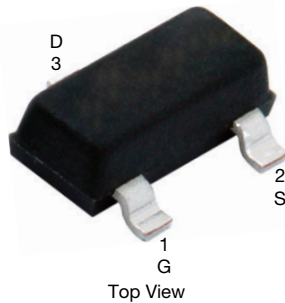


# Automotive P-Channel 60 V (D-S) 175 °C MOSFET

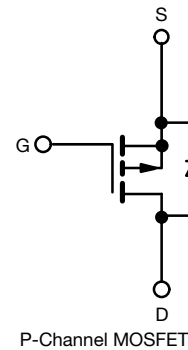
**SOT-23 (TO-236)**

**Marking Code:** 9Dxxx

PRODUCT SUMMARY	
$V_{DS}$ (V)	-60
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -10$ V	0.177
$R_{DS(on)}$ ( $\Omega$ ) at $V_{GS} = -4.5$ V	0.246
$I_D$ (A)	-2.8
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**


ORDERING INFORMATION	
Package	SOT-23
Lead (Pb)-free and halogen-free	SQ2361ES (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		$V_{DS}$	-60	V
Gate-source voltage		$V_{GS}$	$\pm 20$	
Continuous drain current	$T_C = 25$ °C	$I_D$	-2.8	A
	$T_C = 125$ °C		-1.6	
Continuous source current (diode conduction)		$I_S$	-2.5	
Pulsed drain current <sup>a</sup>		$I_{DM}$	-11	
Single pulse avalanche current	L = 0.1 mH	$I_{AS}$	-12.5	
Single pulse avalanche energy				
Maximum power dissipation <sup>a</sup>	$T_C = 25$ °C	$P_D$	2	W
	$T_C = 125$ °C		0.67	
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>	$R_{thJA}$	175	°C/W
Junction-to-foot (drain)		$R_{thJF}$	75	

**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	$V_{DS}$	$V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$	-60	-	-	V	
Gate-source threshold voltage	$V_{GS(th)}$	$V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$	-1.5	-	-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>	$I_{D(on)}$	$V_{GS} = -10\text{ V}$	$V_{DS} \leq -5\text{ V}$	-10	-	A	
Drain-source on-state resistance <sup>a</sup>	$R_{DS(on)}$	$V_{GS} = -10\text{ V}$	$I_D = -2.4\text{ A}$	-	0.130	0.177	$\Omega$
		$V_{GS} = -10\text{ V}$	$I_D = -2.4\text{ A}, T_J = 125\text{ }^\circ\text{C}$	-	-	0.310	
		$V_{GS} = -10\text{ V}$	$I_D = -2.4\text{ A}, T_J = 175\text{ }^\circ\text{C}$	-	-	0.320	
		$V_{GS} = -4.5\text{ V}$	$I_D = -1.8\text{ A}$	-	0.205	0.246	
Forward transconductance <sup>b</sup>	$g_{fs}$	$V_{DS} = -10\text{ V}, I_D = -2\text{ A}$		-	5	S	
<b>Dynamic <sup>b</sup></b>							
Input capacitance	$C_{iss}$	$V_{GS} = 0\text{ V}$	$V_{DS} = -30\text{ V}, f = 1\text{ MHz}$	-	380	550	$\text{pF}$
Output capacitance	$C_{oss}$			-	50	75	
Reverse transfer capacitance	$C_{rss}$			-	30	42	
Total gate charge <sup>c</sup>	$Q_g$	$V_{GS} = -10\text{ V}$	$V_{DS} = -30\text{ V}, I_D = -6\text{ A}$	-	9	12	$\text{nC}$
Gate-source charge <sup>c</sup>	$Q_{gs}$			-	1.6	-	
Gate-drain charge <sup>c</sup>	$Q_{gd}$			-	3.3	-	
Gate resistance	$R_g$	$f = 1\text{ MHz}$		3.1	4.1	8.1	$\Omega$
Turn-on delay time <sup>c</sup>	$t_{d(on)}$	$V_{DD} = -30\text{ V}, R_L = 20\text{ }\Omega$ $I_D \cong -1.5\text{ A}, V_{GEN} = -10\text{ V}, R_g = 1\text{ }\Omega$		-	8	11	$\text{ns}$
Rise time <sup>c</sup>	$t_r$			-	9	12	
Turn-off delay time <sup>c</sup>	$t_{d(off)}$			-	22	26	
Fall time <sup>c</sup>	$t_f$			-	4	6	
<b>Source-Drain Diode Ratings and Characteristics <sup>b</sup></b>							
Pulsed current <sup>a</sup>	$I_{SM}$			-	-	-11	A
Forward voltage	$V_{SD}$	$I_F = -1.5\text{ A}, V_{GS} = 0\text{ V}$		-	-0.9	-1.2	V

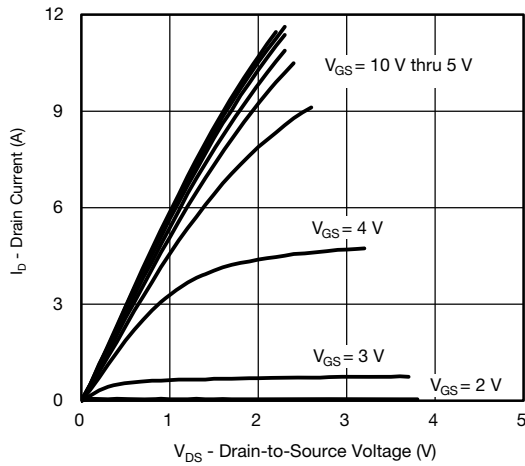
**Notes**

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

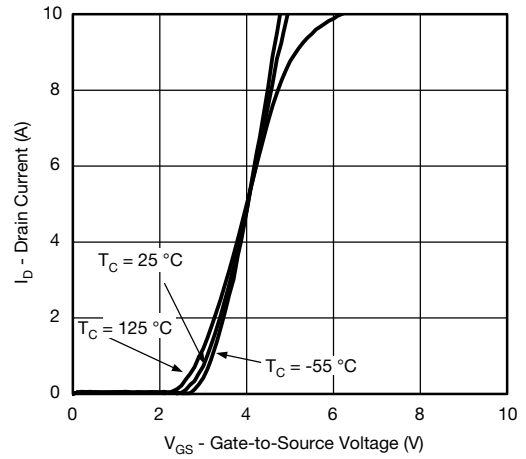
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



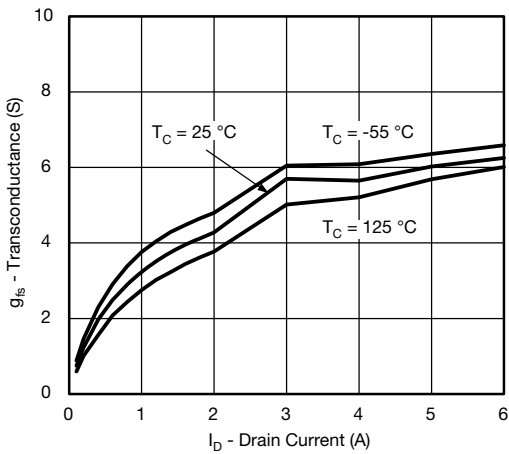
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



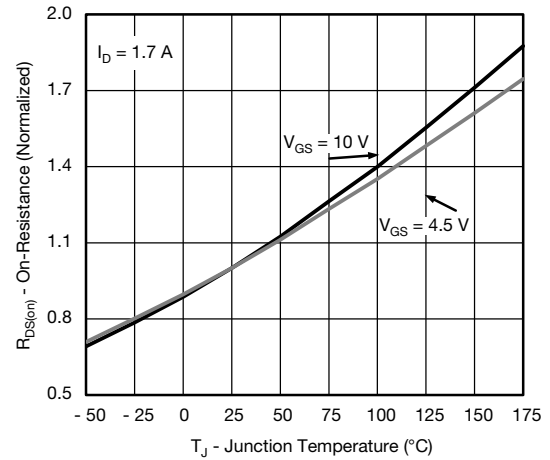
Output Characteristics



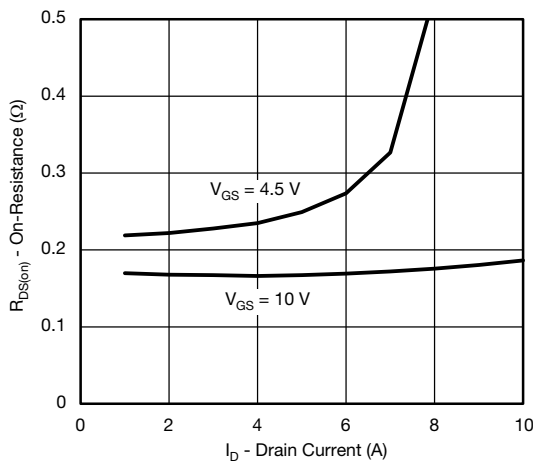
Transfer Characteristics



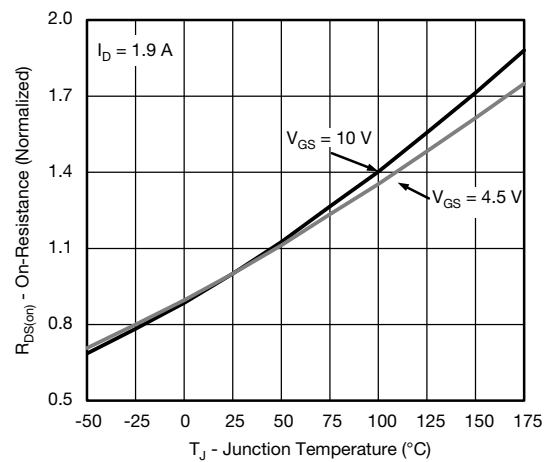
Transconductance



On-Resistance vs. Junction Temperature



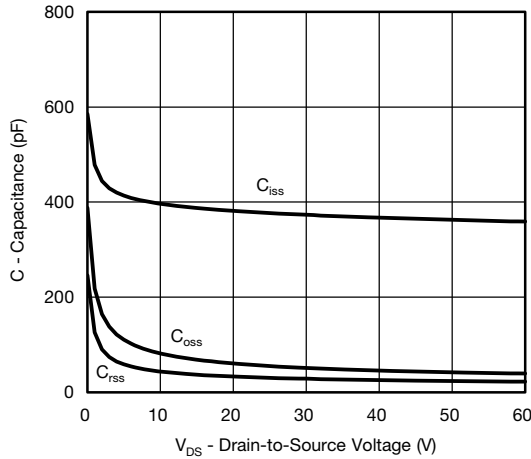
On-Resistance vs. Drain Current



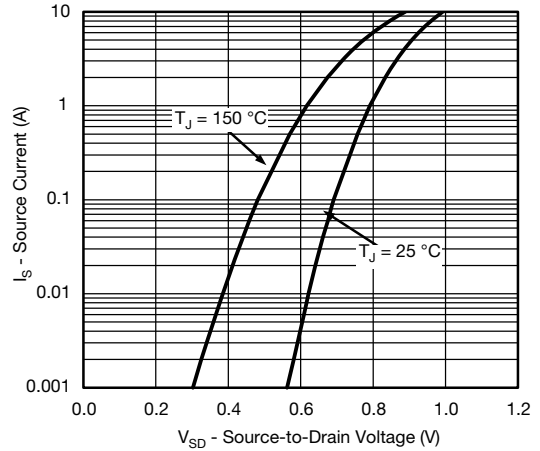
On-Resistance vs. Junction Temperature



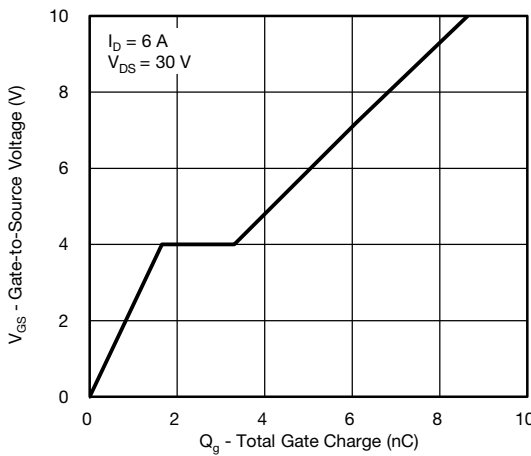
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



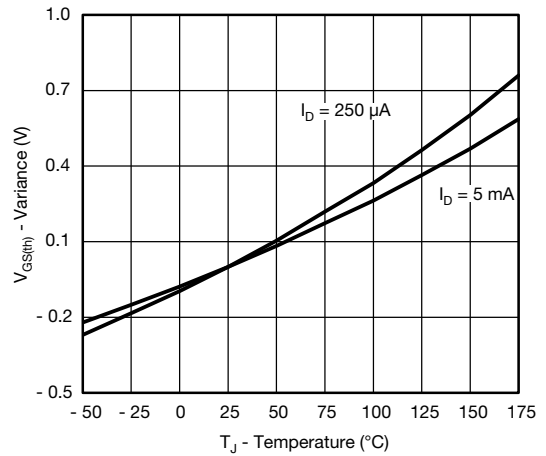
Capacitance



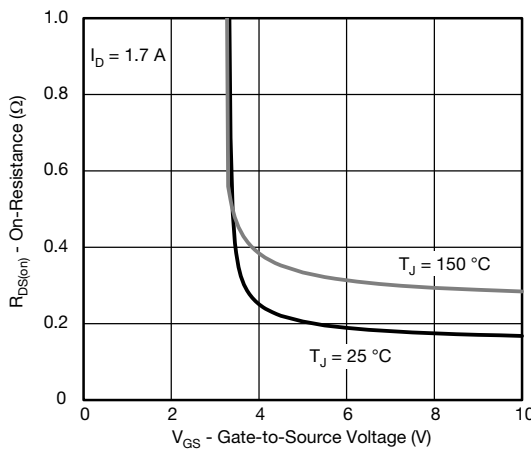
Source-Drain Diode Forward Voltage



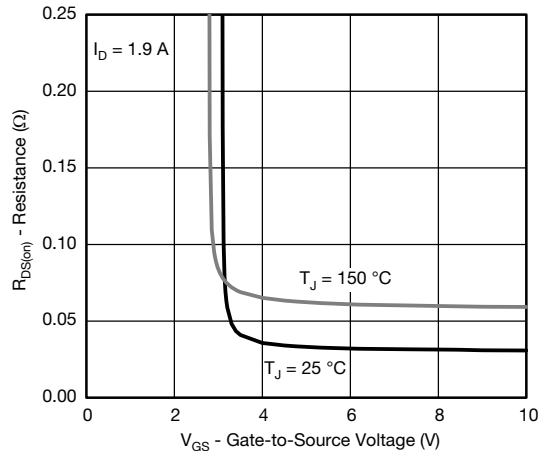
Gate Charge



Threshold Voltage



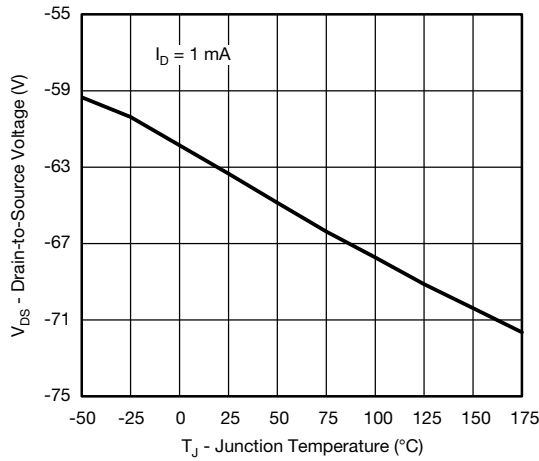
On-Resistance vs. Gate-Source Voltage



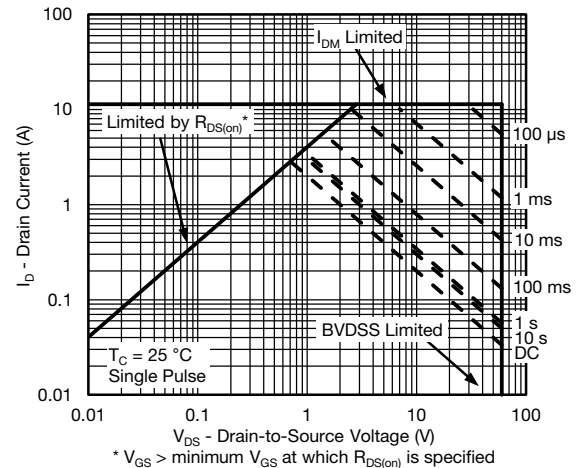
On-Resistance vs. Gate-Source Voltage



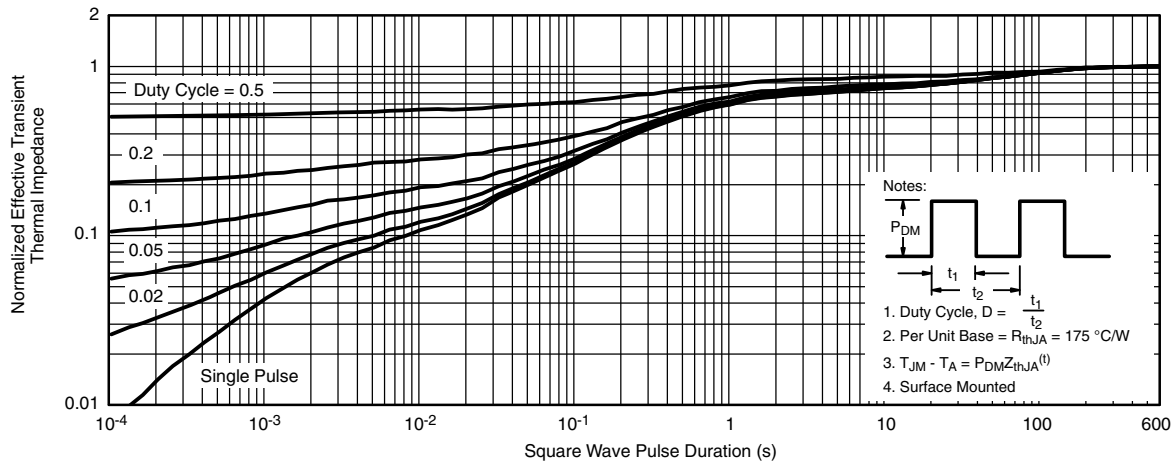
**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



**Drain-Source Breakdown vs. Junction Temperature**



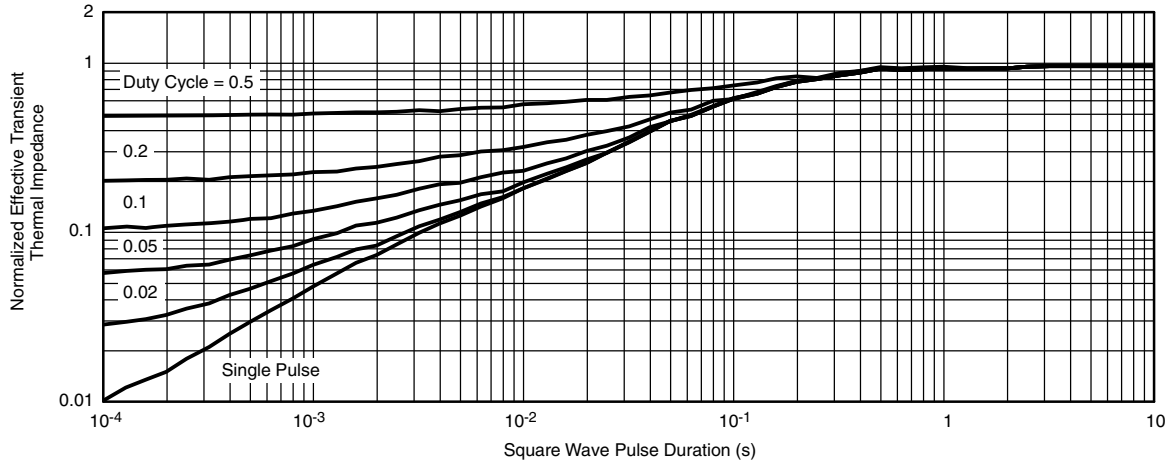
**Safe Operating Area**



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



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



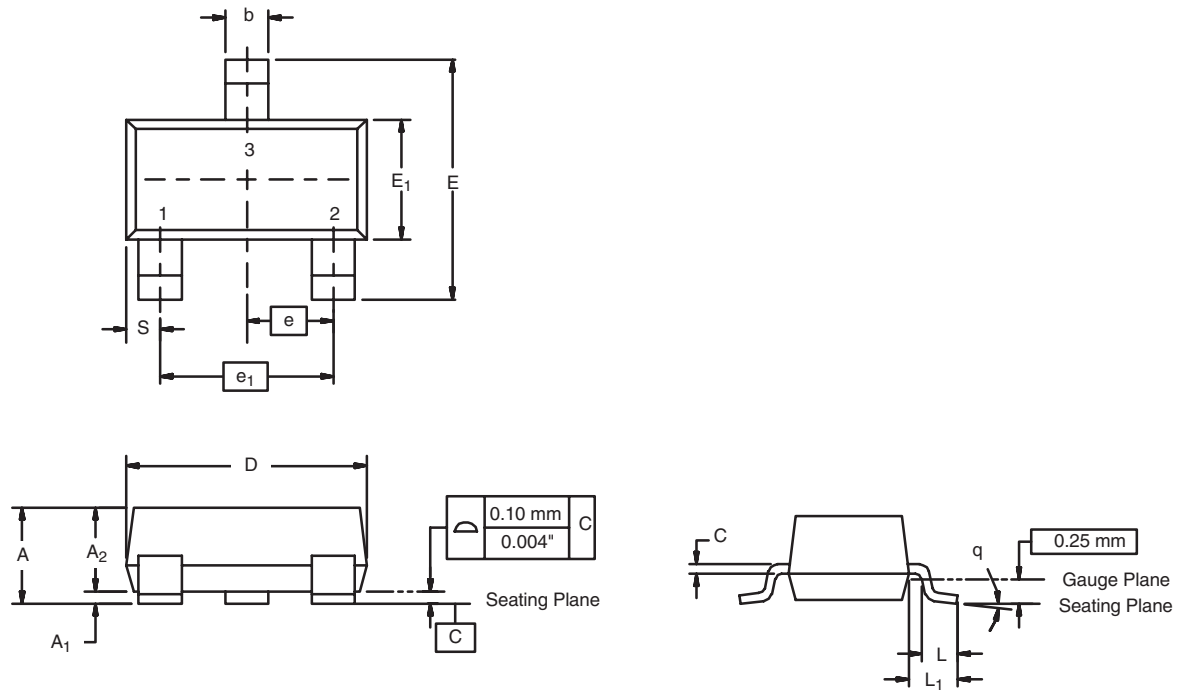
**Normalized Thermal Transient Impedance, Junction-to-Foot**

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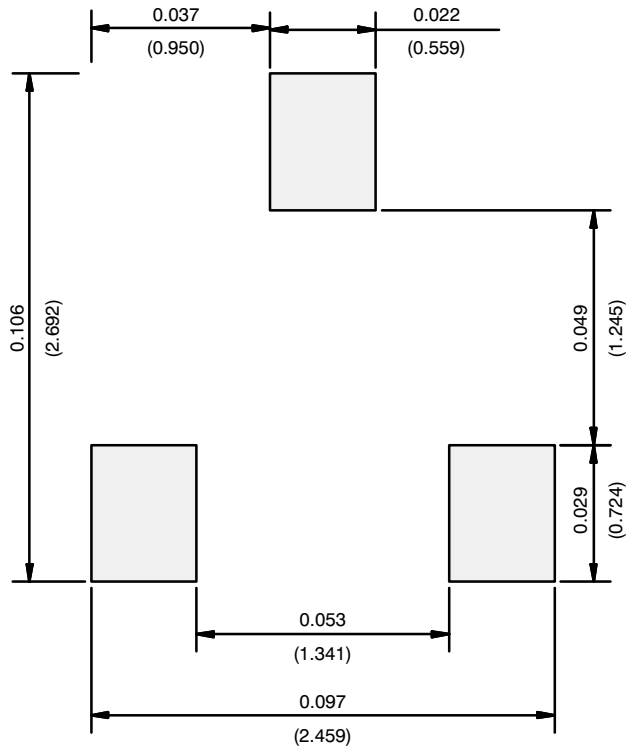
## SOT-23 (TO-236): 3-LEAD



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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