

## ELM16602EA-VB Datasheet

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

#### PRODUCT SUMMARY

|           | V <sub>DS</sub> (V) | R <sub>DS(on)</sub> (Ω)            | I <sub>D</sub> (A) |
|-----------|---------------------|------------------------------------|--------------------|
| N-Channel | 20                  | 0.022 at V <sub>GS</sub> = 10 V    | 5.5                |
|           |                     | 0.030 at V <sub>GS</sub> = 4.5 V   | 4.2                |
| P-Channel | - 20                | 0.055 at V <sub>GS</sub> = - 10 V  | - 3.4              |
|           |                     | 0.079 at V <sub>GS</sub> = - 4.5 V | - 2.5              |

#### FEATURES

- Halogen-free According to IEC 61249-2-21 Definition
- Trench Power MOSFET
- 100 % R<sub>g</sub> Tested
- Compliant to RoHS Directive 2002/95/EC



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



N-Channel MOSFET



P-Channel MOSFET

#### ABSOLUTE MAXIMUM RATINGS T<sub>A</sub> = 25 °C, unless otherwise noted

| Parameter                                                          |                        | Symbol                            | N-Channel   | P-Channel | Unit |
|--------------------------------------------------------------------|------------------------|-----------------------------------|-------------|-----------|------|
| Drain-Source Voltage                                               |                        | V <sub>DS</sub>                   | 20          | - 20      | V    |
| Gate-Source Voltage                                                |                        | V <sub>GS</sub>                   | ± 20        | ± 20      |      |
| Continuous Drain Current (T <sub>J</sub> = 150 °C) <sup>a, b</sup> | T <sub>A</sub> = 25 °C | I <sub>D</sub>                    | 5.5         | - 3.4     | A    |
|                                                                    | T <sub>A</sub> = 70 °C |                                   | 4.0         | - 2.3     |      |
| Pulsed Drain Current                                               |                        | I <sub>DM</sub>                   | 15          | 10        |      |
| Continuous Source Current (Diode Conduction) <sup>a, b</sup>       |                        | I <sub>S</sub>                    | 1.05        | - 1.05    |      |
| Maximum Power Dissipation <sup>a, b</sup>                          | T <sub>A</sub> = 25 °C | P <sub>D</sub>                    | 1.15        |           | W    |
|                                                                    | T <sub>A</sub> = 70 °C |                                   | 0.73        |           |      |
| Operating Junction and Storage Temperature Range                   |                        | T <sub>J</sub> , T <sub>stg</sub> | - 55 to 150 |           | °C   |

#### THERMAL RESISTANCE RATINGS

| Parameter                                | Symbol            | Typical | Maximum | Unit |
|------------------------------------------|-------------------|---------|---------|------|
| Maximum Junction-to-Ambient <sup>a</sup> | R <sub>thJA</sub> | 93      | 110     | °C/W |
|                                          |                   | 130     | 150     |      |
| Maximum Junction-to-Lead                 | R <sub>thJL</sub> | 75      | 90      |      |

Notes:

a. Surface Mounted on FR4 board.

b. t ≤ 5 s.

| SPECIFICATIONS T <sub>J</sub> = 25 °C, unless otherwise noted |                     |                                                                                                                                         |              |          |            |                |      |
|---------------------------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------|--------------|----------|------------|----------------|------|
| Parameter                                                     | Symbol              | Test Conditions                                                                                                                         |              | Min.     | Typ.       | Max.           | Unit |
| Static                                                        |                     |                                                                                                                                         |              |          |            |                |      |
| Gate Threshold Voltage                                        | V <sub>GS(th)</sub> | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 250 μA                                                                             | N-Ch         | 0.5      | 0.8        | 1.5            | V    |
|                                                               |                     | V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = - 250 μA                                                                           | P-Ch         | - 0.5    | -0.8       | -1.5           |      |
| Gate-Body Leakage                                             | I <sub>GSS</sub>    | V <sub>DS</sub> = 0 V, V <sub>GS</sub> = ± 8 V                                                                                          | N-Ch<br>P-Ch |          |            | ± 100<br>± 100 | nA   |
| Zero Gate Voltage Drain Current                               | I <sub>DSS</sub>    | V <sub>DS</sub> = 16 V, V <sub>GS</sub> = 0 V                                                                                           | N-Ch         |          |            | 1              | μA   |
|                                                               |                     | V <sub>DS</sub> = - 16 V, V <sub>GS</sub> = 0 V                                                                                         | P-Ch         |          |            | - 1            |      |
|                                                               |                     | V <sub>DS</sub> = 16 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55 °C                                                                   | N-Ch         |          |            | 5              |      |
|                                                               |                     | V <sub>DS</sub> = - 16 V, V <sub>GS</sub> = 0 V, T <sub>J</sub> = 55 °C                                                                 | P-Ch         |          |            | - 5            |      |
| On-State Drain Current <sup>a</sup>                           | I <sub>D(on)</sub>  | V <sub>DS</sub> = 5 V, V <sub>GS</sub> = 10 V                                                                                           | N-Ch         | 3.7      |            |                | A    |
|                                                               |                     | V <sub>DS</sub> = - 5 V, V <sub>GS</sub> = - 10 V                                                                                       | P-Ch         | - 3      |            |                |      |
| Drain-Source On-State Resistance <sup>a</sup>                 | R <sub>DS(on)</sub> | V <sub>GS</sub> = 10 V, I <sub>D</sub> = 2.5 A                                                                                          | N-Ch         |          | 0.022      |                | Ω    |
|                                                               |                     | V <sub>GS</sub> = - 10 V, I <sub>D</sub> = - 1.8 A                                                                                      | P-Ch         |          | 0.055      |                |      |
|                                                               |                     | V <sub>GS</sub> = 4.5 V, I <sub>D</sub> = 2.0 A                                                                                         | N-Ch         |          | 0.030      |                |      |
|                                                               |                     | V <sub>GS</sub> = - 4.5 V, I <sub>D</sub> = - 1.2 A                                                                                     | P-Ch         |          | 0.079      |                |      |
| Forward Transconductance <sup>a</sup>                         | g <sub>fs</sub>     | V <sub>DS</sub> = 10 V, I <sub>D</sub> = 2.5 A                                                                                          | N-Ch         |          | 4.3        |                | S    |
|                                                               |                     | V <sub>DS</sub> = - 15 V, I <sub>D</sub> = - 1.8 A                                                                                      | P-Ch         |          | 2.4        |                |      |
| Diode Forward Voltage <sup>a</sup>                            | V <sub>SD</sub>     | I <sub>S</sub> = 1.05 A, V <sub>GS</sub> = 0 V                                                                                          | N-Ch         |          | 0.81       | 1.10           | V    |
|                                                               |                     | I <sub>S</sub> = - 1.05 A, V <sub>GS</sub> = 0 V                                                                                        | P-Ch         |          | - 0.83     | - 1.10         |      |
| Dynamic <sup>b</sup>                                          |                     |                                                                                                                                         |              |          |            |                |      |
| Total Gate Charge                                             | Q <sub>g</sub>      | N-Channel<br>V <sub>DS</sub> = 15 V, V <sub>GS</sub> = 5 V, I <sub>D</sub> = 1.8 A                                                      | N-Ch<br>P-Ch |          | 2.1<br>2.4 | 3.2<br>3.6     | nC   |
| Gate-Source Charge                                            | Q <sub>gs</sub>     |                                                                                                                                         | N-Ch<br>P-Ch |          | 0.7<br>0.9 |                |      |
| Gate-Drain Charge                                             | Q <sub>gd</sub>     | P-Channel<br>V <sub>DS</sub> = - 15 V, V <sub>GS</sub> = - 5 V, I <sub>D</sub> = - 1.8 A                                                | N-Ch<br>P-Ch |          | 0.7<br>0.8 |                |      |
| Gate Resistance                                               | R <sub>g</sub>      |                                                                                                                                         | N-Ch<br>P-Ch | 0.5<br>3 |            | 2.4<br>11      | Ω    |
| Turn-On Delay Time                                            | t <sub>d(on)</sub>  | N-Channel<br>V <sub>DD</sub> = 15 V, R <sub>L</sub> = 15 Ω<br>I <sub>D</sub> ≅ 1 A, V <sub>GEN</sub> = 10 V, R <sub>g</sub> = 6 Ω       | N-Ch<br>P-Ch |          | 7<br>8     | 11<br>12       | ns   |
| Rise Time                                                     | t <sub>r</sub>      |                                                                                                                                         | N-Ch<br>P-Ch |          | 9<br>12    | 14<br>18       |      |
| Turn-Off Delay Time                                           | t <sub>d(off)</sub> | P-Channel<br>V <sub>DD</sub> = - 15 V, R <sub>L</sub> = 15 Ω<br>I <sub>D</sub> ≅ - 1 A, V <sub>GEN</sub> = - 10 V, R <sub>g</sub> = 6 Ω | N-Ch<br>P-Ch |          | 13<br>12   | 20<br>18       |      |
|                                                               |                     |                                                                                                                                         | N-Ch<br>P-Ch |          | 5<br>7     | 8<br>11        |      |
| Fall Time                                                     | t <sub>f</sub>      |                                                                                                                                         |              |          |            |                |      |
| Source-Drain Reverse Recovery Time                            | t <sub>rr</sub>     | I <sub>F</sub> = 1.05 A, dI/dt = 100 A/μs                                                                                               | N-Ch         |          | 35         | 60             |      |
|                                                               |                     | I <sub>F</sub> = - 1.05 A, dI/dt = 100 A/μs                                                                                             | P-Ch         |          | 30         | 60             |      |

Notes:

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

**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

**Output Characteristics**

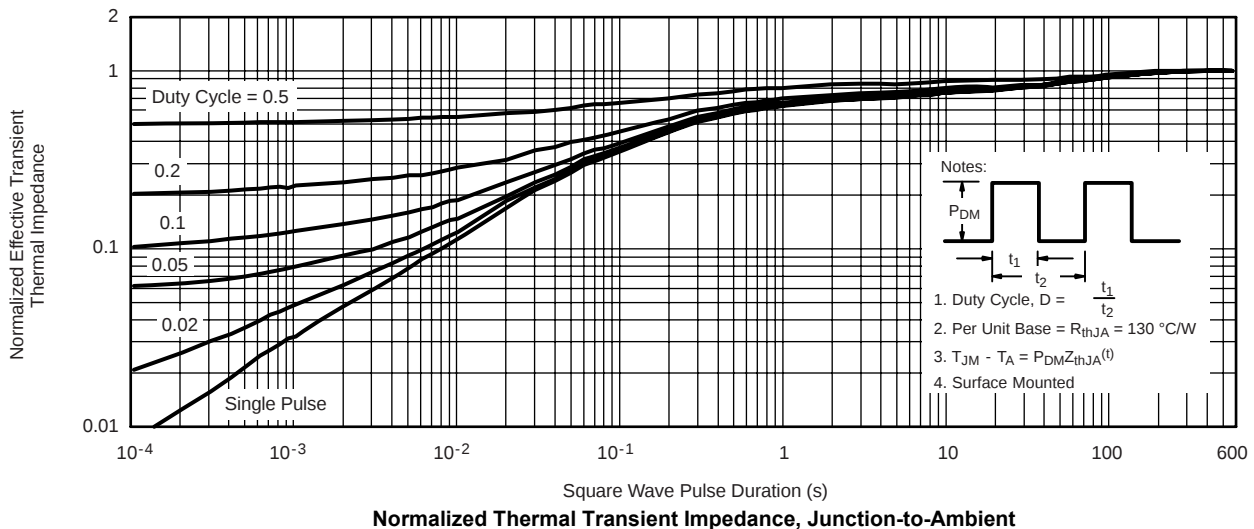
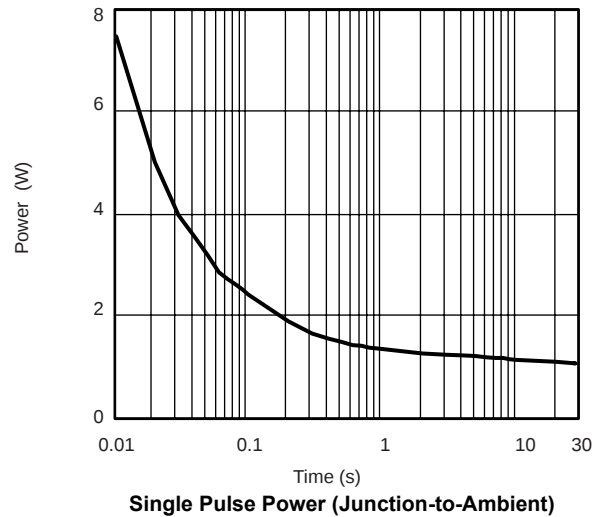
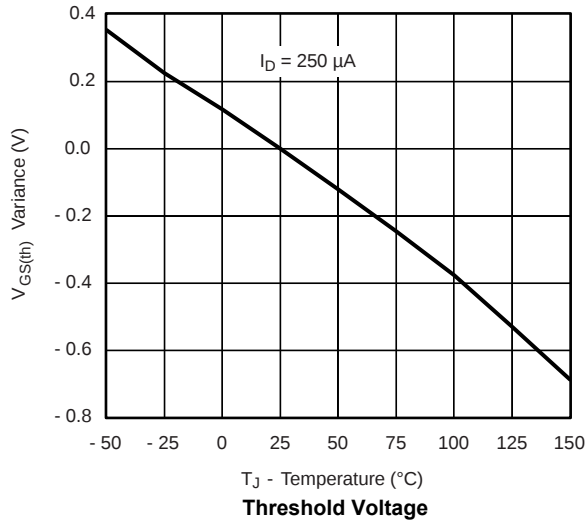
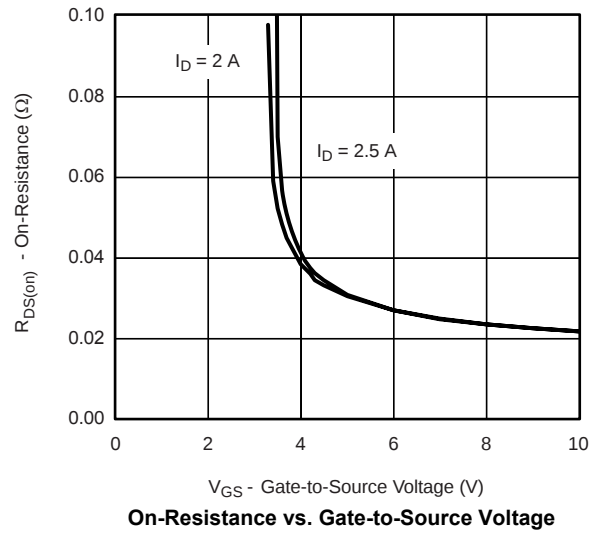
**Transfer Characteristics**

**On-Resistance vs. Drain Current**

**Capacitance**

**Gate Charge**

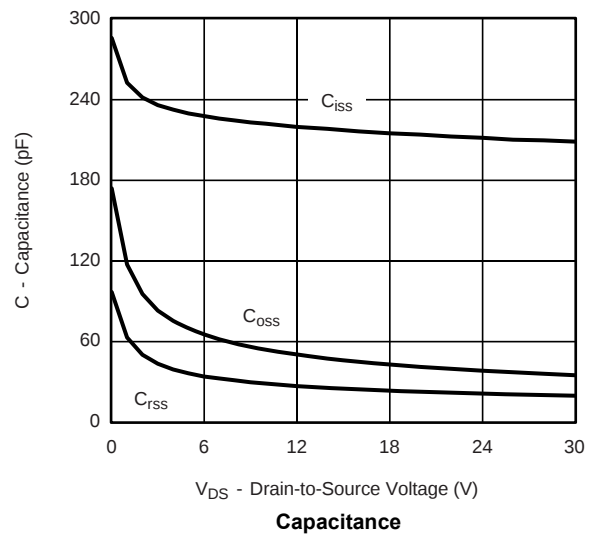
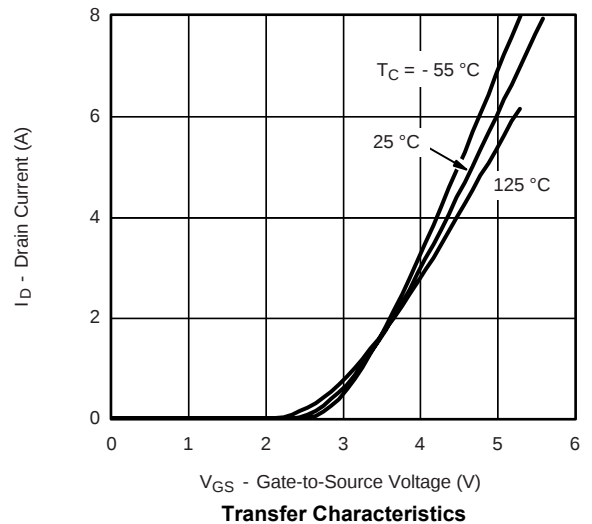
**On-Resistance vs. Junction Temperature**

**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted


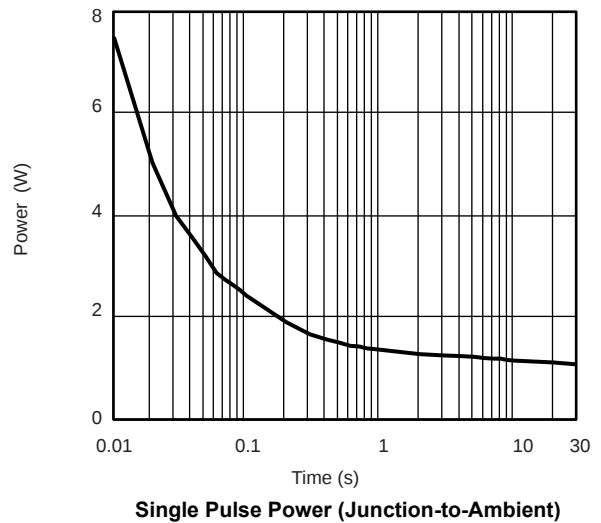
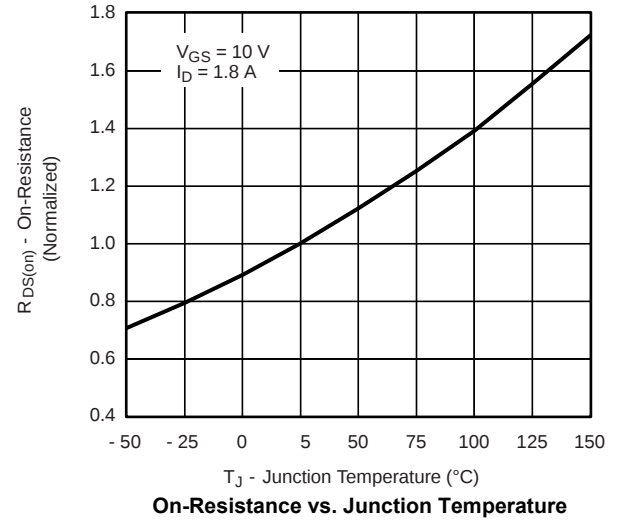
**N-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

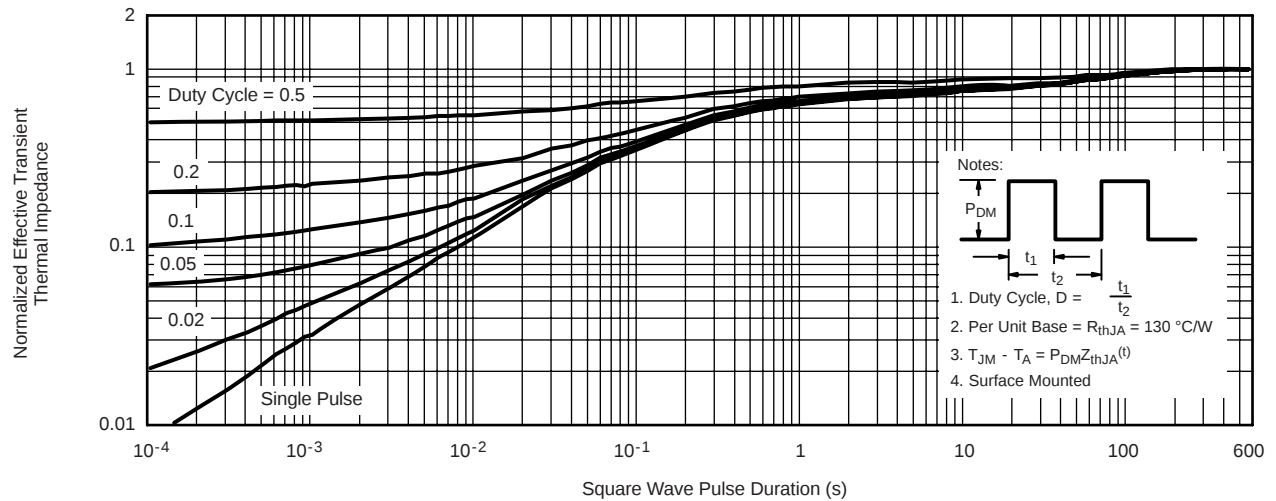
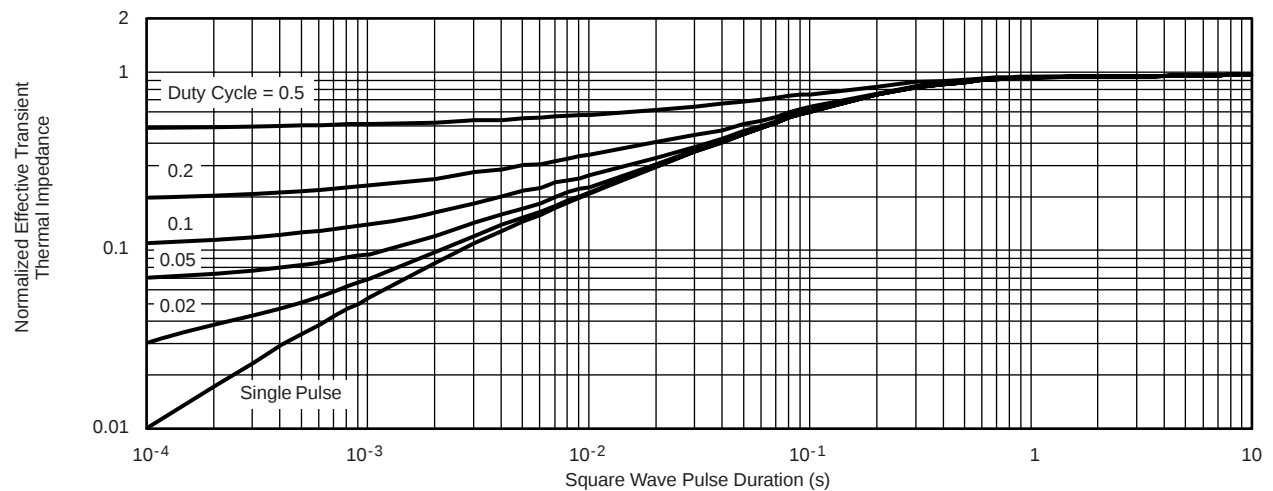


**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



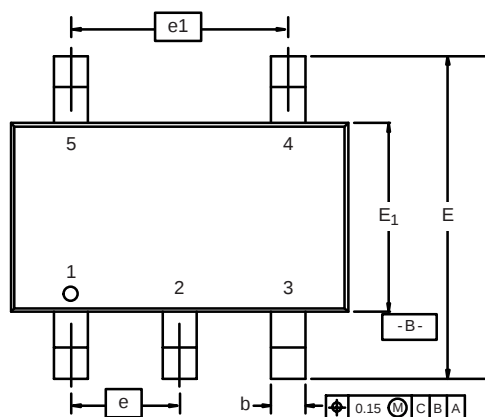
**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted



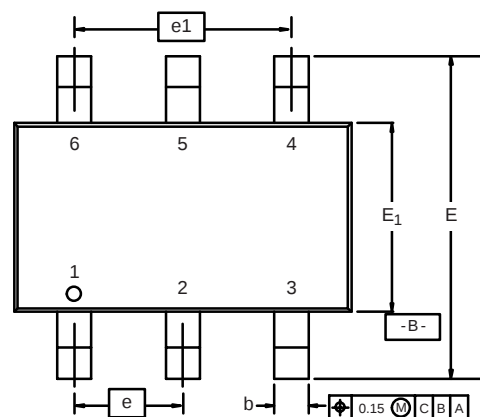
**P-CHANNEL TYPICAL CHARACTERISTICS** 25 °C, unless otherwise noted

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

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

TSOP: 5/6-LEAD

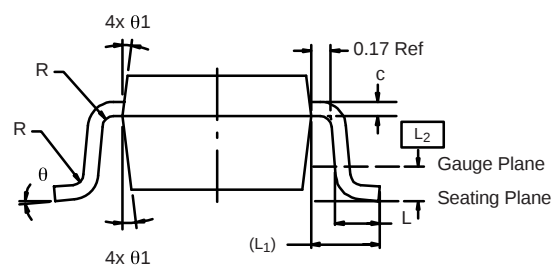
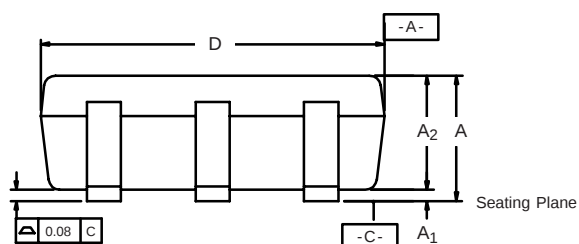
JEDEC Part Number: MO-193C



5-LEAD TSOP

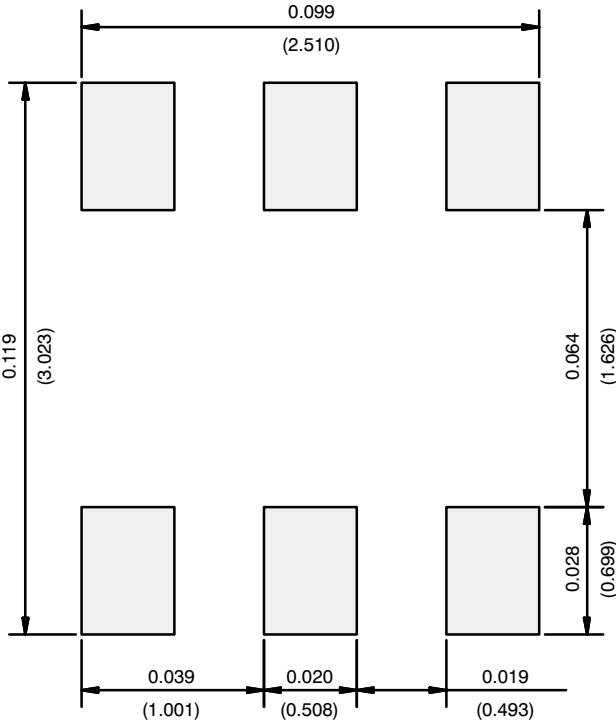


6-LEAD TSOP



|                                | MILLIMETERS |      |      | INCHES     |       |       |
|--------------------------------|-------------|------|------|------------|-------|-------|
| Dim                            | 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 |             |      |      |            |       |       |
| DWG: 5540                      |             |      |      |            |       |       |

RECOMMENDED MINIMUM PADS FOR TSOP-6



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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