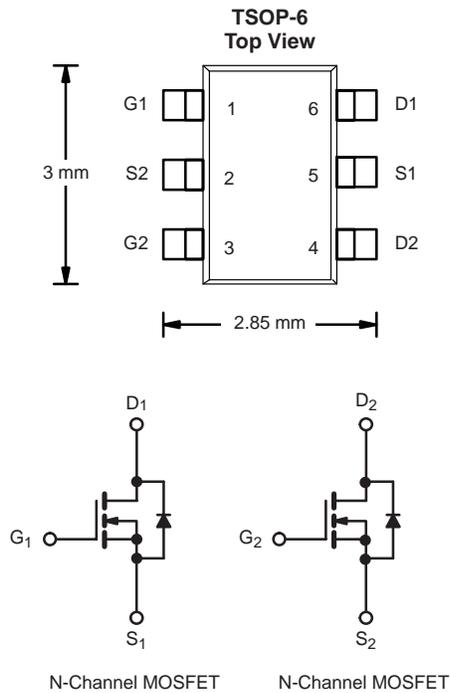


## 2N7002BKS-VB Datasheet

### Dual N-Channel 60 V (D-S) MOSFET

| PRODUCT SUMMARY |                           |            |
|-----------------|---------------------------|------------|
| $V_{DS}$ (V)    | $R_{DS(on)}$ ( $\Omega$ ) | $I_D$ (mA) |
| 60              | 1.8 at $V_{GS} = 10$ V    | 350        |



#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Low On-Resistance: 1.8  $\Omega$
- Low Threshold: 2 V (typ.)
- Low Input Capacitance: 30 pF
- Fast Switching Speed: 25 ns
- Low Input and Output Leakage
- Trench Power MOSFET
- Compliant to RoHS Directive 2002/95/EC



#### BENEFITS

- Low Offset Voltage
- Low-Voltage Operation
- Easily Driven Without Buffer
- High-Speed Circuits
- Low Error Voltage

#### APPLICATIONS

- Direct Logic-Level Interface: TTL/CMOS
- Drivers: Relays, Solenoids, Lamps, Hammers, Display, Memories, Transistors, etc.
- Battery Operated Systems
- Solid-State Relays

| ABSOLUTE MAXIMUM RATINGS $T_A = 25$ °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 ( $T_J = 150$ °C) <sup>b</sup>        | $I_D$          | $T_A = 25$ °C  | 350  |
|  |                | $T_A = 100$ °C | 230  |
| Pulsed Drain Current <sup>a</sup>                              | $I_{DM}$       | 900            | mA   |
| Power Dissipation <sup>b</sup>                                 | $P_D$          | $T_A = 25$ °C  | 0.45 |
|  |                | $T_A = 100$ °C | 0.24 |
| Maximum Junction-to-Ambient <sup>b</sup>                       | $R_{thJA}$     | 350            | °C/W |
| Operating Junction and Storage Temperature Range               | $T_J, T_{stg}$ | - 55 to 150    | °C   |

Notes:

- Pulse width limited by maximum junction temperature.
- Surface Mounted on FR4 board.

\* Pb containing terminations are not RoHS compliant, exemptions may apply.

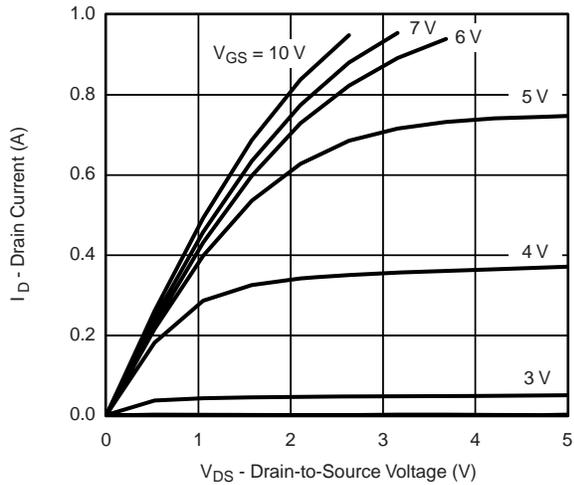
| <b>SPECIFICATIONS</b> $T_A = 25\text{ }^\circ\text{C}$ , unless otherwise noted |              |   |        |                   |            |               |
|---|--------------|---|--------|-------------------|------------|---------------|
| Parameter   | Symbol       | Test Conditions   | Limits |                   |            | Unit          |
|   |              |   | Min.   | Typ. <sup>a</sup> | Max.       |               |
| <b>Static</b>   |              |   |        |                   |            |               |
| Drain-Source Breakdown Voltage  | $V_{DS}$     | $V_{GS} = 0\text{ V}, I_D = 10\text{ }\mu\text{A}$  | 60     |                   |            | V             |
| Gate-Threshold Voltage  | $V_{GS(th)}$ | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$   | 1      |                   | 2.5        |               |
| Gate-Body Leakage   | $I_{GSS}$    | $V_{DS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$   |        |                   | $\pm 10$   | $\mu\text{A}$ |
|   |              | $V_{DS} = 0\text{ V}, V_{GS} = \pm 15\text{ V}$   |        |                   | 1          |               |
|   |              | $V_{DS} = 0\text{ V}, V_{GS} = \pm 10\text{ V}$   |        |                   | $\pm 150$  | nA            |
|   |              | $V_{DS} = 0\text{ V}, V_{GS} = \pm 10\text{ V}, T_J = 85\text{ }^\circ\text{C}$   |        |                   | $\pm 1000$ |               |
|   |              | $V_{DS} = 0\text{ V}, V_{GS} = \pm 5\text{ V}$  |        |                   | $\pm 100$  |               |
| Zero Gate Voltage Drain Current   | $I_{DSS}$    | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}$   |        |                   | 1          | $\mu\text{A}$ |
|   |              | $V_{DS} = 60\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$  |        |                   | 500        |               |
| On-State Drain Current <sup>a</sup>   | $I_{D(on)}$  | $V_{GS} = 10\text{ V}, V_{DS} = 7.5\text{ V}$   | 800    |                   |            | mA            |
|   |              | $V_{GS} = 4.5\text{ V}, V_{DS} = 10\text{ V}$   | 500    |                   |            |               |
| Drain-Source On-Resistance <sup>a</sup>   | $R_{DS(on)}$ | $V_{GS} = 10\text{ V}, I_D = 500\text{ mA}$   |        | 1.8               |            | $\Omega$      |
|   |              | $V_{GS} = 4.5\text{ V}, I_D = 200\text{ mA}$  |        | 3                 |            |               |
| Forward Transconductance <sup>a</sup>   | $g_{fs}$     | $V_{DS} = 10\text{ V}, I_D = 200\text{ mA}$   | 100    |                   |            | mS            |
| Diode Forward Voltage   | $V_{SD}$     | $I_S = 200\text{ mA}, V_{GS} = 0\text{ V}$  |        |                   | 1.3        | V             |
| <b>Dynamic<sup>a</sup></b>  |              |   |        |                   |            |               |
| Total Gate Charge   | $Q_g$        | $V_{DS} = 10\text{ V}, V_{GS} = 4.5\text{ V}$<br>$I_D \cong 250\text{ mA}$  |        | 0.6               | 0.8        | nC            |
| Input Capacitance   | $C_{iss}$    | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V}$<br>$f = 1\text{ MHz}$   |        | 30                |            | pF            |
| Output Capacitance  | $C_{oss}$    |   |        | 6                 |            |               |
| Reverse Transfer Capacitance  | $C_{rss}$    |   |        | 2.5               |            |               |
| <b>Switching<sup>a, b, c</sup></b>  |              |   |        |                   |            |               |
| Turn-On Time  | $t_{d(on)}$  | $V_{DD} = 30\text{ V}, R_L = 150\text{ }\Omega$<br>$I_D \cong 200\text{ mA}, V_{GEN} = 10\text{ V}, R_G = 10\text{ }\Omega$ |        |                   | 25         | ns            |
| Turn-Off Time   | $t_{d(off)}$ |   |        |                   | 35         |               |

Notes:

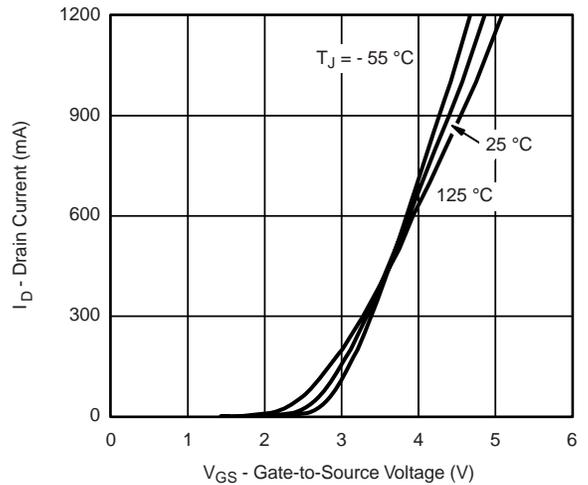
- a. For DESIGN AID ONLY, not subject to production testing.  
 b. Pulse test:  $PW \leq 300\text{ }\mu\text{s}$  duty cycle  $\leq 2\%$ .  
 c. Switching time is essentially independent of operating temperature.

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.

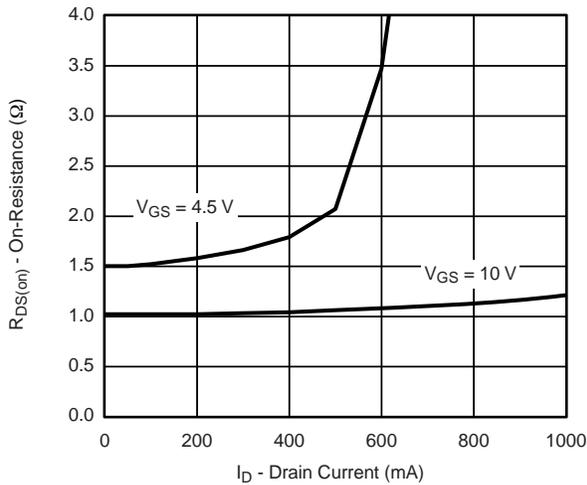
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



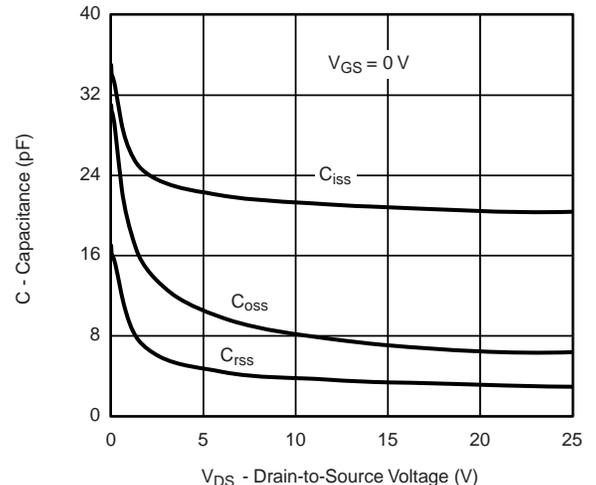
**Output Characteristics**



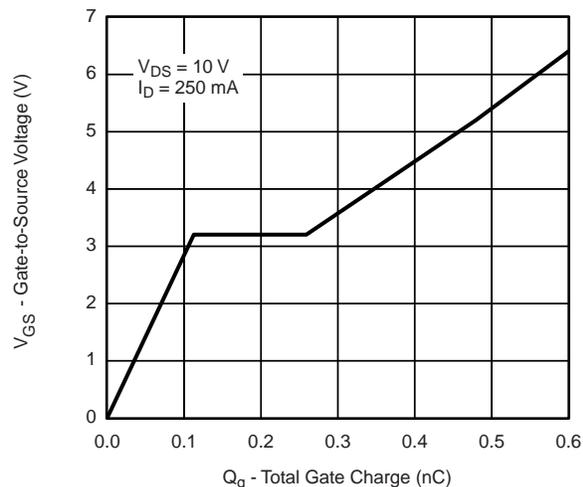
**Transfer Characteristics**



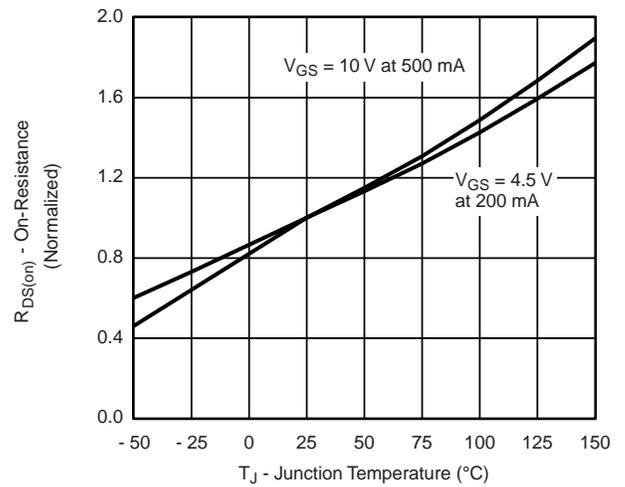
**On-Resistance vs. Drain Current**



**Capacitance**

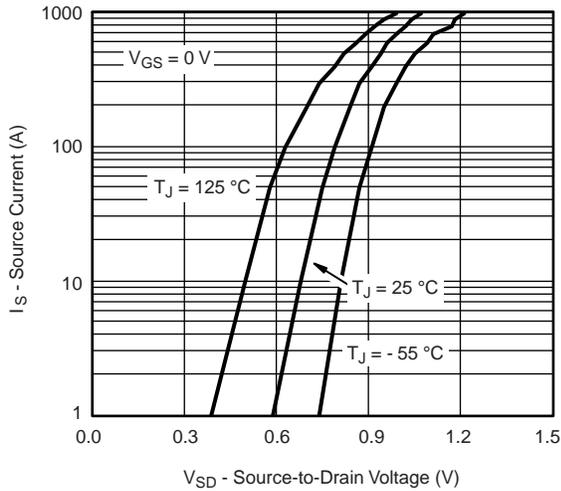


**Gate Charge**

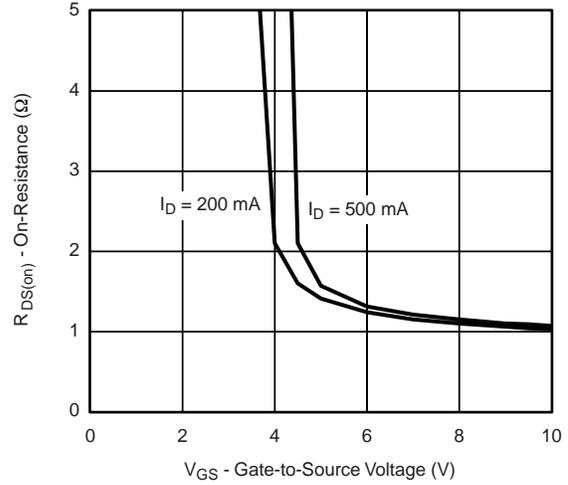


**On-Resistance vs. Junction Temperature**

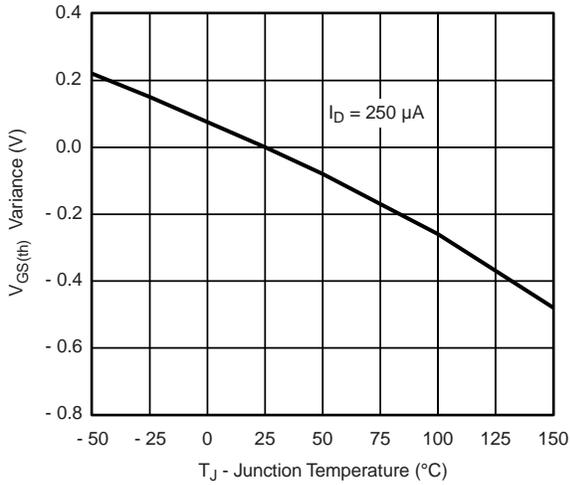
**TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



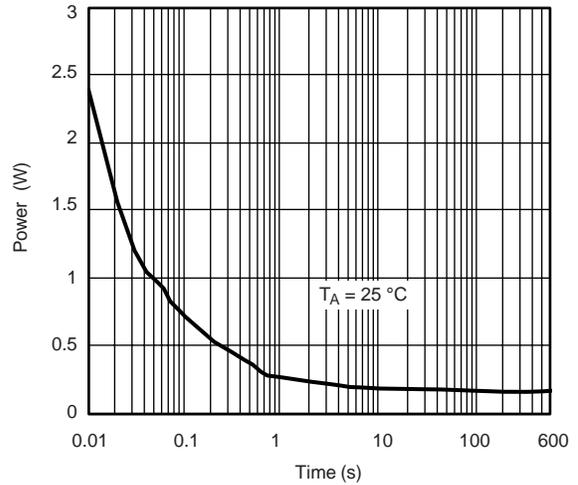
Source-Drain Diode Forward Voltage



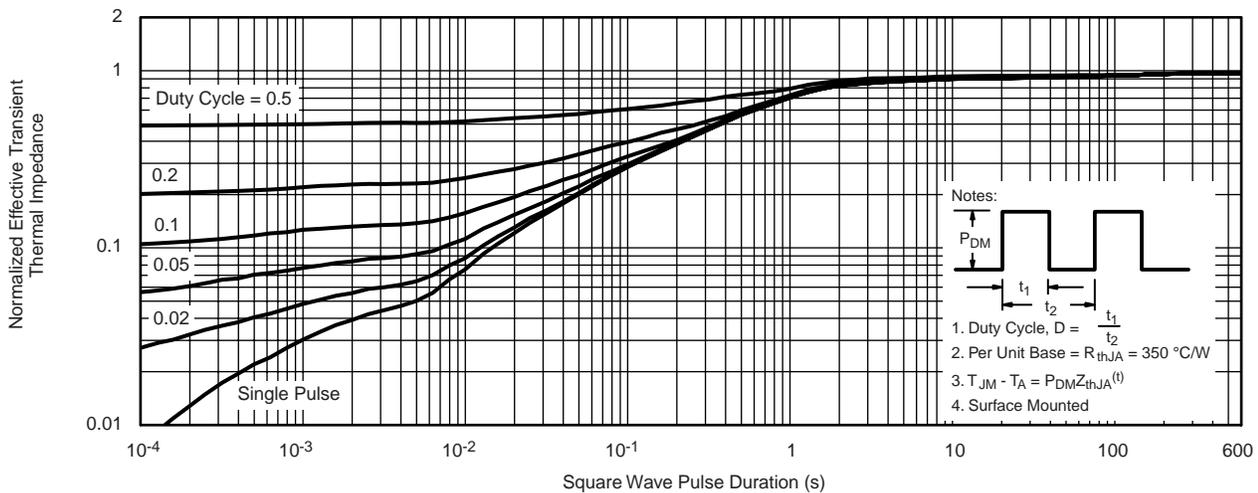
On-Resistance vs. Gate-Source Voltage



Threshold Voltage Variance Over Temperature



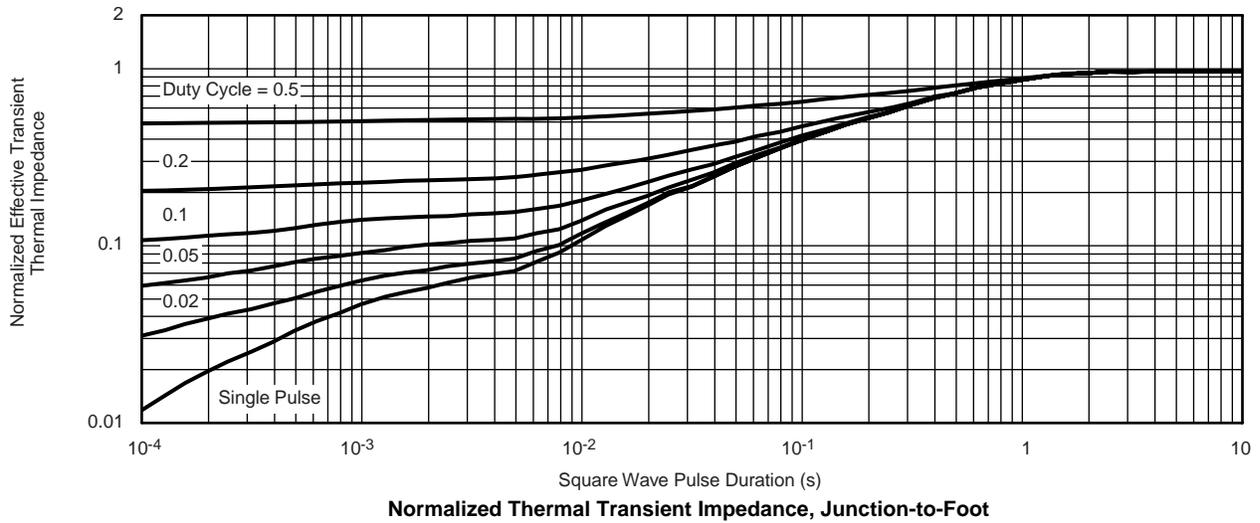
Single Pulse Power, Junction-to-Ambient



Normalized Thermal Transient Impedance, Junction-to-Ambient

- Notes:
1. Duty Cycle,  $D = \frac{t_1}{t_2}$
  2. Per Unit Base =  $R_{thJA} = 350^\circ\text{C/W}$
  3.  $T_{JM} - T_A = P_{DM}Z_{thJA}^{(t)}$
  4. Surface Mounted

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

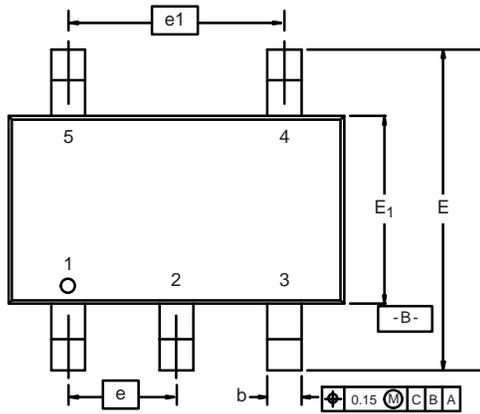


**Note**

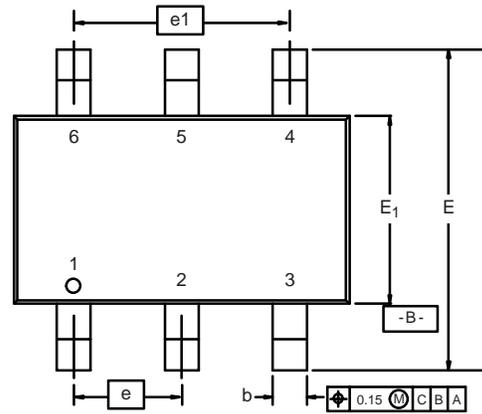
- The characteristics shown in the two graphs
  - Normalized Transient Thermal Impedance Junction-to-Ambient (25 °C)
  - Normalized Transient Thermal Impedance Junction-to-Foot (25 °C)
 are given for general guidelines only to enable the user to get a "ball park" indication of part capabilities. The 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.

TSOP: 5/6-LEAD

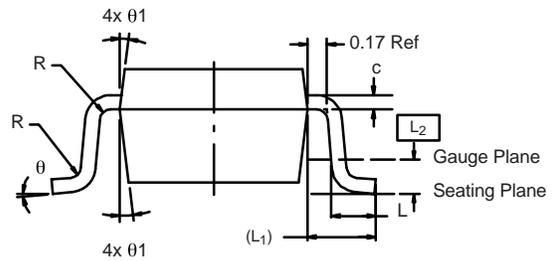
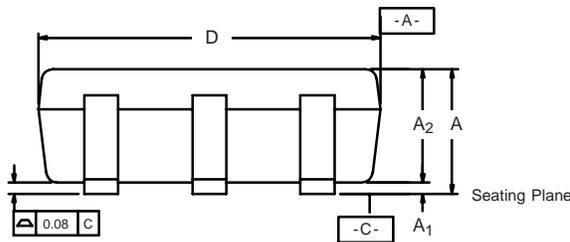
JEDEC Part Number: MO-193C



5-LEAD TSOP

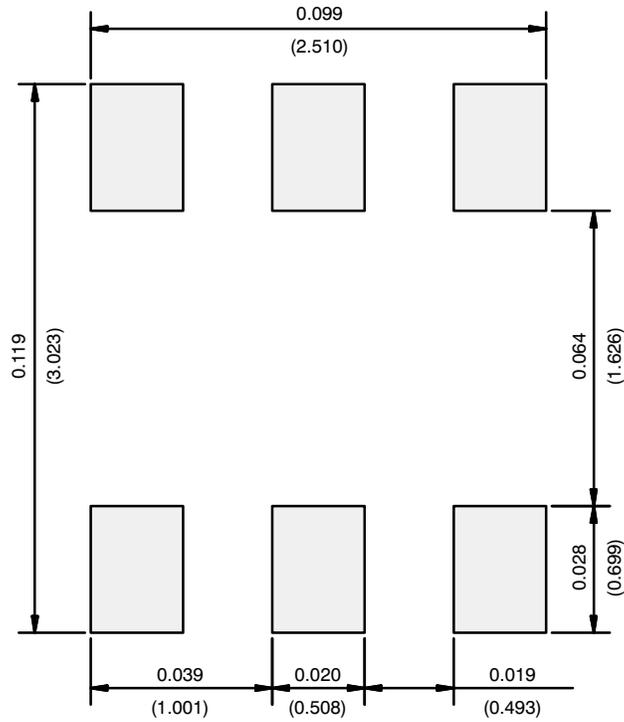


6-LEAD TSOP



| Dim   | MILLIMETERS |      |      | INCHES     |       |       |
|---|-------------|------|------|------------|-------|-------|
|   | Min         | Nom  | Max  | Min        | Nom   | Max   |
| A   | 0.91        | -    | 1.10 | 0.036      | -     | 0.043 |
| A <sub>1</sub>                              | 0.01        | -    | 0.10 | 0.0004     | -     | 0.004 |
| A <sub>2</sub>                              | 0.90        | -    | 1.00 | 0.035      | 0.038 | 0.039 |
| b   | 0.30        | 0.32 | 0.45 | 0.012      | 0.013 | 0.018 |
| c   | 0.10        | 0.15 | 0.20 | 0.004      | 0.006 | 0.008 |
| D   | 2.95        | 3.05 | 3.10 | 0.116      | 0.120 | 0.122 |
| E   | 2.70        | 2.85 | 2.98 | 0.106      | 0.112 | 0.117 |
| E <sub>1</sub>                              | 1.55        | 1.65 | 1.70 | 0.061      | 0.065 | 0.067 |
| e   | 0.95 BSC    |      |      | 0.0374 BSC |       |       |
| e <sub>1</sub>                              | 1.80        | 1.90 | 2.00 | 0.071      | 0.075 | 0.079 |
| L   | 0.32        | -    | 0.50 | 0.012      | -     | 0.020 |
| L <sub>1</sub>                              | 0.60 Ref    |      |      | 0.024 Ref  |       |       |
| L <sub>2</sub>                              | 0.25 BSC    |      |      | 0.010 BSC  |       |       |
| R   | 0.10        | -    | -    | 0.004      | -     | -     |
| θ   | 0°          | 4°   | 8°   | 0°         | 4°    | 8°    |
| θ <sub>1</sub>                              | 7° Nom      |      |      | 7° Nom     |       |       |
| ECN: C-06593-Rev. I, 18-Dec-06<br>DWG: 5540 |             |      |      |            |       |       |

RECOMMENDED MINIMUM PADS FOR TSOP-6



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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