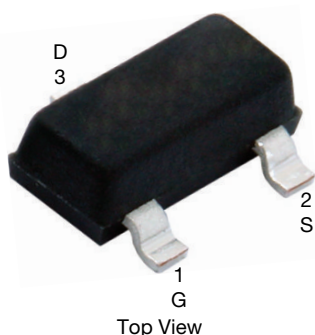


# N-Channel 60 V (D-S) MOSFET

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

**Marking code: 7K**

| PRODUCT SUMMARY                                   |        |
|---------------------------------------------------|--------|
| $V_{DS}$ (V)                                      | 60     |
| $R_{DS(on)}$ max. ( $\Omega$ ) at $V_{GS} = 10$ V | 2      |
| $Q_g$ typ. (nC)                                   | 0.4    |
| $I_D$ (A)                                         | 0.3    |
| Configuration                                     | Single |

## FEATURES

- Low on-resistance:  $2\ \Omega$
- Low threshold: 2 V (typ.)
- Low input capacitance: 25 pF
- Fast switching speed: 25 ns
- Low input and output leakage
- TrenchFET® power MOSFET
- 2000 V ESD protection
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

## Note

\* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details



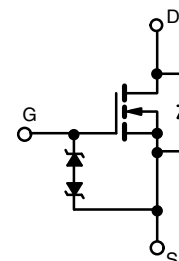
**RoHS\***  
Available  
**HALOGEN**  
**FREE**  
Available

## 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



N-Channel MOSFET

| ORDERING INFORMATION            |                |
|---------------------------------|----------------|
| Package                         | SOT-23         |
| Lead (Pb)-free                  | 2N7002K-T1-E3  |
| Lead (Pb)-free and halogen-free | 2N7002K-T1-GE3 |

| ABSOLUTE MAXIMUM RATINGS ( $T_A = 25\ ^\circ\text{C}$ , unless otherwise noted) |                             |                |             |                    |
|---------------------------------------------------------------------------------|-----------------------------|----------------|-------------|--------------------|
| PARAMETER                                                                       |                             | SYMBOL         | LIMIT       | UNIT               |
| Drain-source voltage                                                            |                             | $V_{DS}$       | 60          | V                  |
| Gate-source voltage                                                             |                             | $V_{GS}$       | $\pm 20$    |                    |
| Continuous drain current ( $T_J = 150\ ^\circ\text{C}$ ) <sup>b</sup>           | $T_A = 25\ ^\circ\text{C}$  | $I_D$          | 0.3         | A                  |
|                                                                                 | $T_A = 100\ ^\circ\text{C}$ |                | 0.19        |                    |
| Pulsed drain current <sup>a</sup>                                               |                             | $I_{DM}$       | 0.8         |                    |
| Power dissipation <sup>b</sup>                                                  | $T_A = 25\ ^\circ\text{C}$  | $P_D$          | 0.35        | W                  |
|                                                                                 | $T_A = 100\ ^\circ\text{C}$ |                | 0.14        |                    |
| Maximum junction-to-ambient <sup>b</sup>                                        |                             | $R_{thJA}$     | 350         | $^\circ\text{C/W}$ |
| Operating junction and storage temperature range                                |                             | $T_J, T_{stg}$ | -55 to +150 | $^\circ\text{C}$   |

## Notes

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



| SPECIFICATIONS (T <sub>A</sub> = 25 °C, unless otherwise noted) |                     |                                                                                                                           |      |                   |        |      |
|-----------------------------------------------------------------|---------------------|---------------------------------------------------------------------------------------------------------------------------|------|-------------------|--------|------|
| PARAMETER                                                       | SYMBOL              | TEST CONDITIONS                                                                                                           | MIN. | TYP. <sup>a</sup> | MAX.   | UNIT |
| Static                                                          |                     |                                                                                                                           |      |                   |        |      |
| Drain-source breakdown voltage                                  | V <sub>DS</sub>     | V <sub>GS</sub> = 0 V, I <sub>D</sub> = 10 μA                                                                             | 60   | -                 | -      | V    |
| Gate-threshold voltage                                          | V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                               | 1    | -                 | 2.5    |      |
| Gate-body leakage                                               | I <sub>GSS</sub>    | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 20 V                                                                           | -    | -                 | ± 10   | μA   |
|                                                                 |                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 15 V                                                                           | -    | -                 | 1      |      |
|                                                                 |                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 10 V                                                                           | -    | -                 | ± 150  | nA   |
|                                                                 |                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 10 V, T <sub>J</sub> = 85 °C                                                   | -    | -                 | ± 1000 |      |
|                                                                 |                     | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 5 V                                                                            | -    | -                 | ± 100  |      |
| Zero gate voltage drain current                                 | I <sub>DSS</sub>    | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V                                                                             | -    | -                 | 1      | μA   |
|                                                                 |                     | V <sub>DS</sub> = 60 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 125 °C                                                    | -    | -                 | 500    |      |
| On-state drain current <sup>b</sup>                             | I <sub>D(on)</sub>  | V <sub>GS</sub> = 10 V, V <sub>DS</sub> = 7.5 V                                                                           | 800  | -                 | -      | mA   |
|                                                                 |                     | V <sub>GS</sub> = 4.5 V, V <sub>DS</sub> = 10 V                                                                           | 500  | -                 | -      |      |
| Drain-source on-resistance <sup>b</sup>                         | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 500 mA                                                                           | -    | -                 | 2      | Ω    |
|                                                                 |                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 200 mA                                                                          | -    | -                 | 4      |      |
| Forward transconductance <sup>b</sup>                           | g <sub>fs</sub>     | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 200 mA                                                                           | 100  | -                 | -      | mS   |
| Diode forward voltage                                           | V <sub>SD</sub>     | I <sub>S</sub> = 200 mA, V <sub>GS</sub> = 0 V                                                                            | -    | -                 | 1.3    | V    |
| Dynamic <sup>a, b</sup>                                         |                     |                                                                                                                           |      |                   |        |      |
| Total gate charge                                               | Q <sub>g</sub>      | V <sub>DS</sub> = 10 V, V <sub>GS</sub> = 4.5 V<br>I <sub>D</sub> ≅ 250 mA                                                | -    | 0.4               | 0.6    | nC   |
| Input capacitance                                               | C <sub>iss</sub>    | V <sub>DS</sub> = 25 V, V <sub>GS</sub> = 0 V<br>f = 1 MHz                                                                | -    | 30                | -      | pF   |
| Output capacitance                                              | C <sub>oss</sub>    |                                                                                                                           | -    | 6                 | -      |      |
| Reverse transfer capacitance                                    | C <sub>rss</sub>    |                                                                                                                           | -    | 2.5               | -      |      |
| Switching <sup>a, c</sup>                                       |                     |                                                                                                                           |      |                   |        |      |
| Turn-on time                                                    | t <sub>d(on)</sub>  | V <sub>DD</sub> = 30 V, R <sub>L</sub> = 150 Ω<br>I <sub>D</sub> ≅ 200 mA, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 10 Ω | -    | -                 | 25     | ns   |
| Turn-off time                                                   | t <sub>d(off)</sub> |                                                                                                                           | -    | -                 | 35     |      |

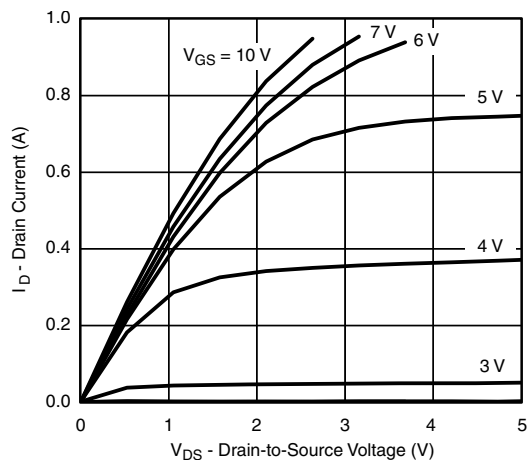
**Notes**

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

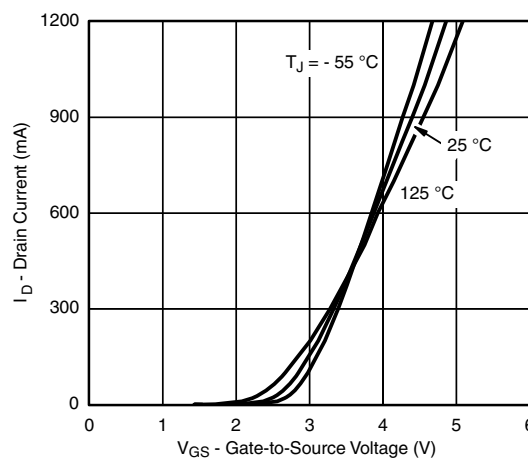
Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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



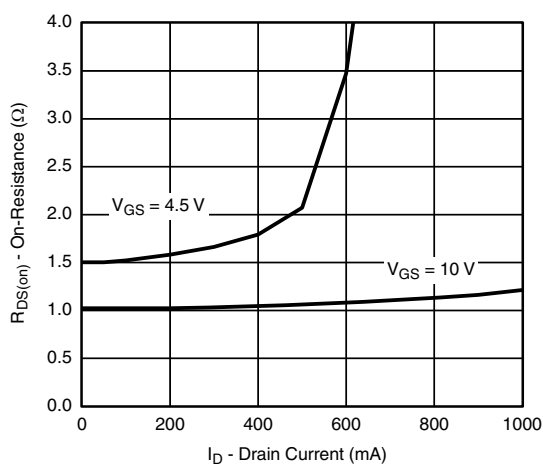
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



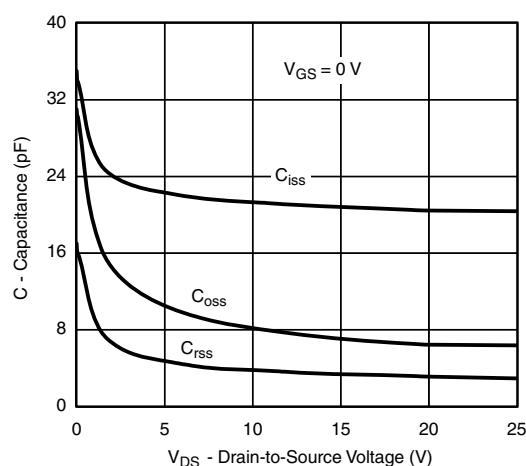
**Output Characteristics**



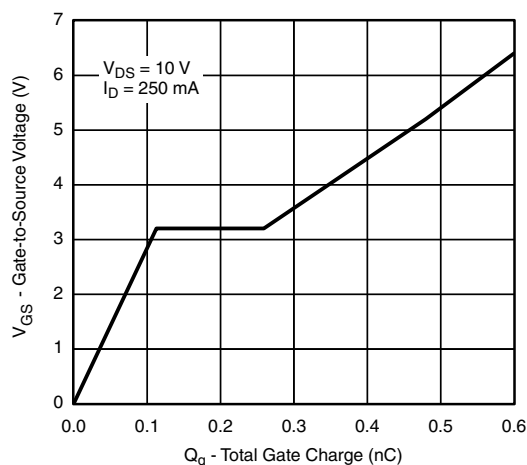
**Transfer Characteristics**



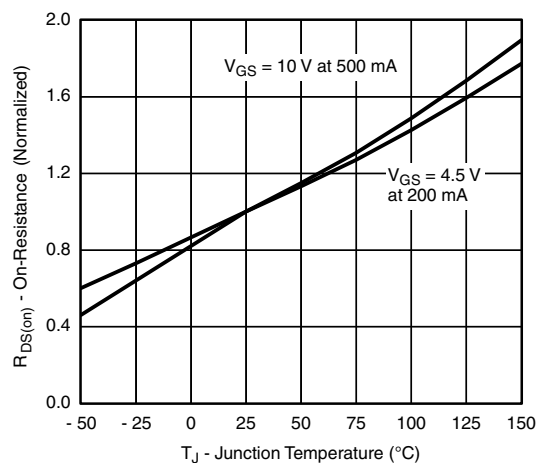
**On-Resistance vs. Drain Current**



**Capacitance**



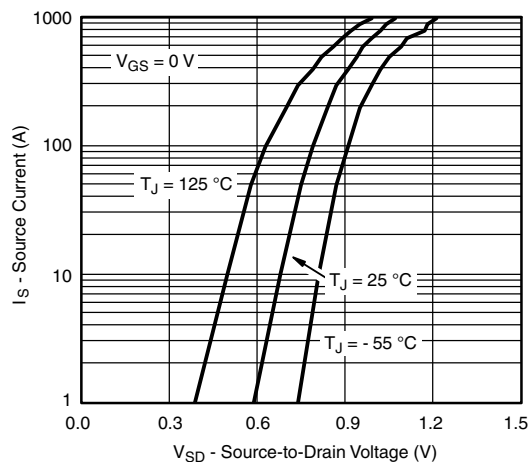
**Gate Charge**



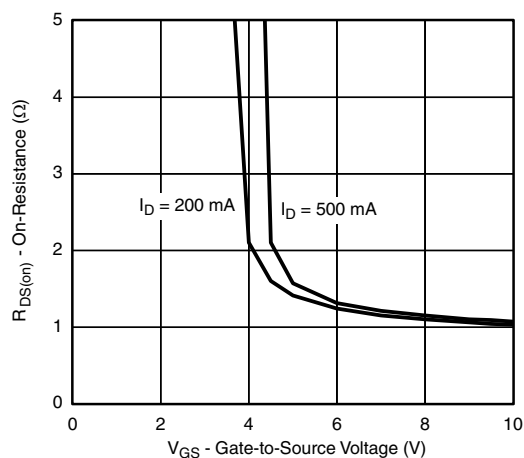
**On-Resistance vs. Junction Temperature**



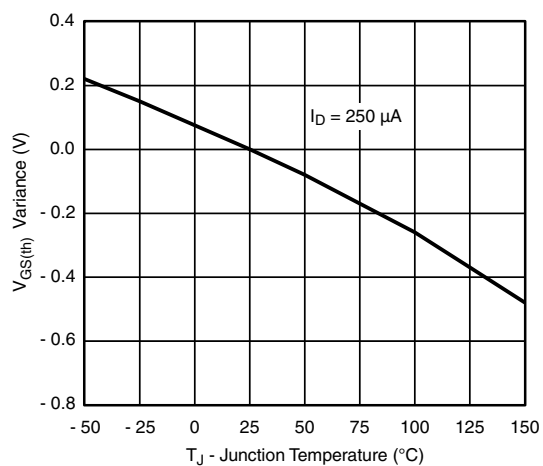
**TYPICAL CHARACTERISTICS** (25 °C, unless otherwise noted)



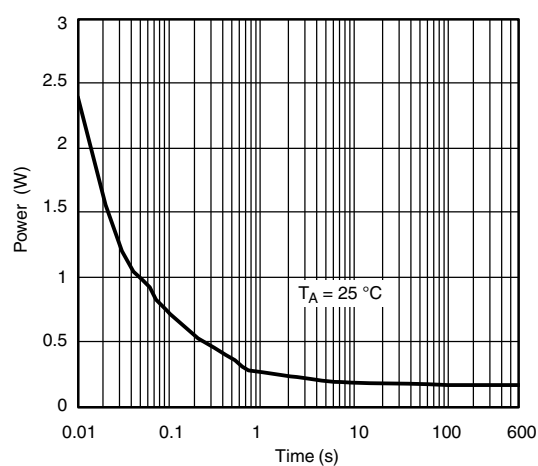
**Source-Drain Diode Forward Voltage**



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



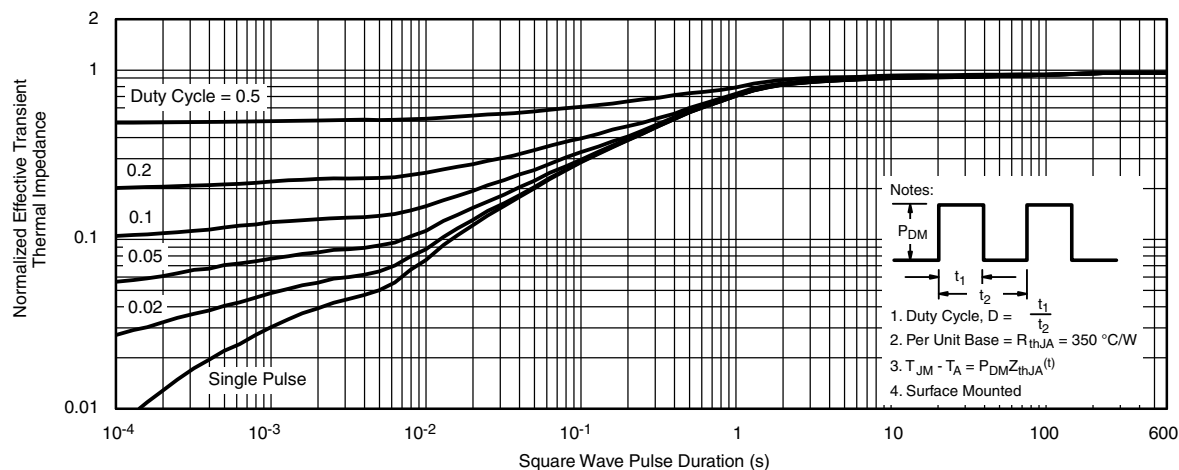
**Threshold Voltage Variance Over Temperature**



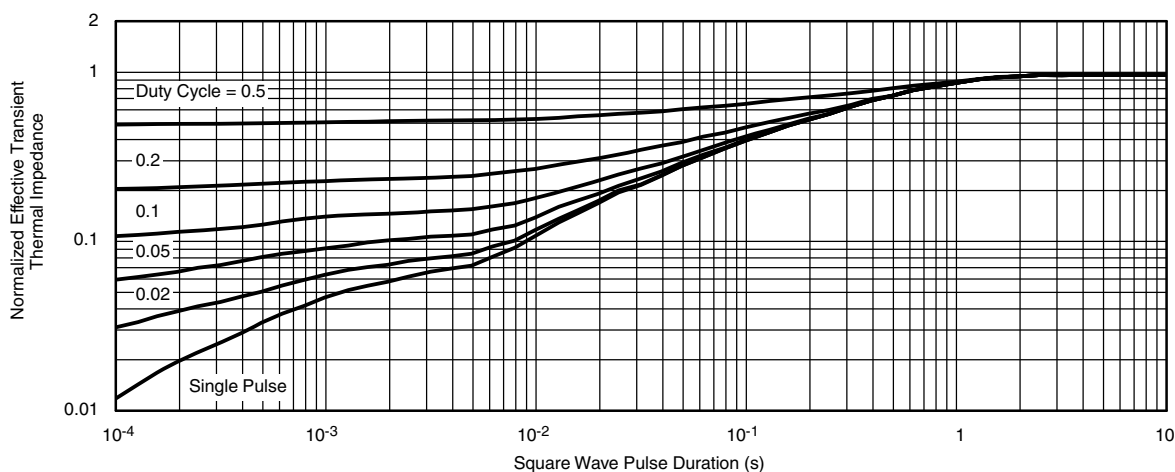
**Single Pulse Power, Junction-to-Ambient**



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



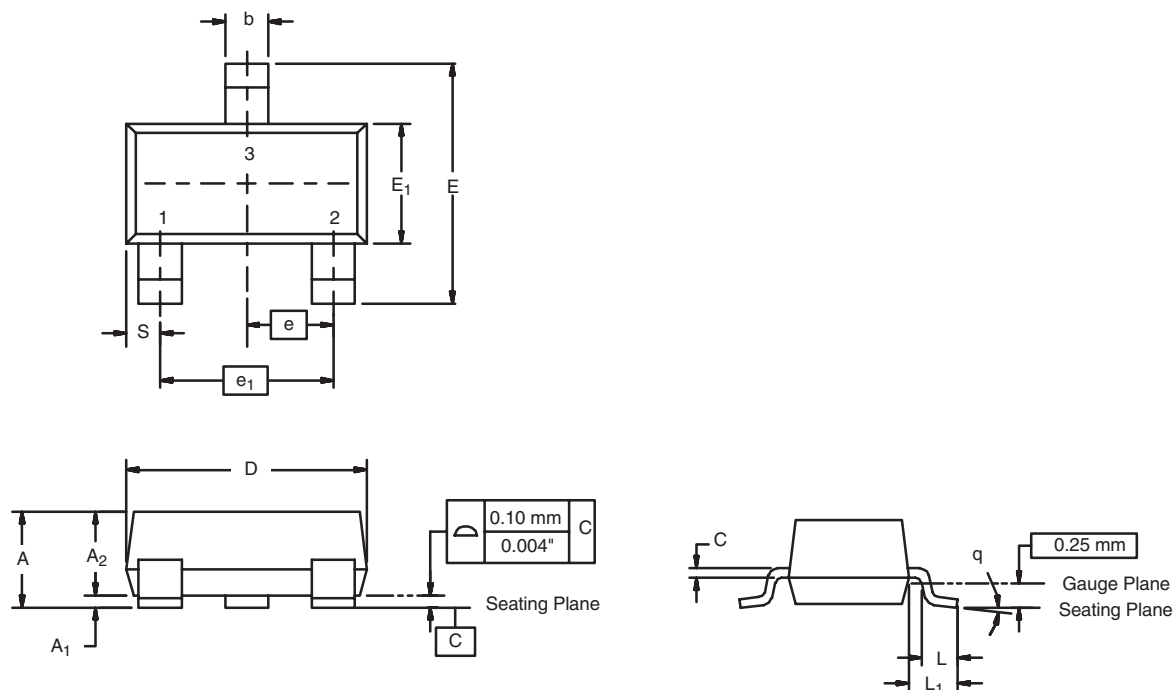
**Normalized Thermal Transient Impedance, Junction-to-Ambient**



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

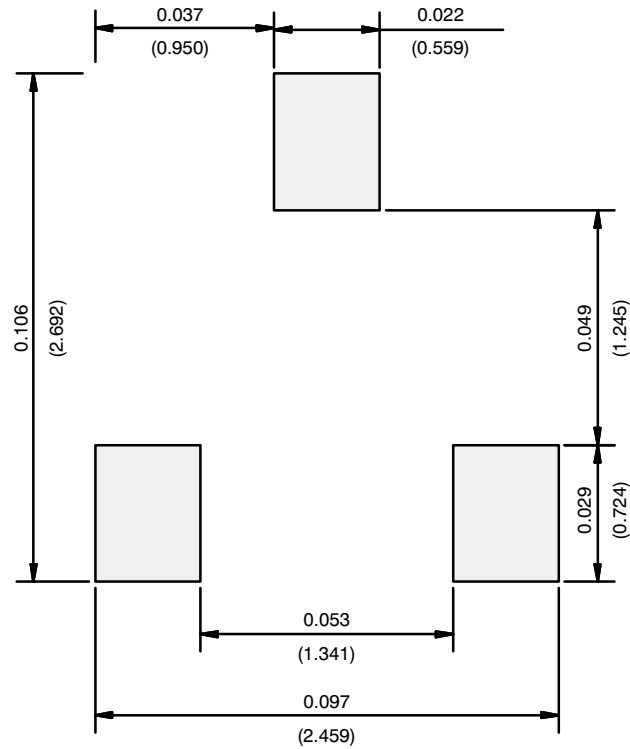
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## SOT-23 (TO-236): 3-LEAD



| 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<br>DWG: 5479 |             |      |            |       |

## RECOMMENDED MINIMUM PADS FOR SOT-23



Recommended Minimum Pads  
Dimensions in Inches/(mm)

[Return to Index](#)



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