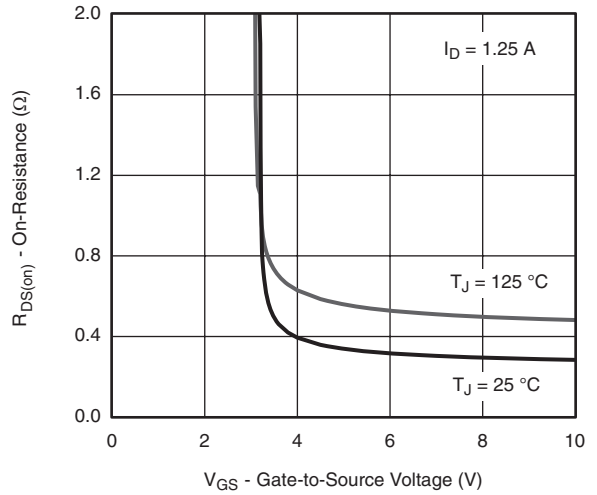
**On-Resistance vs. Junction Temperature**



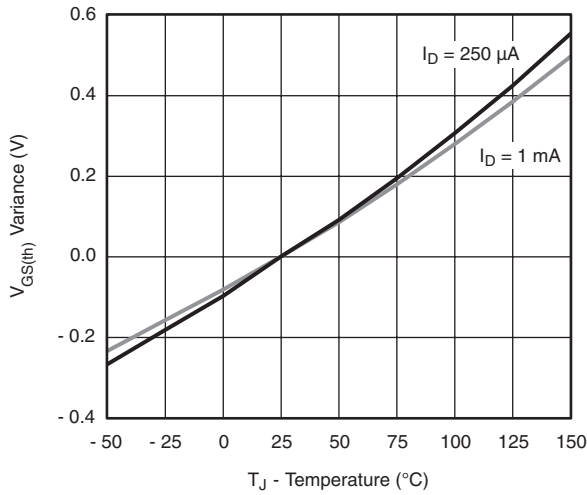
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



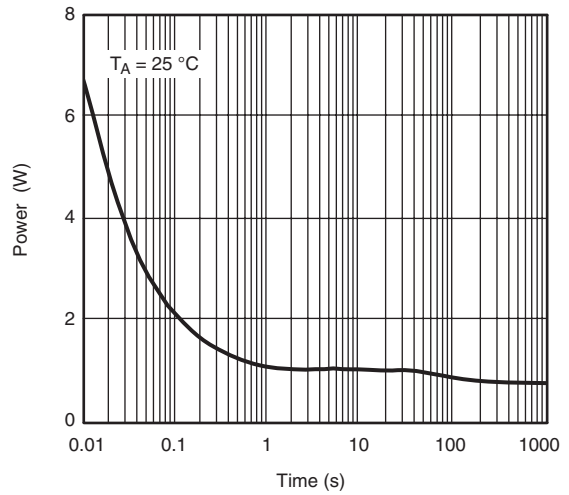
Source-Drain Diode Forward Voltage



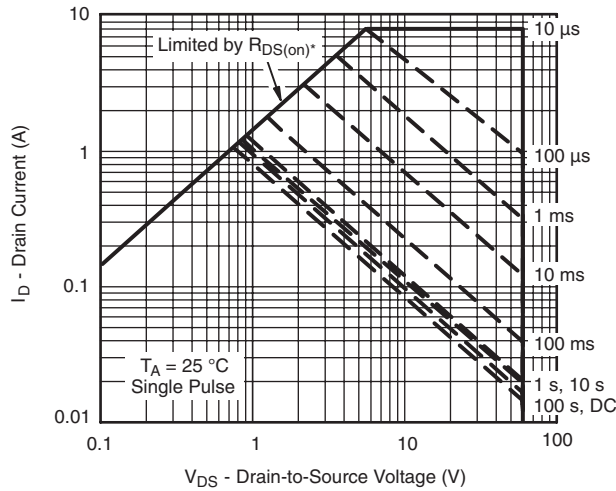
On-Resistance vs. Gate-to-Source Voltage



Threshold Voltage



Single Pulse Power, Junction-to-Ambient

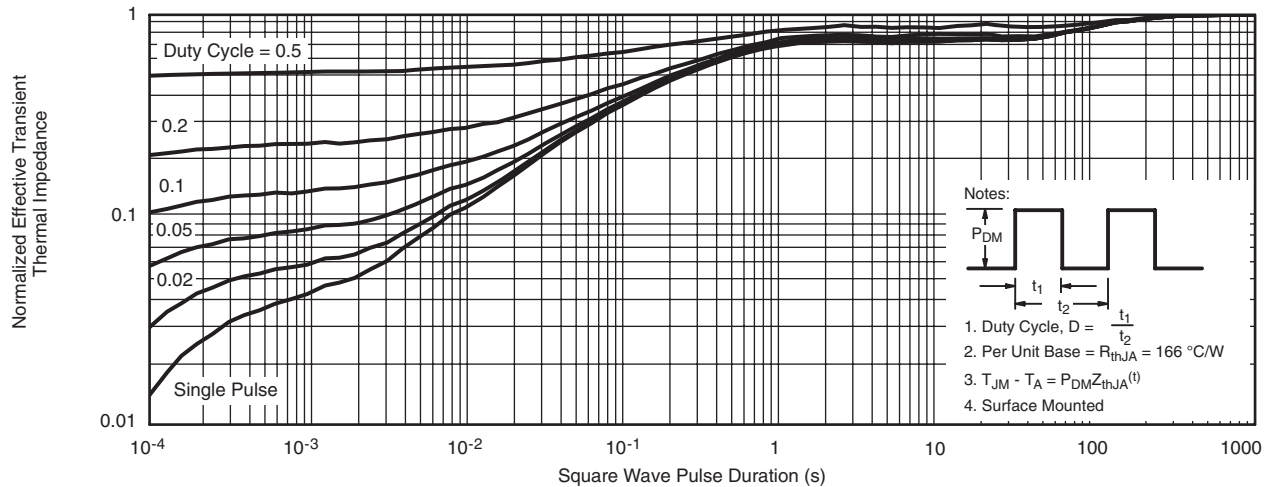


\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified

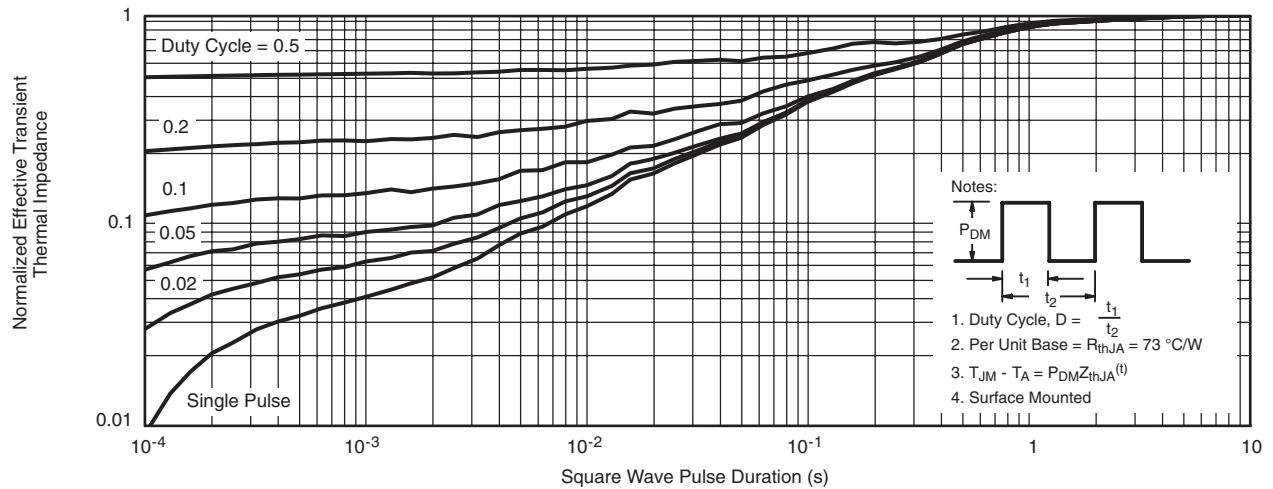
Safe Operating Area, Junction-to-Ambient



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



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



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

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## SOT-23 (TO-236): 3-LEAD



Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	0.89	1.12	0.035	0.044
A <sub>1</sub>	0.01	0.10	0.0004	0.004
A <sub>2</sub>	0.88	1.02	0.0346	0.040
b	0.35	0.50	0.014	0.020
c	0.085	0.18	0.003	0.007
D	2.80	3.04	0.110	0.120
E	2.10	2.64	0.083	0.104
E <sub>1</sub>	1.20	1.40	0.047	0.055
e	0.95 BSC		0.0374 Ref	
e <sub>1</sub>	1.90 BSC		0.0748 Ref	
L	0.40	0.60	0.016	0.024
L <sub>1</sub>	0.64 Ref		0.025 Ref	
S	0.50 Ref		0.020 Ref	
q	3°	8°	3°	8°

ECN: S-03946-Rev. K, 09-Jul-01  
 DWG: 5479

## RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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