

## LML2502G-VB Datasheet

### N-Channel 20 V (D-S) MOSFET

#### PRODUCT SUMMARY

| $V_{DS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (A) <sup>e</sup> | $Q_g$ (Typ.) |
|--------------|---------------------------|------------------------|--------------|
| 20           | 0.022 at $V_{GS} = 4.5$ V | 6 <sup>a</sup>         | 8.8 nC       |
|              | 0.028 at $V_{GS} = 2.5$ V | 6 <sup>a</sup>         |              |
|              | 0.039 at $V_{GS} = 1.8$ V | 5.6                    |              |

#### FEATURES

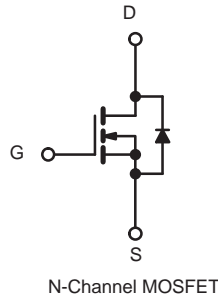
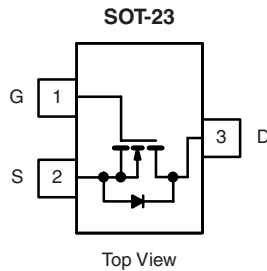
- Halogen-free According to IEC 61249-2-21 Definition
- Trench Power MOSFET
- 100 %  $R_g$  Tested
- Compliant to RoHS Directive 2002/95/EC



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

#### APPLICATIONS

- DC/DC Converters
- Load Switch for Portable Applications



#### ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °C, unless otherwise noted

| Parameter  | Symbol         | Limit                | Unit |
|--|----------------|----------------------|------|
| Drain-Source Voltage                             | $V_{DS}$       | 20                   | V    |
| Gate-Source Voltage                              | $V_{GS}$       | $\pm 12$             |      |
| Continuous Drain Current ( $T_J = 150$ °C)       | $T_C = 25$ °C  | 6 <sup>a</sup>       | A    |
|  | $T_C = 70$ °C  | 5.1                  |      |
|  | $T_A = 25$ °C  | 5 <sup>b, c</sup>    |      |
|  | $T_A = 70$ °C  | 4 <sup>b, c</sup>    |      |
| Pulsed Drain Current                             | $I_{DM}$       | 20                   |      |
| Continuous Source-Drain Diode Current            | $T_C = 25$ °C  | 1.75                 |      |
|  | $T_A = 25$ °C  | 1.04 <sup>b, c</sup> |      |
| Maximum Power Dissipation                        | $T_C = 25$ °C  | 2.1                  | W    |
|  | $T_C = 70$ °C  | 1.3                  |      |
|  | $T_A = 25$ °C  | 1.25 <sup>b, c</sup> |      |
|  | $T_A = 70$ °C  | 0.8 <sup>b, c</sup>  |      |
| Operating Junction and Storage Temperature Range | $T_J, T_{stg}$ | - 55 to 150          | °C   |
| Soldering Recommendations (Peak Temperature)     |                | 260                  |      |

#### THERMAL RESISTANCE RATINGS

| Parameter                                   | Symbol     | Typical | Maximum | Unit |
|---|------------|---------|---------|------|
| Maximum Junction-to-Ambient <sup>b, d</sup> | $R_{thJA}$ | 80      | 100     | °C/W |
| Maximum Junction-to-Foot (Drain)            | $R_{thJF}$ | 40      | 60      |      |

Notes:

- Package limited
- Surface Mounted on 1" x 1" FR4 board.
- $t = 5$  s.
- Maximum under steady state conditions is 125 °C/W.
- Based on  $T_C = 25$  °C.

| SPECIFICATIONS T <sub>J</sub> = 25 °C, unless otherwise noted |                                      |  |      |       |       |       |
|---|--------------------------------------|--|------|-------|-------|-------|
| Parameter   | Symbol                               | Test Conditions  | Min. | Typ.  | Max.  | Unit  |
| Static  |                                      |  |      |       |       |       |
| Drain-Source Breakdown Voltage                                | V <sub>DS</sub>                      | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 250 μA   | 20   |       |       | V     |
| V <sub>DS</sub> Temperature Coefficient                       | ΔV <sub>DS</sub> /T <sub>J</sub>     | I <sub>D</sub> = 250 μA  |      | 25    |       | mV/°C |
| V <sub>GS(th)</sub> Temperature Coefficient                   | ΔV <sub>GS(th)</sub> /T <sub>J</sub> |  |      | - 2.6 |       |       |
| Gate-Source Threshold Voltage                                 | V <sub>GS(th)</sub>                  | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA  | 0.45 |       | 1.0   | V     |
| Gate-Source Leakage   | I <sub>GSS</sub>                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 V   |      |       | ± 100 | nA    |
| Zero Gate Voltage Drain Current                               | I <sub>DSS</sub>                     | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V  |      |       | 1     | μA    |
|   |                                      | V <sub>DS</sub> = 20 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 70 °C  |      |       | 10    |       |
| On-State Drain Current <sup>a</sup>                           | I <sub>D(on)</sub>                   | V <sub>DS</sub> ≤ 5 V, V <sub>GS</sub> = 4.5 V   | 20   |       |       | A     |
| Drain-Source On-State Resistance <sup>a</sup>                 | R <sub>DS(on)</sub>                  | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.0 A  |      | 0.022 |       | Ω     |
|   |                                      | V <sub>GS</sub> = 2.5 V, I <sub>D</sub> = 4.7 A  |      | 0.028 |       |       |
|   |                                      | V <sub>GS</sub> = 1.8 V, I <sub>D</sub> = 4.3 A  |      | 0.039 |       |       |
| Forward Transconductance <sup>a</sup>                         | g <sub>fs</sub>                      | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 5.0 A   |      | 24    |       | S     |
| Dynamic <sup>b</sup>  |                                      |  |      |       |       |       |
| Input Capacitance   | C <sub>iss</sub>                     | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 0 V, f = 1 MHz   |      | 865   |       | pF    |
| Output Capacitance  | C <sub>oss</sub>                     |  |      | 105   |       |       |
| Reverse Transfer Capacitance                                  | C <sub>rss</sub>                     |  |      | 55    |       |       |
| Total Gate Charge   | Q <sub>g</sub>                       | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 5 V, I <sub>D</sub> = 5.0 A  |      | 12    | 18    | nC    |
|   |                                      | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 5.0 A  |      | 8.8   | 14    |       |
| Gate-Source Charge  | Q <sub>gs</sub>                      |  |      | 1.1   |       |       |
| Gate-Drain Charge   | Q <sub>gd</sub>                      |  |      | 0.7   |       |       |
| Gate Resistance   | R <sub>g</sub>                       | f = 1 MHz  | 0.5  | 2.4   | 4.8   | Ω     |
| Turn-On Delay Time  | t <sub>d(on)</sub>                   | V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.2 Ω<br>I <sub>D</sub> ≅ 4 A, V <sub>GEN</sub> = 4.5 V, R <sub>g</sub> = 1 Ω |      | 8     | 16    | ns    |
| Rise Time   | t <sub>r</sub>                       |  |      | 17    | 26    |       |
| Turn-Off Delay Time   | t <sub>d(off)</sub>                  |  |      | 31    | 47    |       |
| Fall Time   | t <sub>f</sub>                       |  |      | 8     | 16    |       |
| Turn-On Delay Time  | t <sub>d(on)</sub>                   | V <sub>DD</sub> = 10 V, R <sub>L</sub> = 2.2 Ω<br>I <sub>D</sub> ≅ 4 A, V <sub>GEN</sub> = 5 V, R <sub>g</sub> = 1 Ω   |      | 5     | 10    |       |
| Rise Time   | t <sub>r</sub>                       |  |      | 13    | 20    |       |
| Turn-Off Delay Time   | t <sub>d(off)</sub>                  |  |      | 21    | 32    |       |
| Fall Time   | t <sub>f</sub>                       |  |      | 6     | 12    |       |
| Drain-Source Body Diode Characteristics                       |                                      |  |      |       |       |       |
| Continuous Source-Drain Diode Current                         | I <sub>S</sub>                       | T <sub>C</sub> = 25 °C   |      |       | 1.75  | A     |
| Pulse Diode Forward Current                                   | I <sub>SM</sub>                      |  |      |       | 20    |       |
| Body Diode Voltage  | V <sub>SD</sub>                      | I <sub>S</sub> = 4 A, V <sub>GS</sub> = 0 V  |      | 0.75  | 1.2   | V     |
| Body Diode Reverse Recovery Time                              | t <sub>rr</sub>                      | I <sub>F</sub> = 4 A, dI/dt = 100 A/μs, T <sub>J</sub> = 25 °C   |      | 12    | 20    | ns    |
| Body Diode Reverse Recovery Charge                            | Q <sub>rr</sub>                      |  |      | 5     | 10    | nC    |
| Reverse Recovery Fall Time                                    | t <sub>a</sub>                       |  |      | 7     |       | ns    |
| Reverse Recovery Rise Time                                    | t <sub>b</sub>                       |  |      | 5     |       |       |

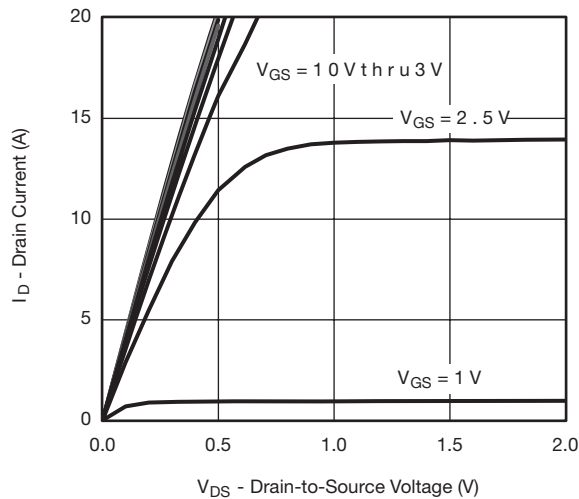
Notes:

a. Pulse test; pulse width  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ 

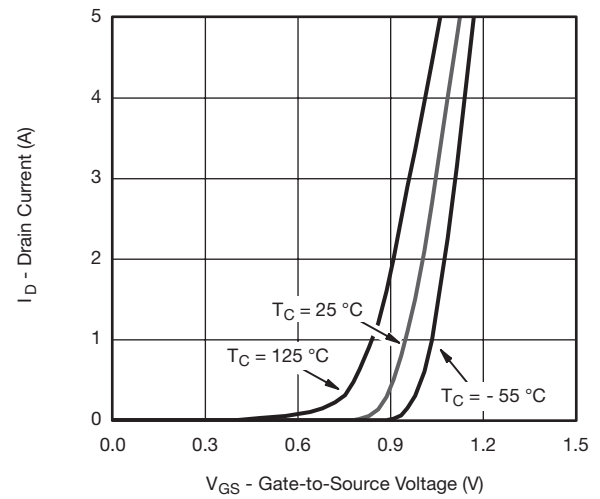
b. Guaranteed by design, not subject to production testing.

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.

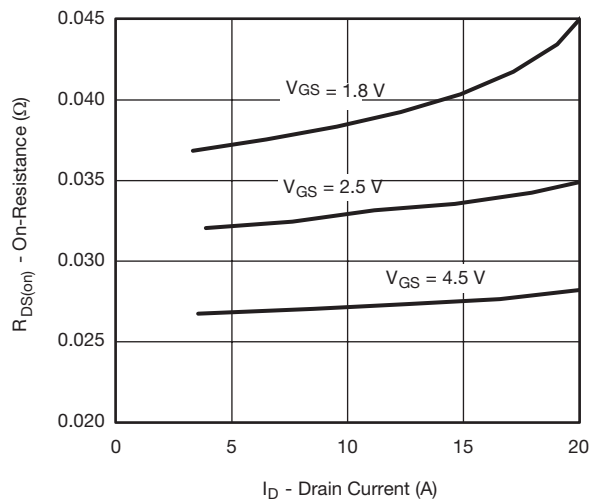
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



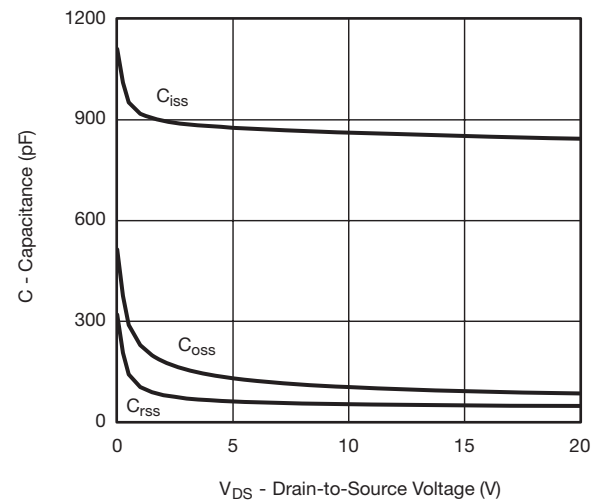
**Output Characteristics**



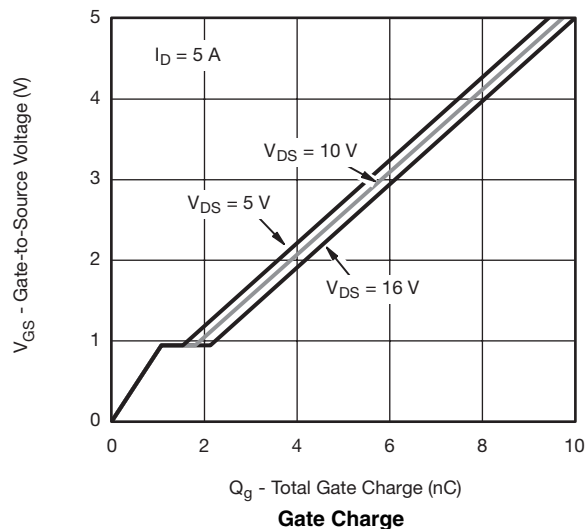
**Transfer Characteristics**



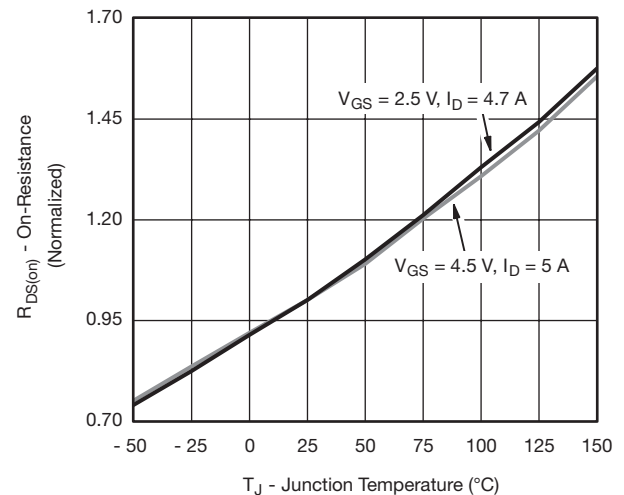
**On-Resistance vs. Drain Current and Gate Voltage**



**Capacitance**



**Gate Charge**



**On-Resistance vs. Junction Temperature**

A log-linear plot showing the source current  $I_S$  (A) on the y-axis versus the source-to-drain voltage  $V_{SD}$  (V) on the x-axis. The y-axis is logarithmic, ranging from 0.1 to 100 A. The x-axis is linear, ranging from 0.0 to 1.2 V. Two curves are plotted: one for  $T_J = 150\text{ }^{\circ}\text{C}$  and one for  $T_J = 25\text{ }^{\circ}\text{C}$ . The  $150\text{ }^{\circ}\text{C}$  curve is shifted to the left of the  $25\text{ }^{\circ}\text{C}$  curve, indicating higher current for the same voltage at higher temperature.

| $V_{SD}$ (V) | $I_S$ (A) at $T_J = 150\text{ }^{\circ}\text{C}$ | $I_S$ (A) at $T_J = 25\text{ }^{\circ}\text{C}$ |
|--------------|--|---|
| 0.35         | 0.1  | -   |
| 0.55         | 1.0  | 0.1   |
| 0.65         | 3.0  | 1.0   |
| 0.85         | 10.0   | 3.0   |
| 1.05         | 20.0   | 10.0  |

Graph showing On-Resistance ( $R_{DS(on)}$ ) versus Gate-to-Source Voltage ( $V_{GS}$ ) for the 2N7000 MOSFET at  $I_D = 5\text{ A}$ . The curves are plotted for two temperatures:  $T_J = 125\text{ }^{\circ}\text{C}$  (upper curve) and  $T_J = 25\text{ }^{\circ}\text{C}$  (lower curve). The on-resistance decreases sharply as  $V_{GS}$  increases from 1.5 V to 2.5 V, then levels off. The on-resistance is higher at  $125\text{ }^{\circ}\text{C}$  than at  $25\text{ }^{\circ}\text{C}$ .

| $V_{GS}$ (V) | $R_{DS(on)}$ ( $\Omega$ ) at $T_J = 125\text{ }^{\circ}\text{C}$ | $R_{DS(on)}$ ( $\Omega$ ) at $T_J = 25\text{ }^{\circ}\text{C}$ |
|--------------|--|---|
| 1.5          | > 0.06   | > 0.06  |
| 2.0          | 0.048  | 0.032   |
| 2.5          | 0.042  | 0.028   |
| 3.0          | 0.040  | 0.027   |
| 4.0          | 0.038  | 0.026   |
| 6.0          | 0.037  | 0.025   |
| 8.0          | 0.036  | 0.025   |

Graph showing  $V_{GS(th)}$  (V) versus  $T_J$  - Temperature ( $^{\circ}C$ ) for  $I_D = 250 \mu A$ . The curve shows a negative linear relationship between  $V_{GS(th)}$  and  $T_J$ .

A line graph showing the power dissipation of a 100 W incandescent lamp over time. The vertical axis is labeled 'Power (W)' and ranges from 0 to 32 with major grid lines every 8 units. The horizontal axis is labeled 'Time (s)' and is on a logarithmic scale with major ticks at 0.001, 0.01, 0.1, 1, 10, and 100. The curve starts at approximately 32 W at 0.001 s and decays rapidly, reaching about 16 W at 0.005 s, 8 W at 0.01 s, and continuing to decrease as time increases, approaching 0 W at 100 s.

Figure 10 is a log-log plot showing the power dissipation characteristics of the device. The y-axis represents the Drain Current ( $I_D$ ) in Amperes (A), ranging from 0.01 to 100. The x-axis represents the Drain-to-Source Voltage ( $V_{DS}$ ) in Volts (V), ranging from 0.1 to 100. The graph is for  $T_A = 25^\circ\text{C}$  Single Pulse. The solid line represents the power limit, labeled "Limited by  $R_{DS(on)}^*$ ". The dashed line represents the thermal limit, labeled "BVDSS Limited". The graph also shows pulse width limits for 100  $\mu\text{s}$ , 1 ms, 10 ms, 100 ms, 1 s, 10 s, and DC.

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

## 4

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



**Current Derating\***



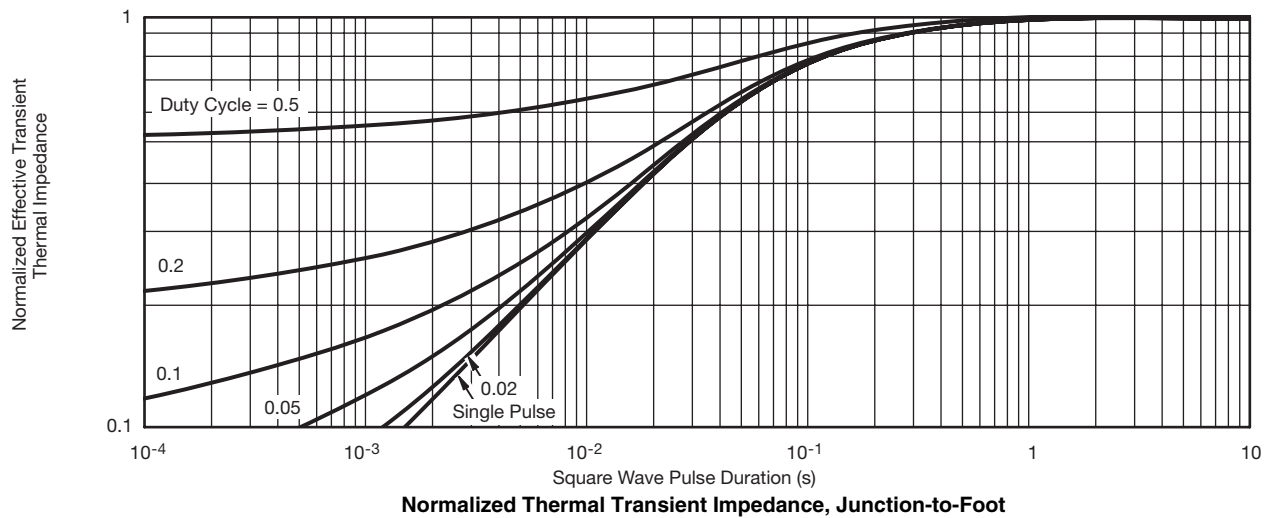
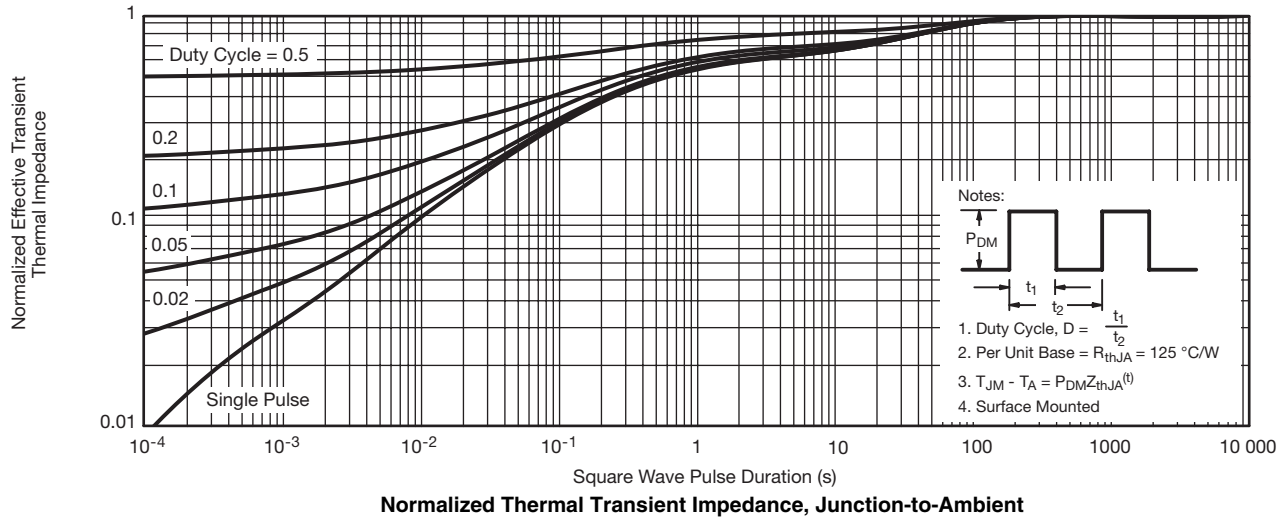
**Power Derating, Junction-to-Foot**



**Power Derating, Junction-to-Ambient**

\* The power dissipation  $P_D$  is based on  $T_{J(max.)} = 150$  °C, using junction-to-case thermal resistance, and is more useful in settling the upper dissipation limit for cases where additional heatsinking is used. It is used to determine the current rating, when this rating falls below the package limit.

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



**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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