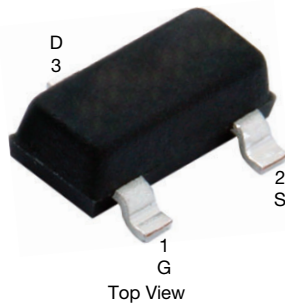


# Automotive P-Channel 60 V (D-S) 175 °C MOSFET

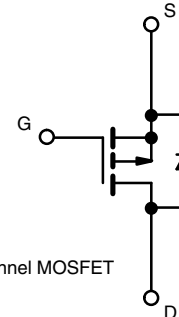
**SOT-23 (TO-236)**

**Marking code: 8P**

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

**FEATURES**

- TrenchFET® power MOSFET
- AEC-Q101 qualified <sup>c</sup>
- 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 | SQ2309ES<br>(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  | $I_D$          | $T_C = 25$ °C  | -1.7 |
|   |                | $T_C = 125$ °C | -1   |
| Continuous source current (diode conduction)                      | $I_S$          | -2.6           | A    |
| Pulsed drain current <sup>a</sup>                                 | $I_{DM}$       | -6.8           |      |
| Single pulse avalanche current                                    | $I_{AS}$       | -6.8           | mJ   |
| Single pulse avalanche energy                                     | $E_{AS}$       | 2.3            |      |
| Maximum power dissipation <sup>a</sup>                            | $P_D$          | $T_C = 25$ °C  | 2    |
|   |                | $T_C = 125$ °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        | $R_{thJA}$ | 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 (FR4 material)
- Parametric verification ongoing



| 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 | -2.0  | -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  | $C_{rss}$    |  |   | -    | 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       | 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 MHz  |   | 4.95 | 9.88  | 14.80     | $\Omega$      |
| Turn-on delay time <sup>c</sup>   | $t_{d(on)}$  | $V_{DD} = -30\text{ V}$ , $R_L = 30\text{ }\Omega$<br>$I_D \cong -3\text{ A}$ , $V_{GEN} = -10\text{ V}$ , $R_g = 1\text{ }\Omega$ |   | -    | 5     | 8         | 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             |

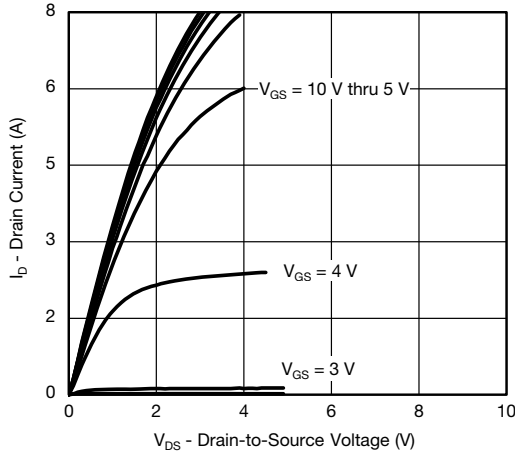
**Notes**

- 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

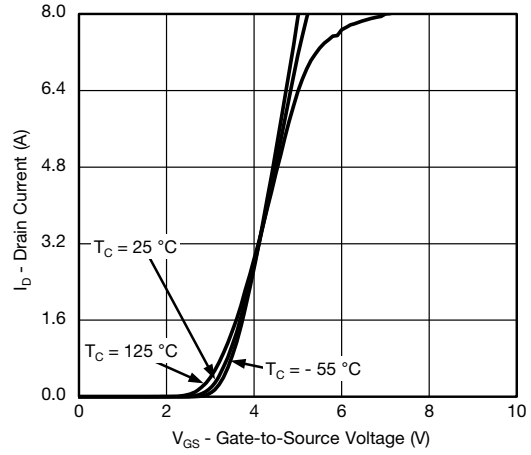
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



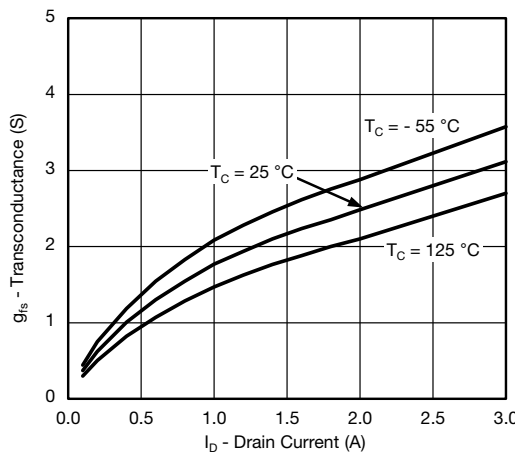
TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25 °C, unless otherwise noted)



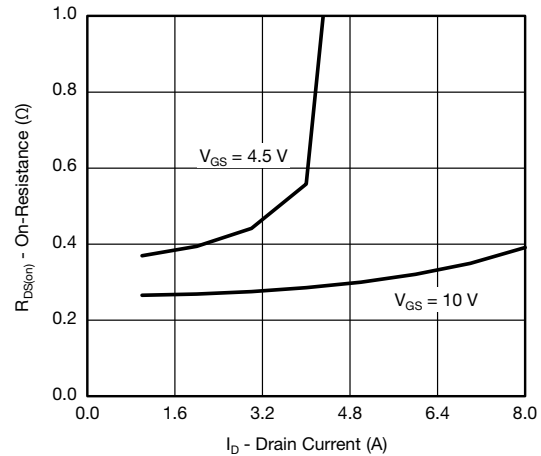
Output Characteristics



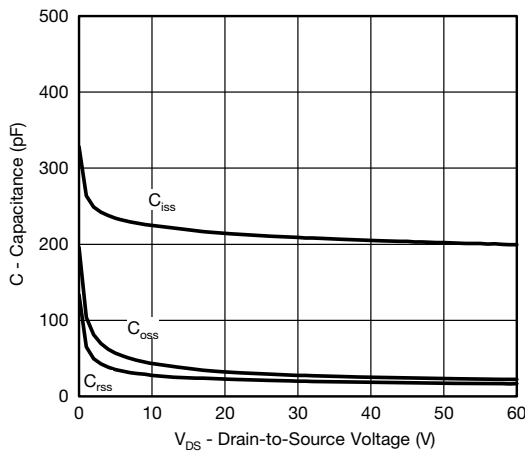
Transfer Characteristics



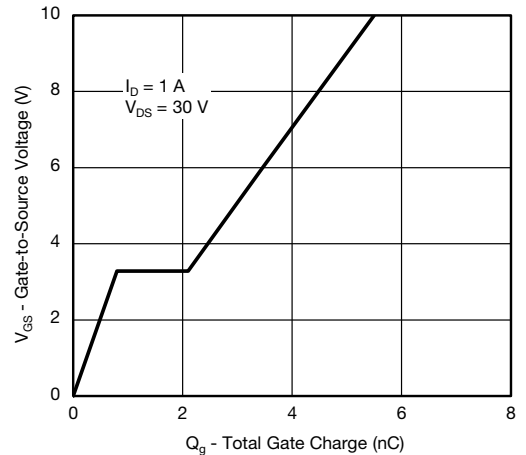
Transconductance



On-Resistance vs. Drain Current

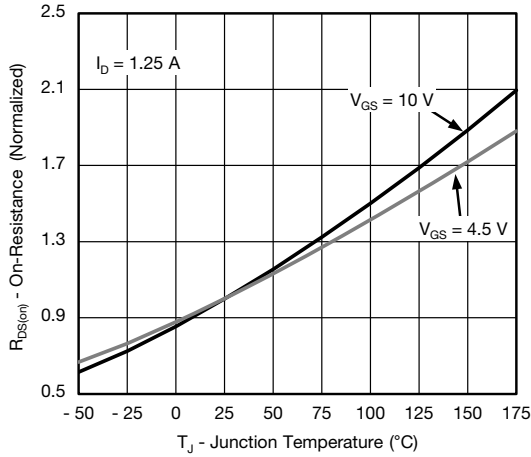


Capacitance

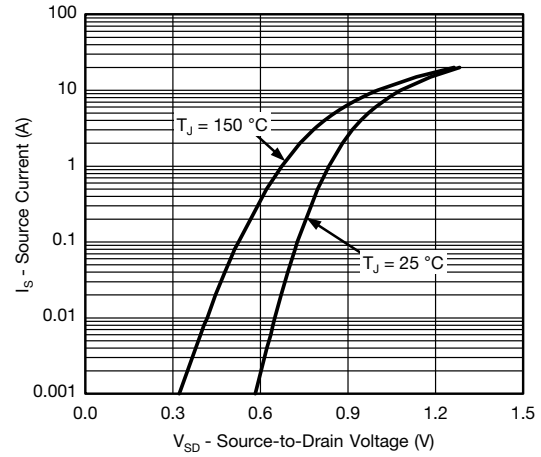


Gate Charge

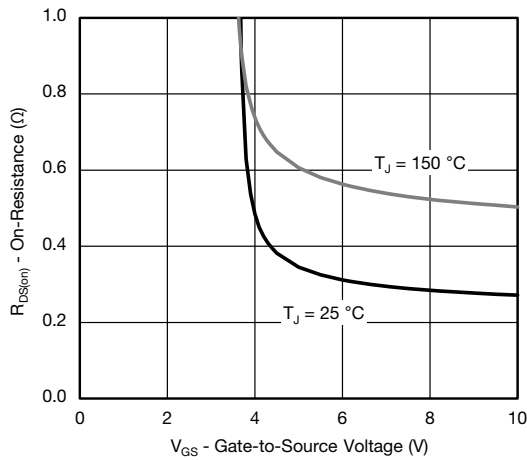
**TYPICAL CHARACTERISTICS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)



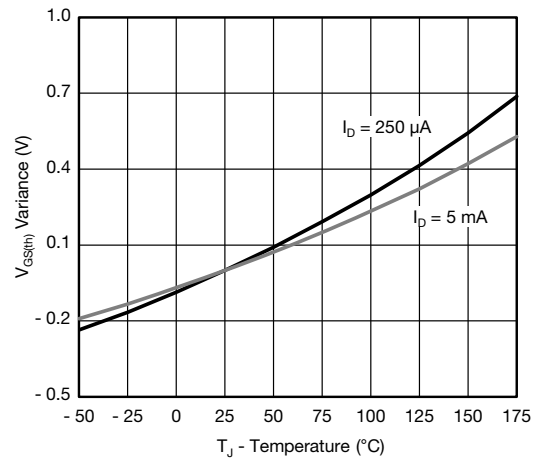
**On-Resistance vs. Junction Temperature**



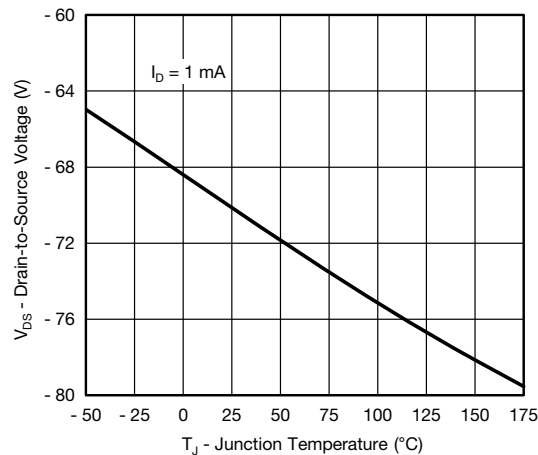
**Source Drain Diode Forward Voltage**



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



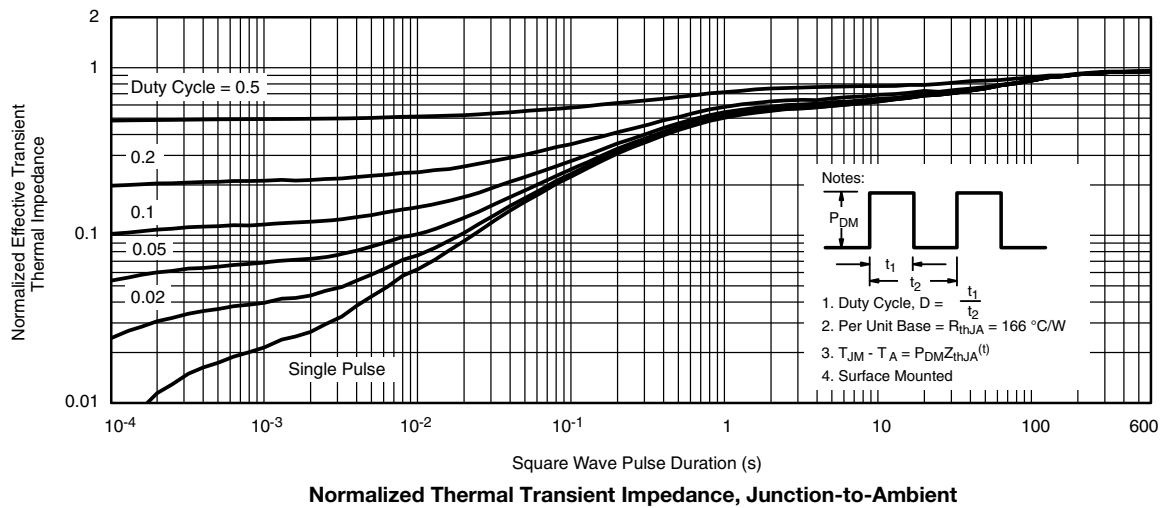
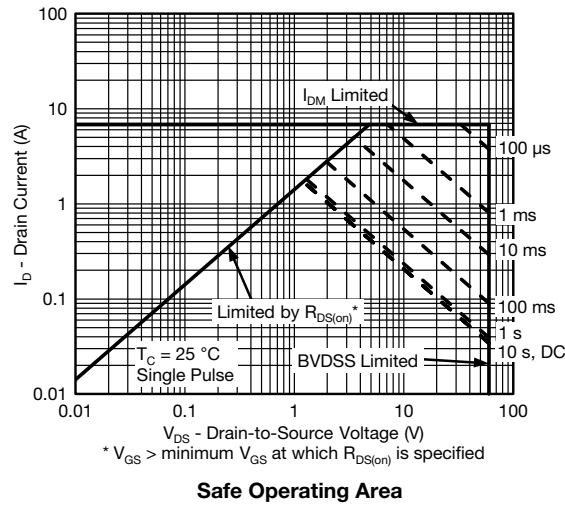
**Threshold Voltage**



**Drain Source Breakdown vs. Junction Temperature**

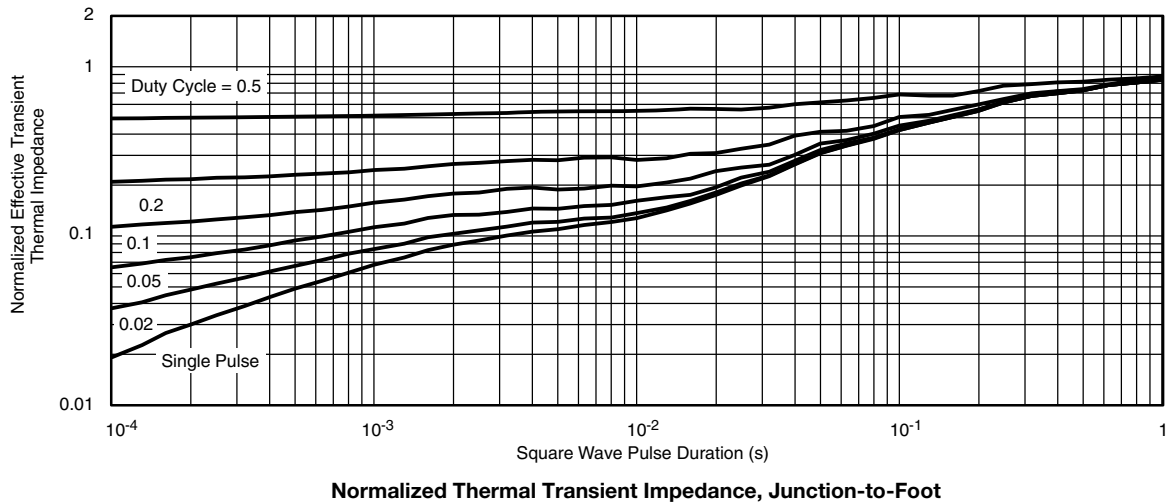


**THERMAL RATINGS** ( $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted)





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



**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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