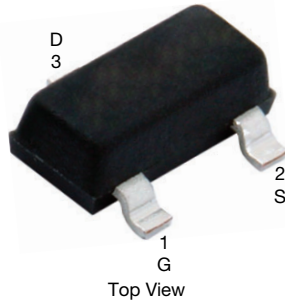


# Automotive P-Channel 40 V (D-S) 175 °C MOSFET

SOT-23 (TO-236)



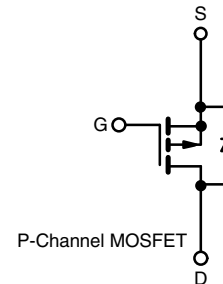
Marking Code: 9Axxx

PRODUCT SUMMARY	
$V_{DS}$ (V)	-40
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -10$ V	0.094
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -4.5$ V	0.188
$I_D$ (A)	-4.1
Configuration	Single

**FEATURES**

- TrenchFET® power MOSFET
- AEC-Q101 qualified
- 100 %  $R_g$  and UIS tested
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

AUTOMOTIVE GRADE


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


P-Channel MOSFET

ORDERING INFORMATION	
Package	SOT-23
Lead (Pb)-free and halogen-free	SQ2389ES (for detailed order number please see <a href="http://www.vishay.com/doc?79771">www.vishay.com/doc?79771</a> )

ABSOLUTE MAXIMUM RATINGS ( $T_C = 25$ °C, unless otherwise noted)			
PARAMETER	SYMBOL	LIMIT	UNIT
Drain-source voltage	$V_{DS}$	-40	V
Gate-source voltage	$V_{GS}$	$\pm 20$	
Continuous drain current	$I_D$	$T_C = 25$ °C	-4.1
		$T_C = 125$ °C	-2.4
Continuous source current (diode conduction)	$I_S$	-3.6	A
Pulsed drain current <sup>a</sup>	$I_{DM}$	-16	mJ
Single pulse avalanche current	$I_{AS}$	-12	
Single pulse avalanche energy	$E_{AS}$	7.2	
Maximum power dissipation <sup>a</sup>	$P_D$	$T_C = 25$ °C	3
		$T_C = 125$ °C	1
Operating junction and storage temperature range	$T_J, T_{stg}$	-55 to +175	°C

THERMAL RESISTANCE RATINGS			
PARAMETER	SYMBOL	LIMIT	UNIT
Junction-to-ambient	$R_{thJA}$	166	°C/W
Junction-to-foot (drain)	$R_{thJF}$	50	

**Notes**

- Pulse test; pulse width  $\leq 300$   $\mu$ s, duty cycle  $\leq 2$  %
- When mounted on 1" square PCB (FR4 material)



SPECIFICATIONS ( $T_C = 25\text{ }^\circ\text{C}$ , unless otherwise noted)							
PARAMETER	SYMBOL	TEST CONDITIONS	MIN.	TYP.	MAX.	UNIT	
<b>Static</b>							
Drain-source breakdown voltage	$V_{DS}$	$V_{GS} = 0\text{ V}$ , $I_D = -250\text{ }\mu\text{A}$	-40	-	-	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	$I_{DSS}$	$V_{GS} = 0\text{ V}$	$V_{DS} = -40\text{ V}$	-	-	-1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$	$V_{DS} = -40\text{ V}$ , $T_J = 125\text{ }^\circ\text{C}$	-	-	-50	
		$V_{GS} = 0\text{ V}$	$V_{DS} = -40\text{ V}$ , $T_J = 175\text{ }^\circ\text{C}$	-	-	-150	
On-state drain current <sup>a</sup>	$I_{D(on)}$	$V_{GS} = -10\text{ V}$	$V_{DS} \leq -5\text{ V}$	-10	-	A	
Drain-source on-state resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -3\text{ A}$	-	0.084	0.094	$\Omega$
		$V_{GS} = -10\text{ V}$	$I_D = -3\text{ A}$ , $T_J = 125\text{ }^\circ\text{C}$	-	-	0.144	
		$V_{GS} = -10\text{ V}$	$I_D = -3\text{ A}$ , $T_J = 175\text{ }^\circ\text{C}$	-	-	0.169	
		$V_{GS} = -4.5\text{ V}$	$I_D = -3\text{ A}$	-	0.140	0.188	
Forward transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = -10\text{ V}$ , $I_D = -3\text{ A}$	-	5	-	S	
<b>Dynamic <sup>b</sup></b>							
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = -20\text{ V}$ , $f = 1\text{ MHz}$	-	360	420	$\mu\text{F}$
Output capacitance	$C_{oss}$			-	80	100	
Reverse transfer capacitance	$C_{rss}$			-	42	54	
Total gate charge <sup>c</sup>	$Q_g$	$V_{GS} = -10\text{ V}$	$V_{DS} = -20\text{ V}$ , $I_D = -3\text{ A}$	-	8.2	12	nC
Gate-source charge <sup>c</sup>	$Q_{gs}$			-	1.1	-	
Gate-drain charge <sup>c</sup>	$Q_{gd}$			-	3	-	
Gate resistance	$R_g$	f = 1 MHz		3.1	4.1	7	$\Omega$
Turn-on delay time <sup>c</sup>	$t_{d(on)}$	$V_{DD} = -20\text{ V}$ , $R_L = 6.7\text{ }\Omega$ $I_D \cong -3\text{ A}$ , $V_{GEN} = -10\text{ V}$ , $R_g = 1\text{ }\Omega$		-	7	10	ns
Rise time <sup>c</sup>	$t_r$			-	12	16	
Turn-off delay time <sup>c</sup>	$t_{d(off)}$			-	16	20	
Fall time <sup>c</sup>	$t_f$			-	4	8	
<b>Source-Drain Diode Ratings and Characteristics <sup>b</sup></b>							
Pulsed current <sup>a</sup>	$I_{SM}$			-	-	-10	A
Forward voltage	$V_{SD}$	$I_F = -1.5\text{ A}$ , $V_{GS} = 0\text{ V}$		-	-0.8	-1.2	V

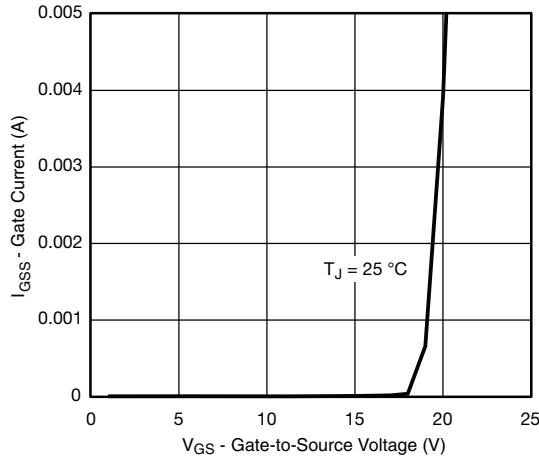
**Notes**

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

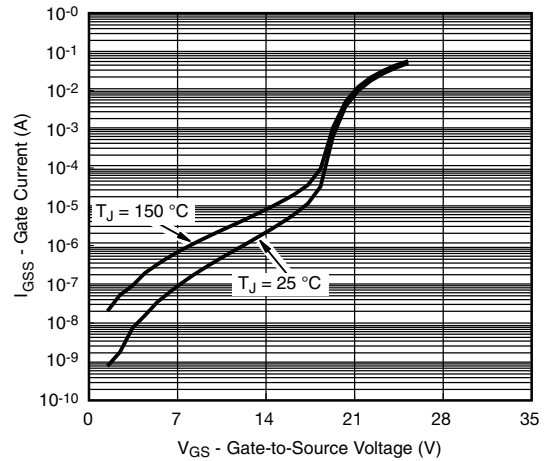
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



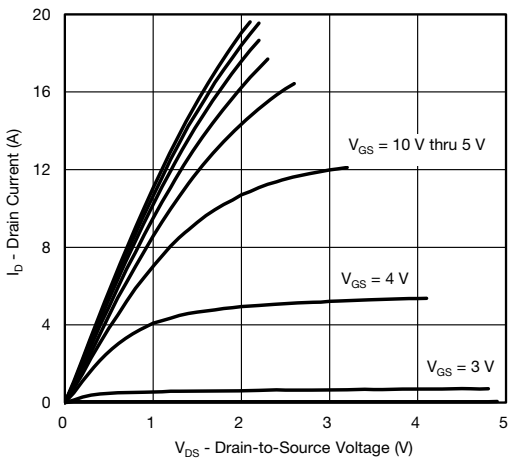
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



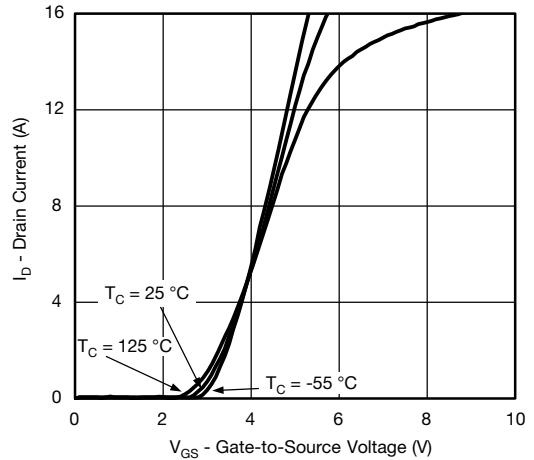
**Gate Current vs. Gate-Source Voltage**



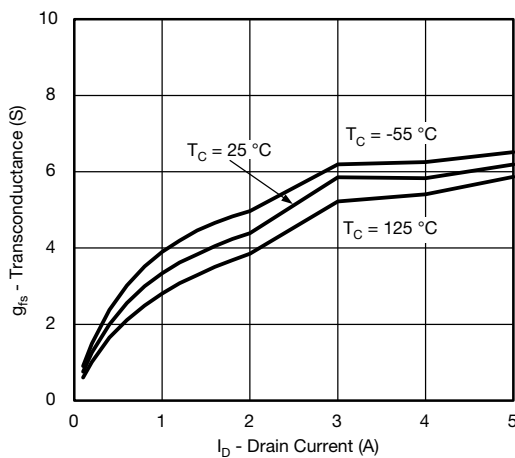
**Gate Current vs. Gate-Source Voltage**



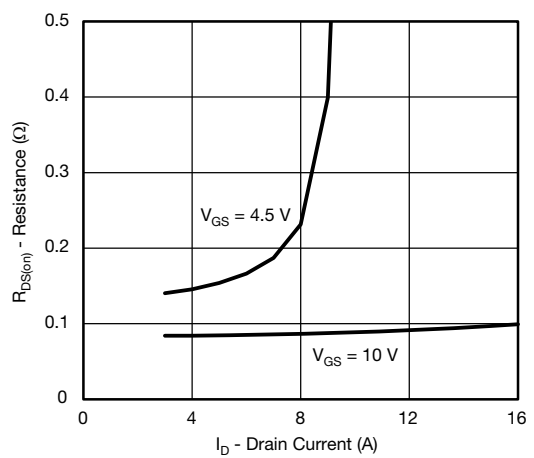
**Output Characteristics**



**Transfer Characteristics**



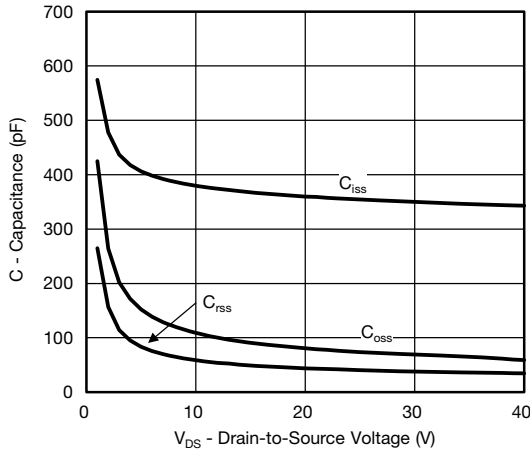
**Transconductance**



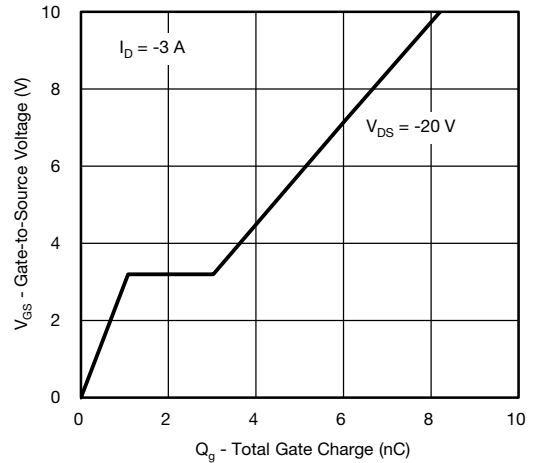
**On-Resistance vs. Drain Current**



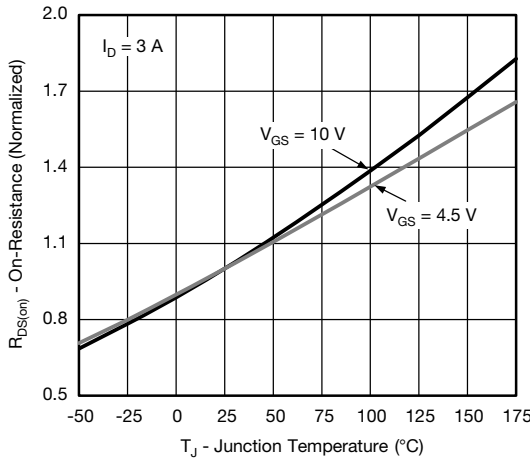
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



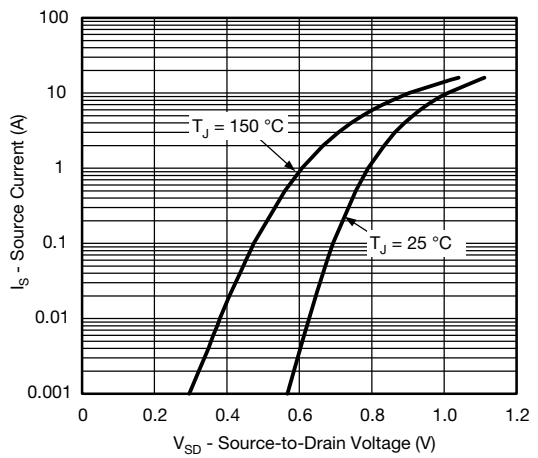
Capacitance



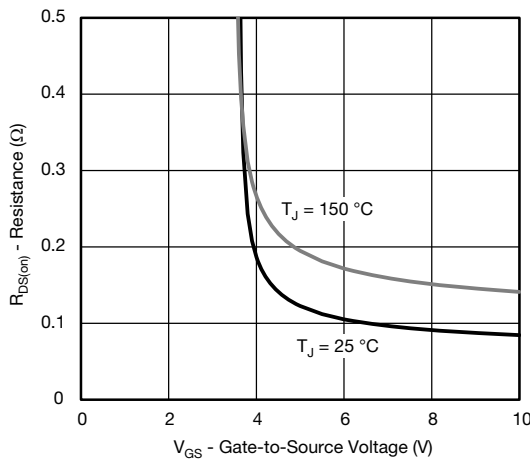
Gate Charge



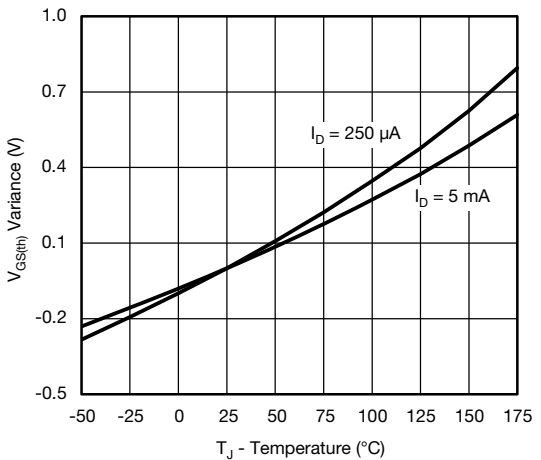
On-Resistance vs. Junction Temperature



Source-Drain Diode Forward Voltage



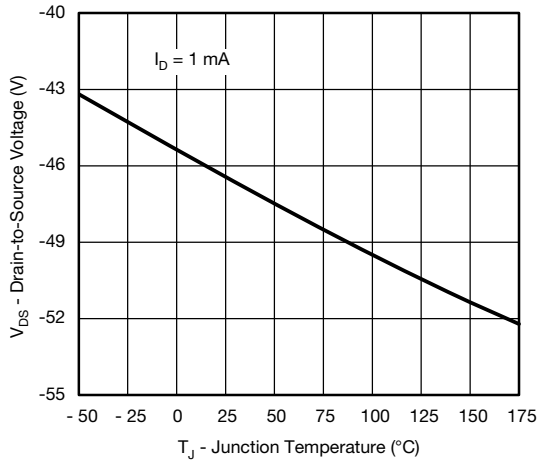
On-Resistance vs. Gate-Source Voltage



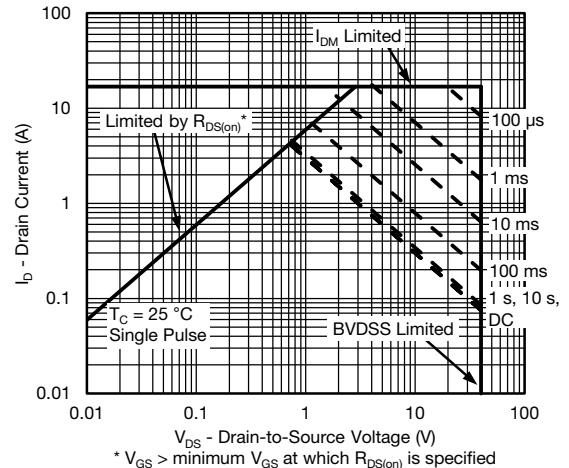
Threshold Voltage



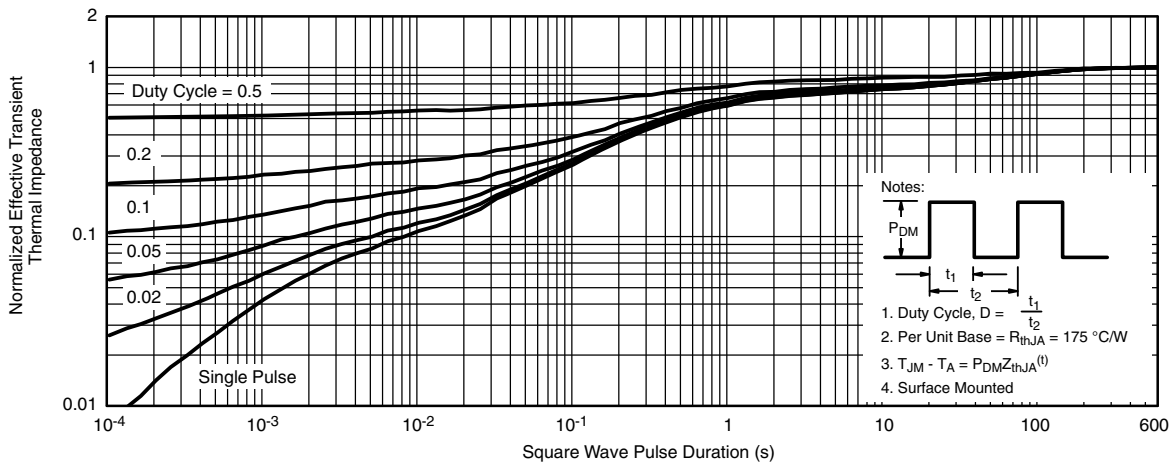
**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Drain Source Breakdown vs. Junction Temperature**



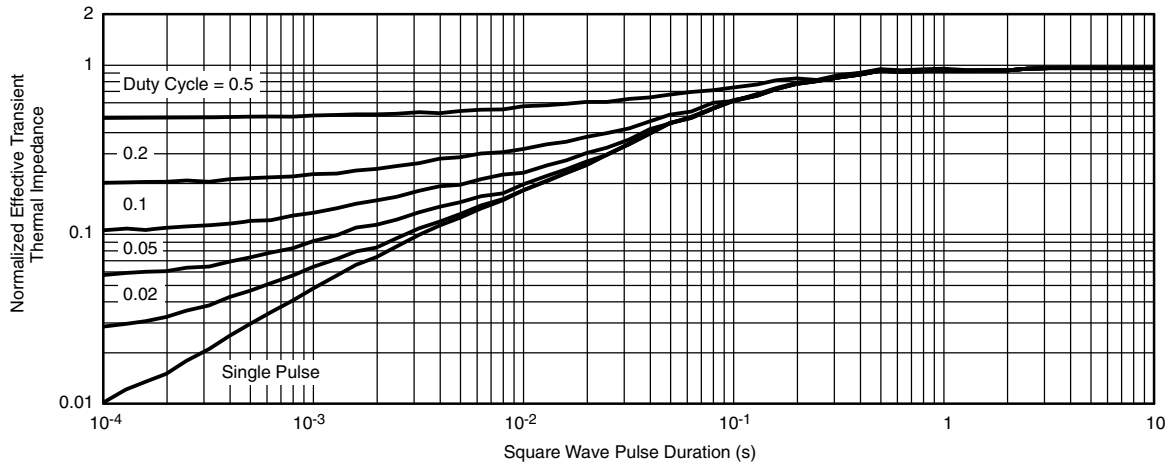
**Safe Operating Area**  
\*  $V_{GS} >$  minimum  $V_{GS}$  at which  $R_{DS(on)}$  is specified



**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.

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/ppg?63248](http://www.vishay.com/ppg?63248).

## 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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