# 60V N-CHANNEL ENHANCEMENT MODE MOSFET

## Product Summary

| $V_{(BR)DSS}$ | $R_{DS(ON)}$ Max | $I_D$ Max $T_A$ = +25°C |
|---|---|---|
| 60V | 40mΩ @ $V_{GS}$ = 10V | 5.0A |
| | 55mΩ @ $V_{GS}$ = 4.5V | 4.2A |

## Features

- 100% Unclamped Inductive Switch (UIS) Test in Production
- Low On-Resistance
- **Lead-Free Finish; RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **Qualified to AEC-Q101 Standards for High Reliability**

## Description

This new generation MOSFET is designed to minimize the on-state resistance ($R_{DS(ON)}$), yet maintain superior switching performance, making it ideal for high efficiency power management applications.

## Mechanical Data

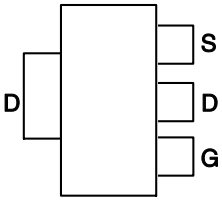
- Case: SOT223
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0 (Note 1)
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals Connections: See Diagram Below
- Terminals: Finish – Matte Tin Annealed over Copper Leadframe. Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.112 grams (Approximate)

## Applications

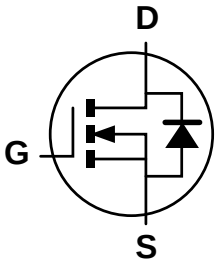
- Motor Control
- Transformer Driving Switch
- DC-DC Converters
- Power Management Functions
- Uninterrupted Power Supply

SOT223

Top View




Pin Out – Top View



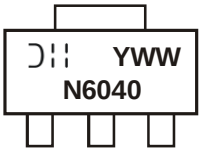

Equivalent Circuit

## Ordering Information (Note 4)

| Part Number | Marking | Reel Size (inches) | Quantity per Reel |
|---|---|---|---|
| DMN6040SE-13 | N6040 | 13 | 2,500 |

Notes:
1. EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant. All applicable RoHS exemptions applied.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
4. For packaging details, go to our website at http://www.diodes.com/products/packages.html.

## Marking Information




N6040 = Product Type Marking Code
= Manufacturer's Marking
YWW = Date Code Marking
Y = Year (ex: 16 = 2016)
WW = Week (01 – 53)

## Maximum Ratings (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | | | Symbol | Value | Units |
|---|---|---|---|---|---|
| Drain-Source Voltage | | | $V_{DSS}$ | 60 | V |
| Gate-Source Voltage | | | $V_{GSS}$ | ±20 | V |
| Continuous Drain Current (Note 6) $V_{GS}$ = 10V | Steady State | $T_A$ = +25°C<br>$T_A$ = +70°C | $I_D$ | 5.0<br>4.0 | A |
| | t < 10s | $T_A$ = +25°C<br>$T_A$ = +70°C | $I_D$ | 7.1<br>5.5 | A |
| Pulsed Drain Current (10µs Pulse, Duty Cycle = 1%) | | | $I_{DM}$ | 30 | A |
| Maximum Body Diode Continuous Current | | | $I_S$ | 3.4 | A |
| Avalanche Current (Note 7) L = 0.1mH | | | $I_{AS}$ | 14.2 | A |
| Avalanche Energy (Note 7) L = 0.1mH | | | $E_{AS}$ | 10 | mJ |

## Thermal Characteristics (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | | Symbol | Value | Units |
|---|---|---|---|---|
| Total Power Dissipation (Note 5) | $T_A$ = +25°C | $P_D$ | 1.2 | W |
| | $T_A$ = +70°C | | 0.7 | |
| Thermal Resistance, Junction to Ambient (Note 5) | Steady State | $R_{\theta JA}$ | 106 | °C/W |
| | t < 10s | | 53 | |
| Total Power Dissipation (Note 6) | $T_A$ = +25°C | $P_D$ | 2 | W |
| | $T_A$ = +70°C | | 1.2 | |
| Thermal Resistance, Junction to Ambient (Note 6) | Steady State | $R_{\theta JA}$ | 65 | °C/W |
| | t < 10s | | 34 | |
| Thermal Resistance, Junction to Case (Note 6) | | $R_{\theta JC}$ | 9 | °C/W |
| Operating and Storage Temperature Range | | $T_J$, $T_{STG}$ | -55 to +150 | °C |

## Electrical Characteristics (@$T_A$ = +25°C, unless otherwise specified.)

| Characteristic | Symbol | Min | Typ | Max | Unit | Test Condition |
|---|---|---|---|---|---|---|
| **OFF CHARACTERISTICS** (Note 8) | | | | | | |
| Drain-Source Breakdown Voltage | $BV_{DSS}$ | 60 | — | — | V | $V_{GS}$ = 0V, $I_D$ = 250µA |
| Zero Gate Voltage Drain Current | $I_{DSS}$ | — | — | 1 | µA | $V_{DS}$ = 60V, $V_{GS}$ = 0V |
| Gate-Source Leakage | $I_{GSS}$ | — | — | ±100 | nA | $V_{GS}$ = ±20V, $V_{DS}$ = 0V |
| **ON CHARACTERISTICS** (Note 8) | | | | | | |
| Gate Threshold Voltage | $V_{GS(TH)}$ | 1 | — | 3 | V | $V_{DS}$ = $V_{GS}$, $I_D$ = 250µA |
| Static Drain-Source On-Resistance | $R_{DS(ON)}$ | — | 30 | 40 | mΩ | $V_{GS}$ = 10V, $I_D$ = 12A |
| | | — | 35 | 55 | | $V_{GS}$ = 4.5V, $I_D$ = 6A |
| Diode Forward Voltage | $V_{SD}$ | — | 0.7 | 1.2 | V | $V_{GS}$ = 0V, $I_S$ = 1A |
| **DYNAMIC CHARACTERISTICS** (Note 9) | | | | | | |
| Input Capacitance | $C_{ISS}$ | — | 1,287 | — | pF | $V_{DS}$ = 25V, $V_{GS}$ = 0V<br>f = 1.0MHz |
| Output Capacitance | $C_{OSS}$ | — | 57 | — | | |
| Reverse Transfer Capacitance | $C_{RSS}$ | — | 44 | — | | |
| Gate Resistance | $R_G$ | — | 1.2 | — | Ω | $V_{DS}$ = 0V, $V_{GS}$ = 0V, f = 1.0MHz |
| Total Gate Charge ($V_{GS}$ = 10V) | $Q_G$ | — | 22.4 | — | nC | $V_{DS}$ = 30V, $I_D$ = 4.3A |
| Total Gate Charge ($V_{GS}$ = 4.5V) | $Q_G$ | — | 10.4 | — | | |
| Gate-Source Charge | $Q_{GS}$ | — | 4.9 | — | | |
| Gate-Drain Charge | $Q_{GD}$ | — | 3.0 | — | | |
| Turn-On Delay Time | $t_{D(ON)}$ | — | 6.6 | — | ns | $V_{GS}$ = 10V, $V_{DD}$ = 30V, $R_G$ = 6Ω,<br>$I_D$ = 4.3A |
| Turn-On Rise Time | $t_R$ | — | 8.1 | — | | |
| Turn-Off Delay Time | $t_{D(OFF)}$ | — | 20.1 | — | | |
| Turn-Off Fall Time | $t_F$ | — | 4.0 | — | | |
| Body Diode Reverse Recovery Time | $t_{RR}$ | — | 18 | — | ns | $I_S$ = 4.3A, di/dt = 100A/µs |
| Body Diode Reverse Recovery Charge | $Q_{RR}$ | — | 11.9 | — | nC | $I_S$ = 4.3A, di/dt = 100A/µs |

Notes: 5. Device mounted on FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout.
6. Device mounted on FR-4 substrate PC board, 2oz copper, with thermal vias to bottom layer 1-inch square copper plate.
7. $I_{AS}$ and $E_{AS}$ rating are based on low frequency and duty cycles to keep $T_J$ = +25°C.
8. Short duration pulse test used to minimize self-heating effect.
9. Guaranteed by design. Not subject to product testing.

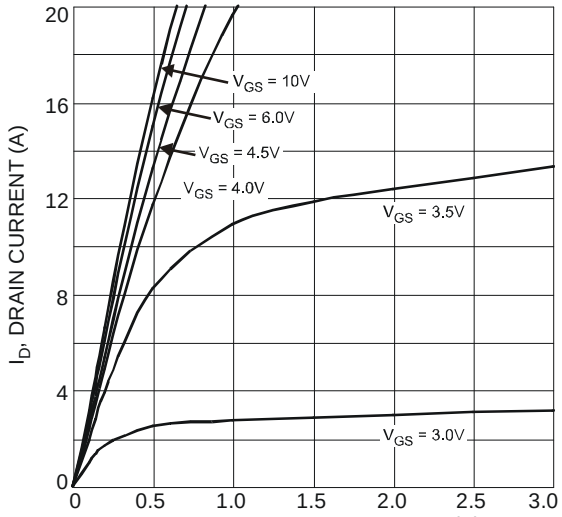



Figure 1 Typical Output Characteristic

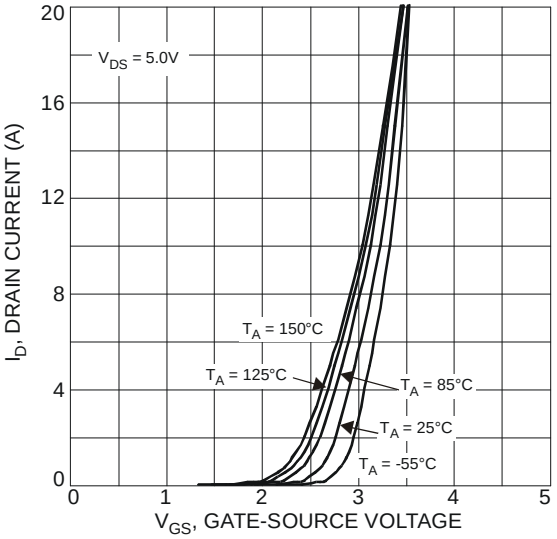



Figure 2 Typical Transfer Characteristics

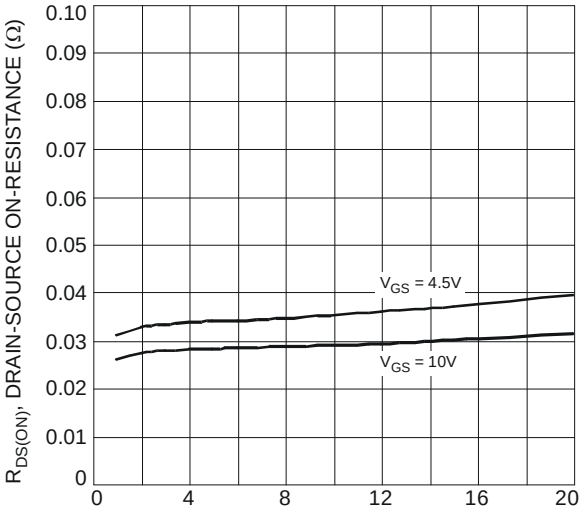



Figure 3 Typical On-Resistance vs. Drain Current and Gate Voltage

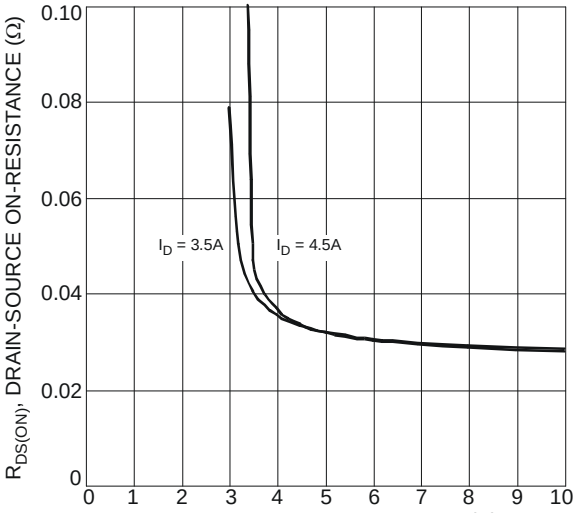



Figure 4 Typical On-Resistance vs. Drain Current and Gate Voltage

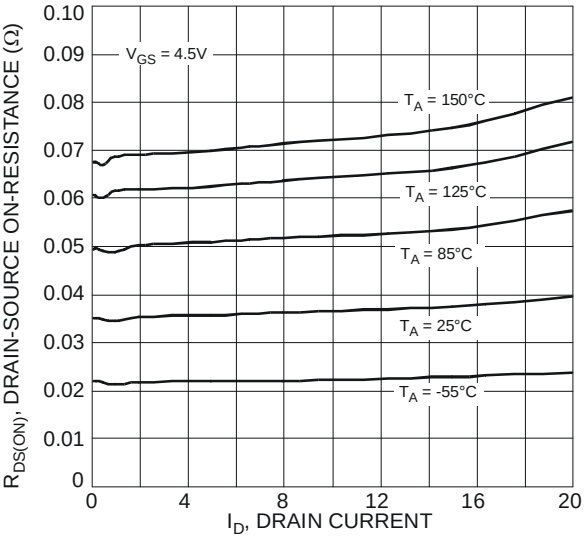



Figure 5 Typical On-Resistance vs. Drain Current and Temperature

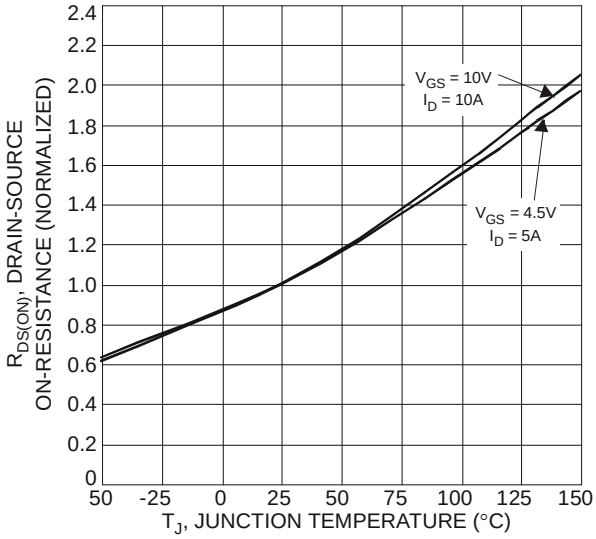



Figure 6 On-Resistance Variation with Temperature

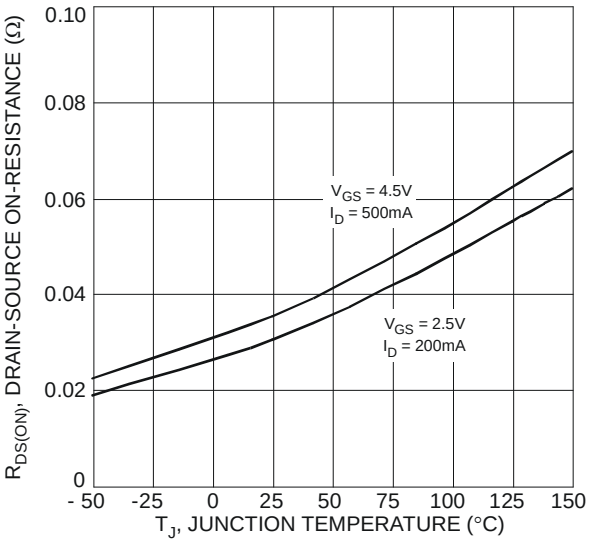



Figure 7 On-Resistance Variation with Temperature

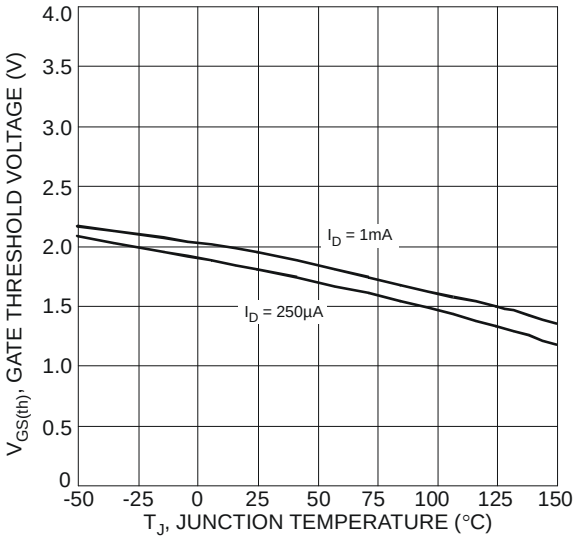



Figure 8 Gate Threshold Variation vs. Ambient Temperature

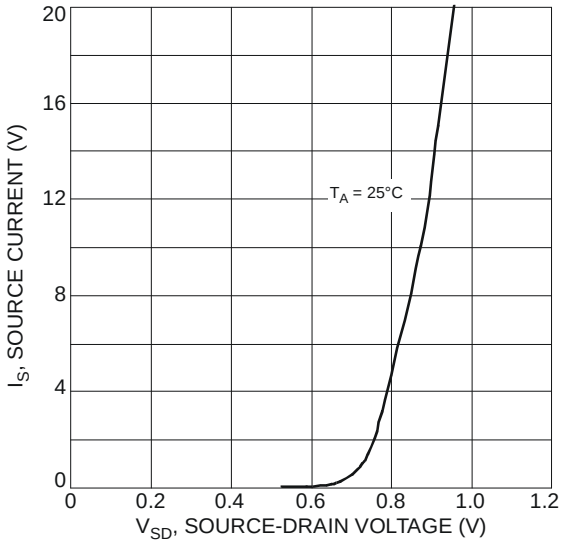



Figure 9 Diode Forward Voltage vs. Current

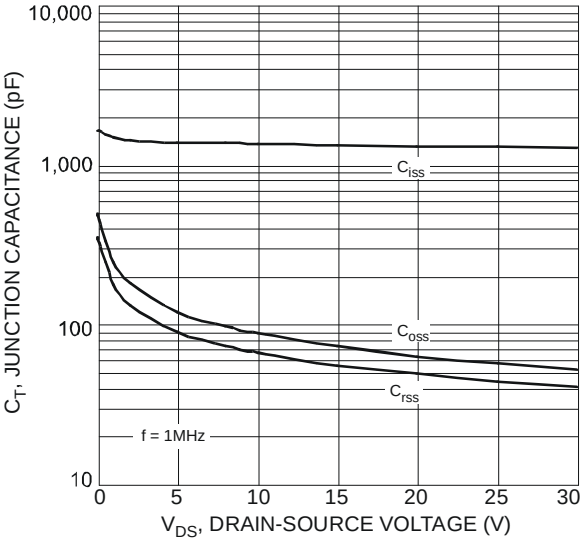



Figure 10 Typical Junction Capacitance

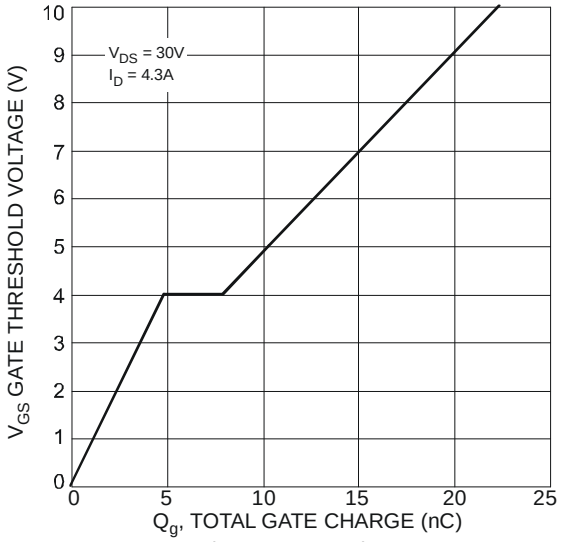



Figure 11 Gate Charge

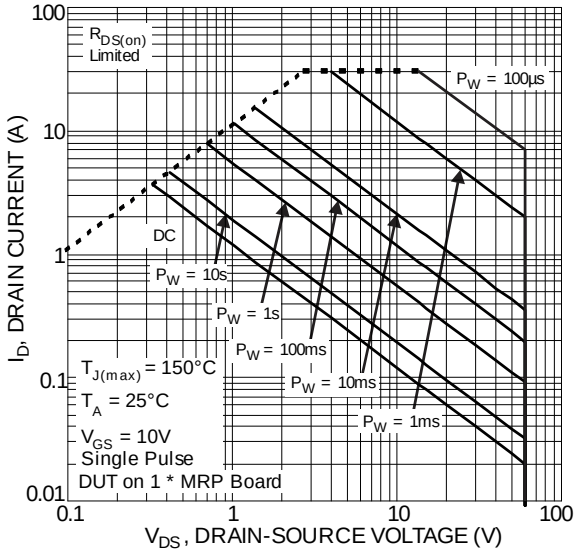



Figure 12 SOA, Safe Operation Area

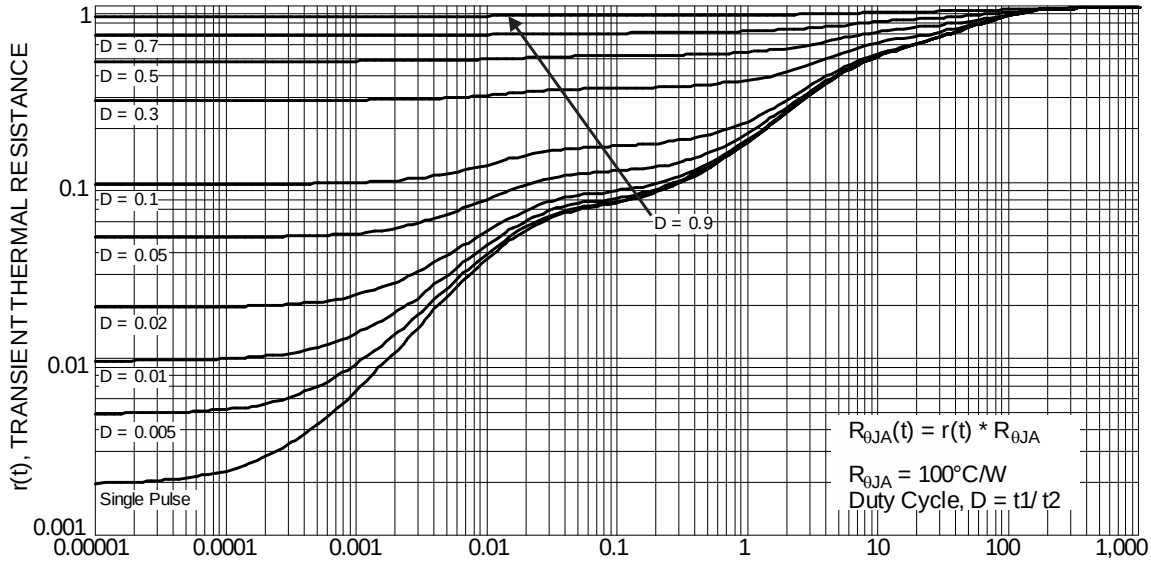
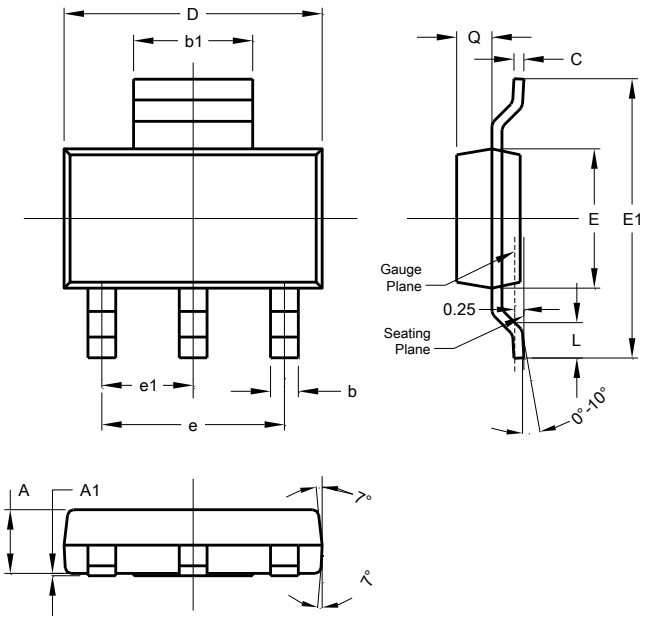



Figure 13 Transient Thermal Resistance

## Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

**SOT223**

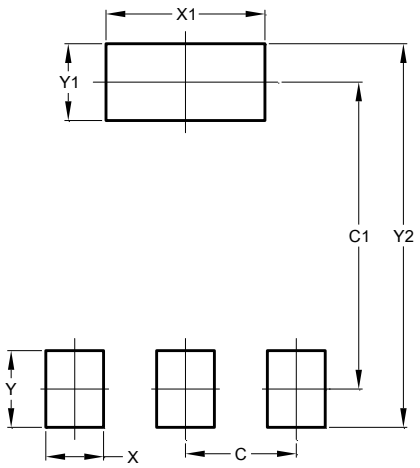



| SOT223 | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 1.55 | 1.65 | 1.60 |
| **A1** | 0.010 | 0.15 | 0.05 |
| **b** | 0.60 | 0.80 | 0.70 |
| **b1** | 2.90 | 3.10 | 3.00 |
| **C** | 0.20 | 0.30 | 0.25 |
| **D** | 6.45 | 6.55 | 6.50 |
| **E** | 3.45 | 3.55 | 3.50 |
| **E1** | 6.90 | 7.10 | 7.00 |
| **e** | – | – | 4.60 |
| **e1** | – | – | 2.30 |
| **L** | 0.85 | 1.05 | 0.95 |
| **Q** | 0.84 | 0.94 | 0.89 |
| **All Dimensions in mm** | | | |

## Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

**SOT223**




| Dimensions | Value (in mm) |
|---|---|
| **C** | 2.30 |
| **C1** | 6.40 |
| **X** | 1.20 |
| **X1** | 3.30 |
| **Y** | 1.60 |
| **Y1** | 1.60 |
| **Y2** | 8.00 |

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