

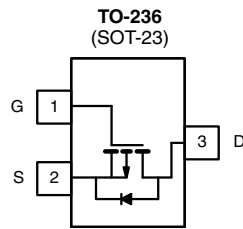
## Automotive P-Channel 60 V (D-S) 175 °C MOSFET



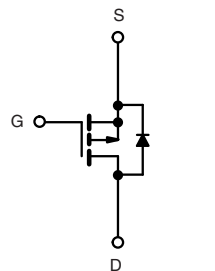
PRODUCT SUMMARY	
$V_{DS}$ (V)	- 60
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -10$ V	0.335
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -4.5$ V	0.500
$I_D$ (A)	- 1.7
Configuration	Single

### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- TrenchFET® Power MOSFET
- AEC-Q101 Qualified<sup>c</sup>
- 100 %  $R_g$  and UIS Tested
- Compliant to RoHS Directive 2002/95/EC



\* Marking Code:8Pxxx



ORDERING INFORMATION	
Package	SOT-23
Lead (Pb)-free and Halogen-free	SQ2309ES-T1-GE3

ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °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	$T_C = 25$ °C	$I_D$	- 1.7	A
	$T_C = 125$ °C		- 1	
Continuous Source Current (Diode Conduction)		$I_S$	- 2.6	
Pulsed Drain Current <sup>a</sup>		$I_{DM}$	- 6.8	
Single Pulse Avalanche Current	L = 0.1 mH	$I_{AS}$	- 15	
Single Pulse Avalanche Energy		$E_{AS}$	11	mJ
Maximum Power Dissipation <sup>a</sup>	$T_C = 25$ °C	$P_D$	2	W
	$T_C = 125$ °C		0.6	
Operating Junction and Storage Temperature Range		$T_J, T_{stg}$	- 55 to + 175	°C

THERMAL RESISTANCE RATINGS				
PARAMETER		SYMBOL	LIMIT	UNIT
Junction-to-Ambient	PCB Mount <sup>b</sup>	$R_{thJA}$	166	°C/W
Junction-to-Foot (Drain)		$R_{thJF}$	73	

### Notes

- Pulse test; pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2$  %.
- When mounted on 1" square PCB (FR-4 material).
- Parametric verification ongoing.



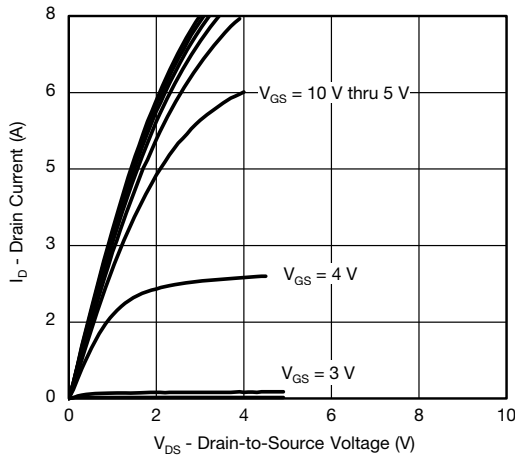
<b>SPECIFICATIONS</b> ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS		MIN.	TYP.	MAX.	UNIT
<b>Static</b>							
Drain-Source Breakdown Voltage	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$		-60	-	-	V
Gate-Source Threshold Voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$		-1.5	-2.0	-2.5	
Gate-Source Leakage	$I_{GSS}$	$V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$		-	-	$\pm 100$	nA
Zero Gate Voltage Drain Current	$I_{DSS}$	$V_{GS} = 0\text{ V}$	$V_{DS} = -60\text{ V}$	-	-	-1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$	$V_{DS} = -60\text{ V}, T_J = 125\text{ }^\circ\text{C}$	-	-	-50	
		$V_{GS} = 0\text{ V}$	$V_{DS} = -60\text{ V}, T_J = 175\text{ }^\circ\text{C}$	-	-	-150	
On-State Drain Current <sup>a</sup>	$I_{D(on)}$	$V_{GS} = -10\text{ V}$	$V_{DS} \leq -5\text{ V}$	-5	-	-	A
Drain-Source On-State Resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -1.25\text{ A}$	-	0.268	0.335	$\Omega$
		$V_{GS} = -10\text{ V}$	$I_D = -1.25\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	-	0.567	
		$V_{GS} = -10\text{ V}$	$I_D = -1.25\text{ A}, T_J = 175\text{ }^\circ\text{C}$	-	-	0.704	
		$V_{GS} = -4.5\text{ V}$	$I_D = -1\text{ A}$	-	0.370	0.500	
Forward Transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = -5\text{ V}, I_D = -1\text{ A}$		-	1.8	-	S
<b>Dynamic<sup>b</sup></b>							
Input Capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = -25\text{ V}, f = 1\text{ MHz}$	-	211	265	$\text{pF}$
Output Capacitance	$C_{oss}$			-	30	40	
Reverse Transfer Capacitance	$C_{riss}$			-	21	30	
Total Gate Charge <sup>c</sup>	$Q_g$	$V_{GS} = -10\text{ V}$	$V_{DS} = -30\text{ V}, I_D = -1\text{ A}$	-	5.5	8.5	$\text{nC}$
Gate-Source Charge <sup>c</sup>	$Q_{gs}$			-	0.8	-	
Gate-Drain Charge <sup>c</sup>	$Q_{gd}$			-	1.3	-	
Gate Resistance	$R_g$	$f = 1\text{ MHz}$		4.95	9.88	14.80	$\Omega$
Turn-On Delay Time <sup>c</sup>	$t_{d(on)}$	$V_{DD} = -30\text{ V}, R_L = 30\text{ }\Omega$ $I_D \equiv -3\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\text{ }\Omega$		-	5	8	$\text{ns}$
Rise Time <sup>c</sup>	$t_r$			-	9	14	
Turn-Off Delay Time <sup>c</sup>	$t_{d(off)}$			-	12	18	
Fall Time <sup>c</sup>	$t_f$			-	9	14	
<b>Source-Drain Diode Ratings and Characteristics<sup>b</sup></b>							
Pulsed Current <sup>a</sup>	$I_{SM}$			-	-	-6.8	A
Forward Voltage	$V_{SD}$	$I_F = -1.5\text{ A}, V_{GS} = 0\text{ V}$		-	-0.85	-1.2	V

**Notes**

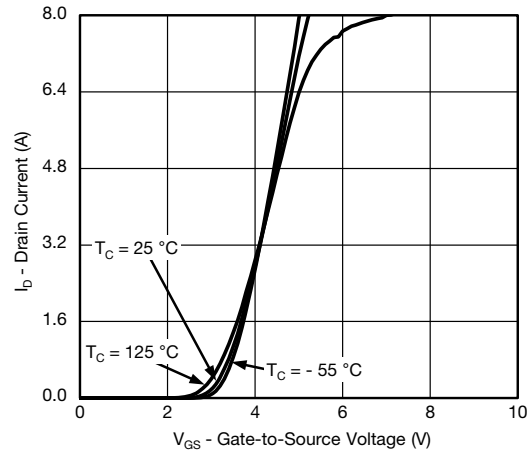
- a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .
- b. Guaranteed by design, not subject to production testing.
- c. Independent of operating temperature.

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.

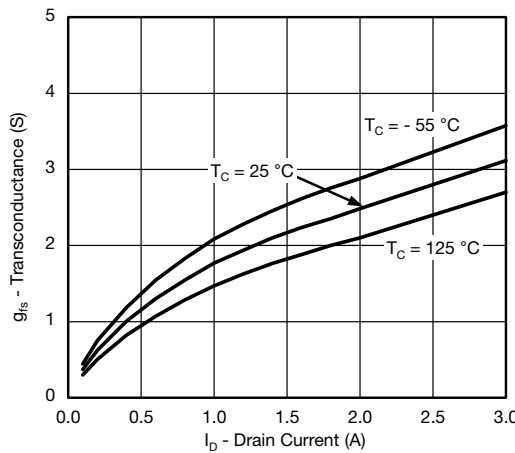
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



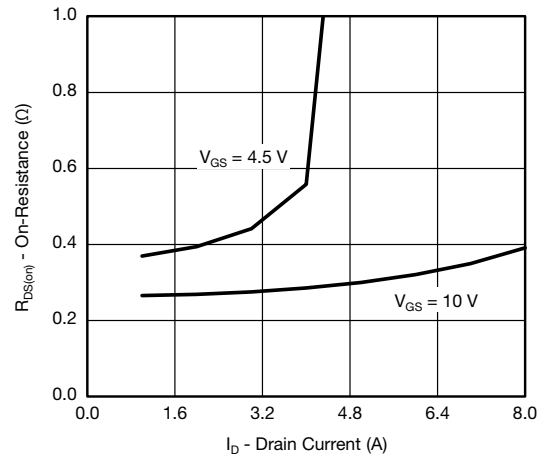
**Output Characteristics**



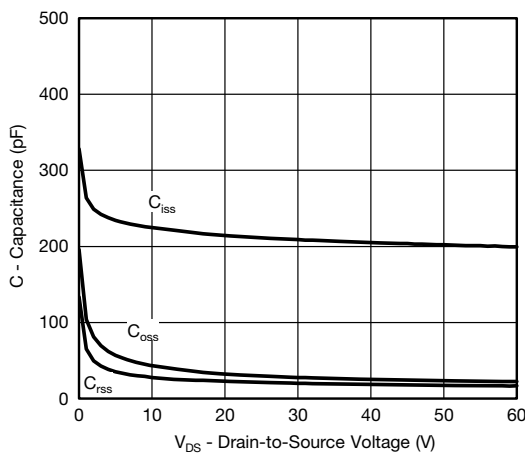
**Transfer Characteristics**



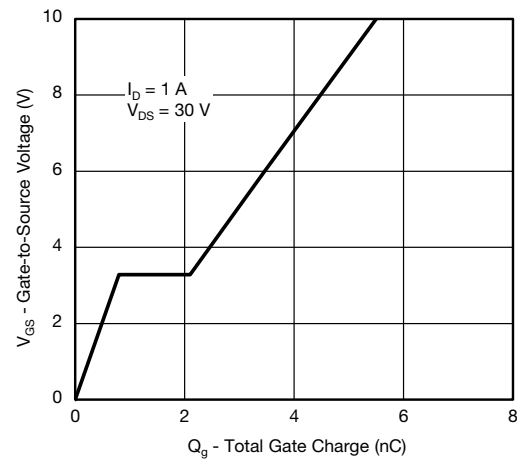
**Transconductance**



**On-Resistance vs. Drain Current**

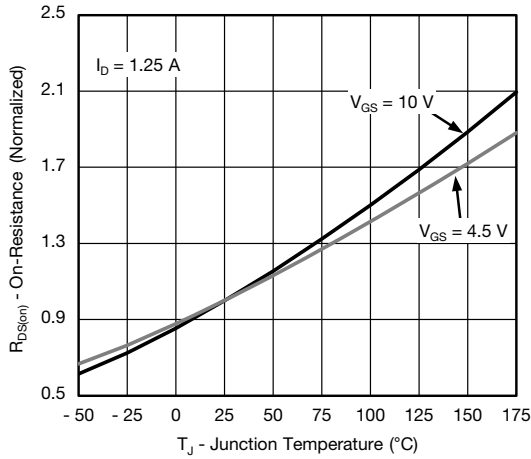


**Capacitance**

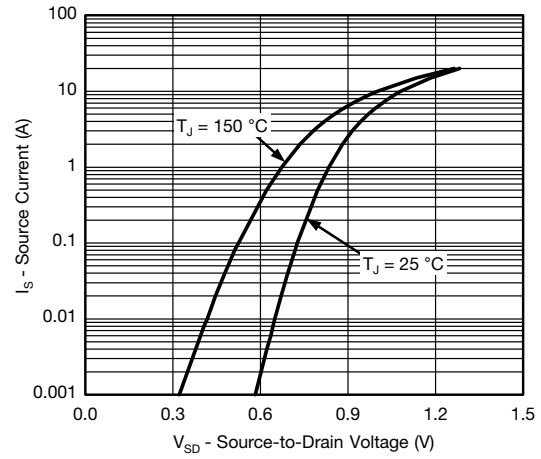


**Gate Charge**

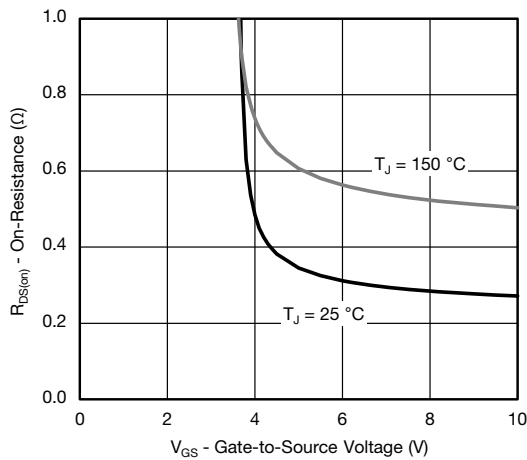
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



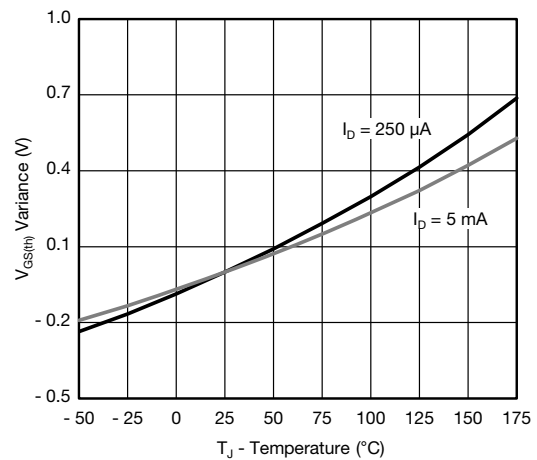
**On-Resistance vs. Junction Temperature**



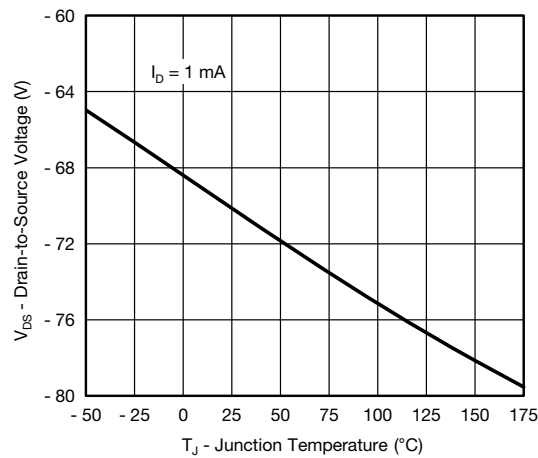
**Source Drain Diode Forward Voltage**



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

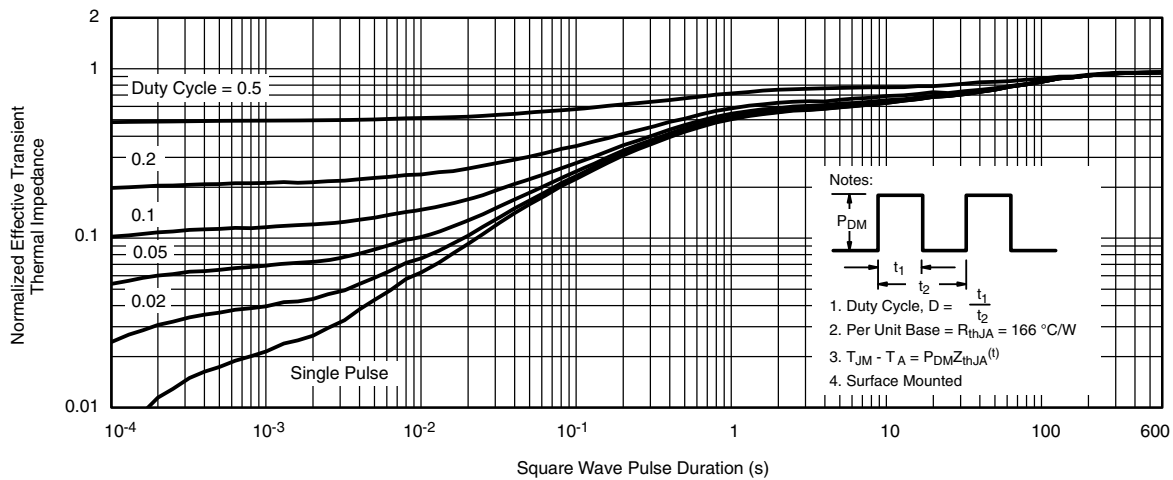
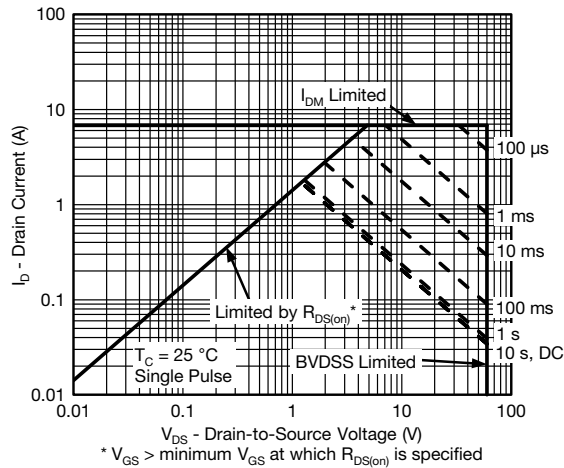


**Threshold Voltage**



**Drain Source Breakdown vs. Junction Temperature**

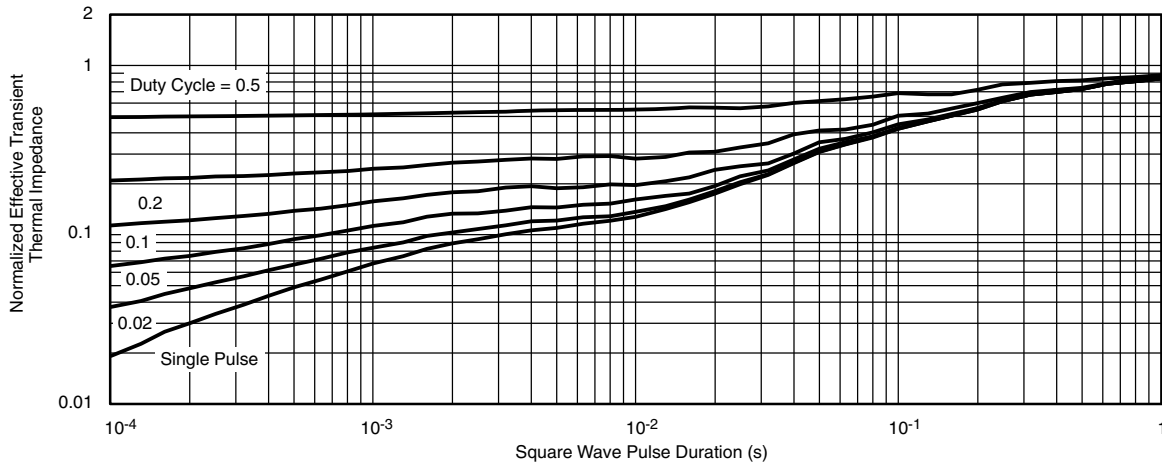
**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



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



**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



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

**Note**

- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  - Normalized Transient Thermal Impedance Junction-to-Foot (25 °C)are given for general guidelines only to enable the user to get a “ball park” indication of part capabilities. The data are extracted from single pulse transient thermal impedance characteristics which are developed from empirical measurements. The latter is valid for the part mounted on printed circuit board - FR4, size 1" x 1" x 0.062", double sided with 2 oz. copper, 100 % on both sides. The part capabilities can widely vary depending on actual application parameters and operating conditions.

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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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