

60V N-CHANNEL SELF PROTECTED ENHANCEMENT MODE INTELLIFET MOSFET WITH PROGRAMMABLE CURRENT LIMIT
Product Summary

- Continuous Drain Source Voltage $V_{DS} = 60V$
- On-State Resistance: 500m Ω
- Nominal Load Current ($V_{IN} = 5V$): 1.4A
- Clamping Energy: 550mJ

Description

The ZXMS6003G is a self-protected low-side IntelliFET™ MOSFET. It features monolithic overtemperature, overcurrent, overvoltage (active clamp), and ESD protected logic level functionality. It is intended as a general purpose switch with status indication and programmable current limit.

Applications

- Especially Suited for Loads with a High In-Rush Current Such as Lamps and Motors
- All Types of Resistive, Inductive, and Capacitive Loads in Switching Applications
- μC Compatible Power Switch for 12V and 24V DC Applications
- Replaces Electromechanical Relays and Discrete Circuits
- Linear Mode Capability - The current-limiting protection circuitry is designed to deactivate at low V_{DS} in order not to compromise the load current during normal operation. The design max. DC operating current is therefore determined by the thermal capability of the package/board combination rather than by the protection circuitry.
Note: This does not compromise the product's ability to self-protect during short-circuit load conditions.
- Current Limit is Programmable via an External Resistor R_{PROG} Connected Between Status and IN pins
- Status Pin Voltage Reflects the Gate Drive Applied Internally to the Power MOSFET
- With $V_{IN} = 5V$ and $R_{PROG} = 24k\Omega$:
 - Status Voltage: 5V Indicates Normal Operation
 - Status Voltage: 2V to 3V Indicates the Device is in Current-Limiting Mode
 - Status Voltage $<1V$ Indicates the Device is in Thermal Shutdown

- Notes:
1. EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant. All applicable RoHS exemptions applied.
 2. See <https://www.diodes.com/quality/lead-free/> 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.

Features and Benefits

- Current Limit Programmable via External Resistor
- Status Pin (Analog Status Indication)
- Logic Level Input
- Short-Circuit Protection with Auto Restart
- Overvoltage Protection (Active Clamp)
- Thermal Shutdown with Auto Restart
- Overcurrent Protection
- Input Protection (ESD)
- Load Dump Protection (Actively Protects Load)
- High Continuous Current Rating
- **Lead-Free Finish; RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Mechanical Data

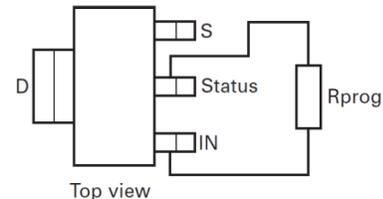
- Case: SOT223 (Type DN)
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Matte Tin Finish (e3)
- Weight: 0.112 grams (Approximate)

SOT223 (Type DN)



Top View

Note: R_{PROG} must be connected between the Status and IN pins.



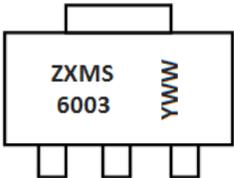
Top view

Ordering Information (Note 4)

| Part Number | Marking | Reel Size (inches) | Tape Width (mm) | Quantity per Reel |
|-------------|----------|--------------------|-----------------|-------------------|
| ZXMS6003GTA | ZXMS6003 | 7 | 12 | 1000 Units |

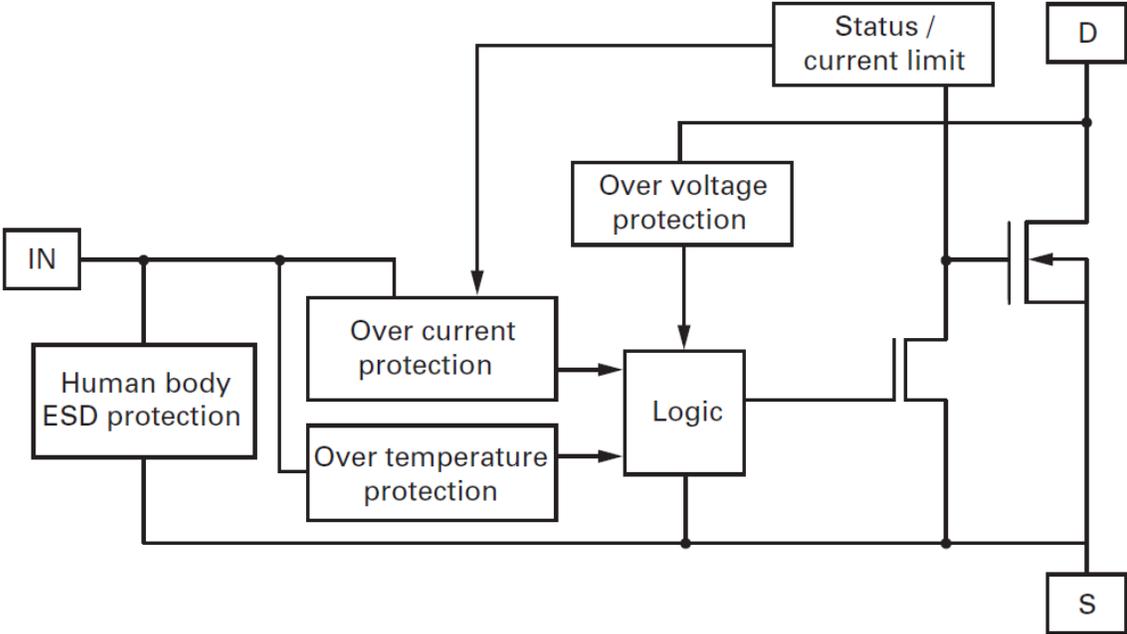
Note: 4. For packaging details, go to our website at <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

Marking Information



ZXMS6003 = Product Type Marking Code
 YWW = Date Code Marking
 Y or \bar{Y} = Last Digit of Year (ex: 8 = 2018)
 WW or $\bar{W}W$ = Week Code (01 to 53)

Functional Block Diagram



Absolute Maximum Ratings (@ $T_A = +25^\circ\text{C}$, unless otherwise stated.)

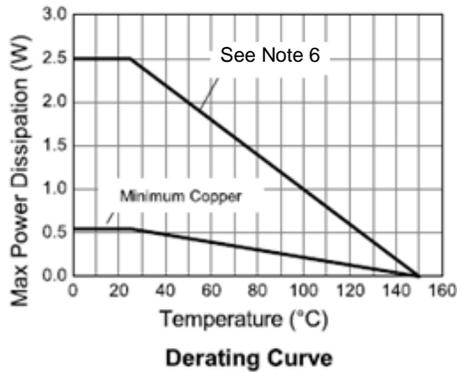
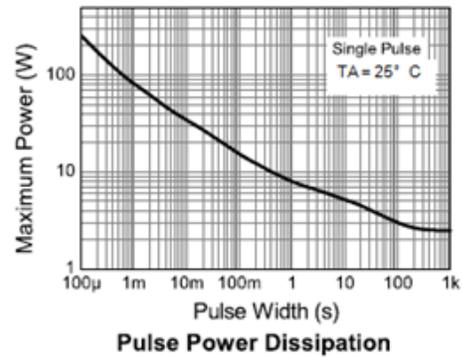
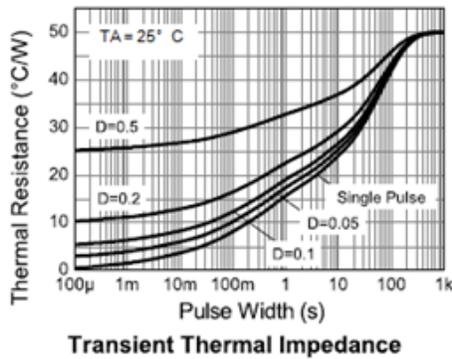
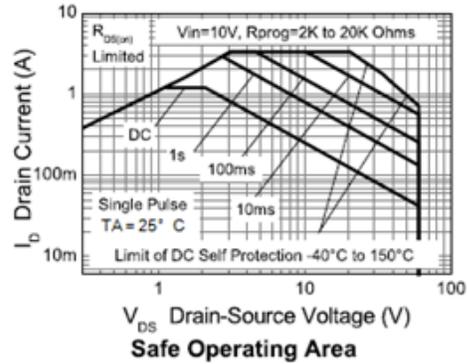
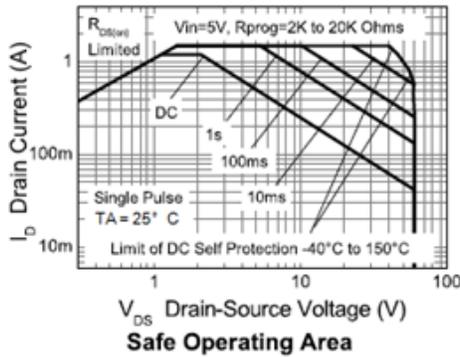
| Parameter | Symbol | Limit | Unit |
|---|----------------|-------------|------------------|
| Continuous Drain-Source Voltage | V_{DS} | 60 | V |
| Drain-Source Voltage for Short-Circuit Protection $V_{IN} = 5\text{V}$ (Note 5) | $V_{DS(SC)}$ | 36 | V |
| Drain-Source Voltage for Short-Circuit Protection $V_{IN} = 10\text{V}$ (Note 5) | $V_{DS(SC)}$ | 20 | V |
| Continuous Input Voltage | V_{IN} | -0.2 to +10 | V |
| Peak Input Voltage | V_{IN} | -0.2 to +20 | V |
| Operating Temperature Range | T_J | -40 to +150 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{STG} | -55 to +150 | $^\circ\text{C}$ |
| Power Dissipation at @ $T_A = +25^\circ\text{C}$ (Note 6) | P_D | 2.5 | W |
| Continuous Drain Current @ $V_{IN} = 10\text{V}$; $T_A = +25^\circ\text{C}$ (Note 6) | I_D | 1.6 | A |
| Continuous Drain Current @ $V_{IN} = 5\text{V}$; $T_A = +25^\circ\text{C}$ (Note 6) | I_D | 1.4 | A |
| Continuous Source Current (Body Diode) (Note 6) | I_S | 3 | A |
| Pulsed Source Current (Body Diode) (Note 7) | I_S | 8 | A |
| Unclamped Single Pulse Inductive Energy | E_{AS} | 550 | mJ |
| Load Dump Protection | $V_{LOADDUMP}$ | 80 | V |
| Electrostatic Discharge (Human Body Model) | V_{ESD} | 4000 | V |
| DIN Humidity Category, DIN 40 040 | — | E | — |
| IEC Climatic Category, DIN IEC 68-1 | — | 40/150/56 | — |

Thermal Resistance (@ $T_A = +25^\circ\text{C}$, unless otherwise stated.)

| Parameter | Symbol | Value | Unit |
|------------------------------|-----------------|-------|--------------------|
| Junction to Ambient (Note 6) | $R_{\theta JA}$ | 50 | $^\circ\text{C/W}$ |
| Junction to Ambient (Note 7) | $R_{\theta JA}$ | 28 | $^\circ\text{C/W}$ |

- Notes:
5. For $I_{D(LIM)} < 1.2\text{A}$ (see safe operating area curve).
 6. For a device surface mounted on 50mm x 50mm x 1.6mm FR-4 board with a high coverage of single sided 2oz weight copper.
 7. For a device surface mounted on FR-4 board and measured at $t < 10\text{s}$.

Thermal Characteristics

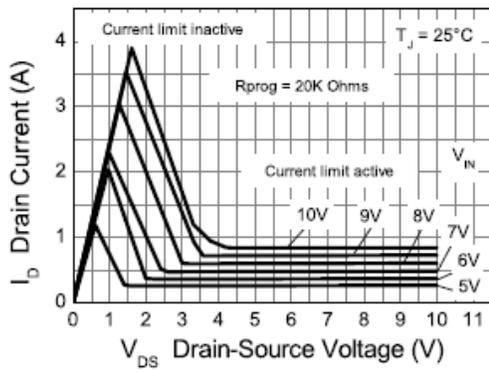


Electrical Characteristics (@T_A = +25°C, unless otherwise stated.)

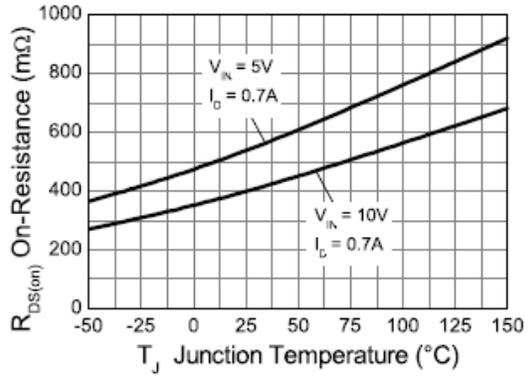
| Parameter | Symbol | Min | Typ | Max | Unit | Conditions |
|---|------------------------------------|------|------|-----|------|---|
| Static Characteristics | | | | | | |
| Drain-Source Clamp Voltage | V _{DS(AZ)} | 60 | 70 | 75 | V | I _D = 10mA |
| Off State Drain Current | I _{DSS} | — | 0.1 | 3 | μA | V _{DS} = 12V, V _{IN} = 0V |
| Off State Drain Current | I _{DSS} | — | 3 | 15 | μA | V _{DS} = 32V, V _{IN} = 0V |
| Input Threshold Voltage (Note 8) | V _{IN(TH)} | 1 | 2.1 | — | V | V _{DS} = V _{GS} , I _D = 1mA |
| Input Current | I _{IN} | — | 0.7 | 1.2 | mA | V _{IN} = 5V |
| Input Current | I _{IN} | — | 1.5 | 2.7 | mA | V _{IN} = 7V |
| Input Current | I _{IN} | — | 4 | 7 | mA | V _{IN} = 10V |
| Static Drain-Source On-State Resistance | R _{DS(ON)} | — | 520 | 675 | mΩ | V _{IN} = 5V, I _D = 0.2A |
| Static Drain-Source On-State Resistance | R _{DS(ON)} | — | 385 | 500 | mΩ | V _{IN} = 10V, I _D = 0.5A |
| Current Limit (Note 9) | I _{D(LIM)} | 0.2 | 0.3 | 0.4 | A | V _{IN} = 5V, V _{DS} = 10V, R _{PROG} = 20k |
| Current Limit (Note 9) | I _{D(LIM)} | 0.7 | 0.9 | 1.2 | A | V _{IN} = 10V, V _{DS} = 10V, R _{PROG} = 20k |
| Dynamic Characteristics | | | | | | |
| Turn-On Time (V _{IN} to 90% I _D) | t _{ON} | — | 3 | — | μs | R _{PROG} = 20k, R _L = 22Ω, V _{IN} = 0 to 10V, V _{DD} = 12V |
| Turn-Off Time (V _{IN} to 90% I _D) | t _{OFF} | — | 13 | — | μs | R _{PROG} = 20k, R _L = 22Ω, V _{IN} = 10V to 0V, V _{DD} = 12V |
| Slew Rate On (70 to 50% V _{DD}) | dV _{DS} /dt _{ON} | — | 8 | — | V/μs | R _{PROG} = 20k, R _L = 22Ω, V _{IN} = 0 to 10V, V _{DD} = 12V |
| Slew Rate Off (50 to 70% V _{DD}) | dV _{DS} /dt _{ON} | — | 3.2 | — | V/μs | R _{PROG} = 20k, R _L = 22Ω, V _{IN} = 10V to 0V, V _{DD} = 12V |
| Protection Functions (Note 10) | | | | | | |
| Required Input Voltage for Over-Temperature Protection | V _{PROT} | 4.5 | — | — | V | — |
| Thermal Overload Trip Temperature | T _{JT} | +150 | +175 | — | °C | — |
| Thermal Hysteresis | — | — | +1 | — | °C | — |
| Unclamped Single Pulse Inductive Energy T _J = +25°C | E _{AS} | 550 | — | — | mJ | I _{D(ISO)} = 0.7A, V _{DD} = 32V |
| Unclamped Single Pulse Inductive Energy T _J = +150°C | E _{AS} | 200 | — | — | mJ | I _{D(ISO)} = 0.7A, V _{DD} = 32V |
| Status Flag | | | | | | |
| Normal Operation | V _{STATUS} | — | 4.95 | — | V | V _{IN} = 5V |
| Current Limit Operating | V _{STATUS} | — | 2.5 | — | V | V _{IN} = 5V |
| Thermal Shutdown Activated | V _{STATUS} | — | 0.2 | 1 | V | V _{IN} = 5V |
| Normal Operation | V _{STATUS} | — | 8 | — | V | V _{IN} = 10V |
| Current Limit Operation | V _{STATUS} | — | 3 | — | V | V _{IN} = 10V |
| Thermal Shutdown Activated | V _{STATUS} | — | 0.35 | 1 | V | V _{IN} = 10V |
| Inverse Diode | | | | | | |
| Source Drain Voltage | V _{SD} | — | — | 1 | V | V _{IN} = 0V, -I _D = 1.4A |

- Notes:
- Protection features may operate outside spec for V_{IN} < 4.5V.
 - The drain current is limited to a reduced value when V_{DS} exceeds a safe level.
 - Integrated protection functions are designed to prevent IC destruction under fault conditions described in the datasheet. Fault conditions are considered as "outside" normal operating range. Protection functions are not designed for continuous, repetitive operation.

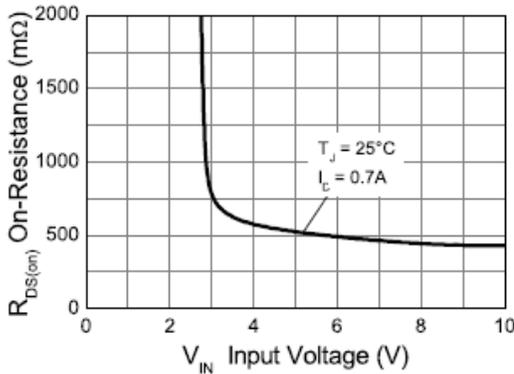
Typical Characteristics



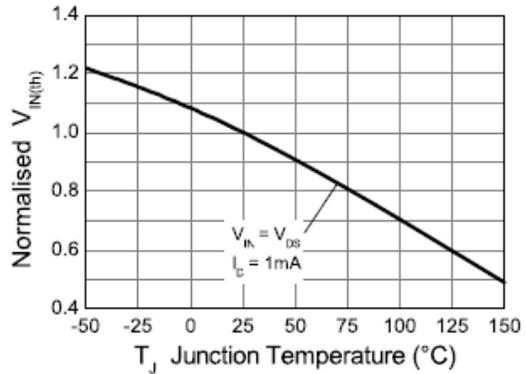
Typical Output Characteristic



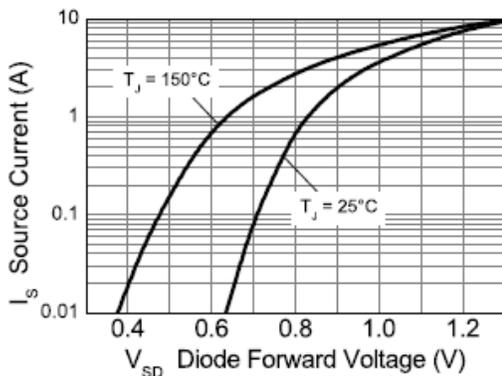
On-state Resistance vs Temperature



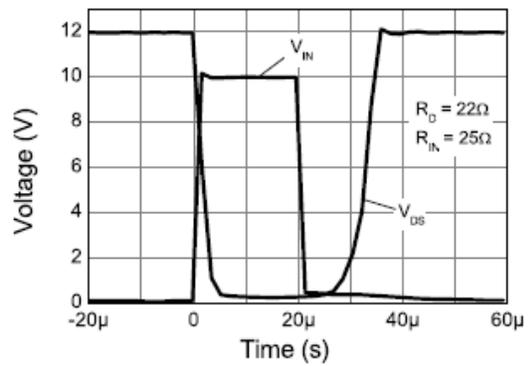
On-Resistance vs Input Voltage



Threshold Voltage vs Temperature



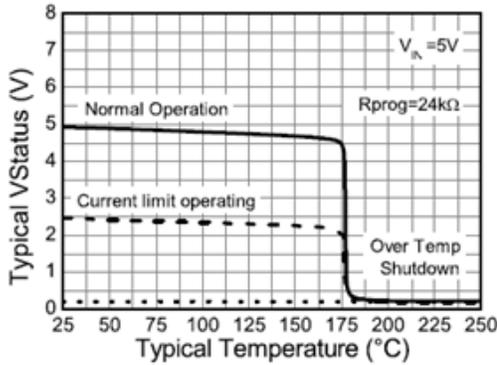
Source-Drain Diode Forward Voltage



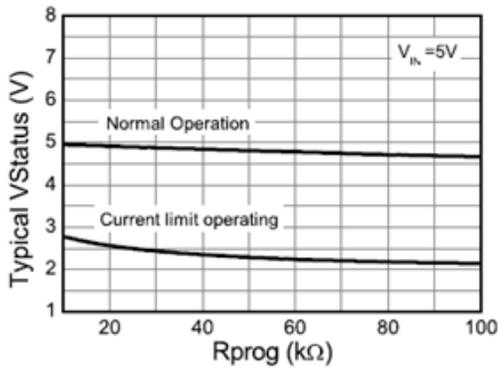
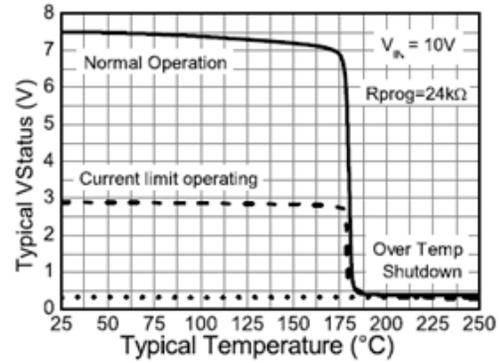
Switching Speed

Typical Characteristics (cont.)

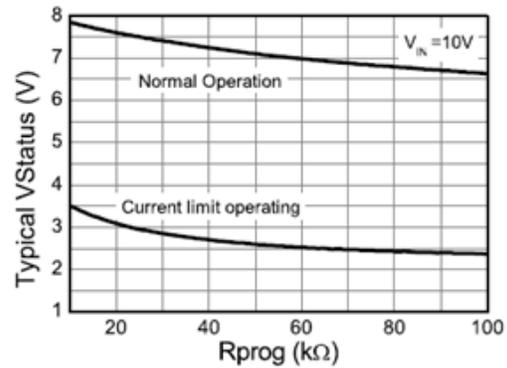
Current Limiting and Over Temp Shutdown Status Indication at Vin=5V



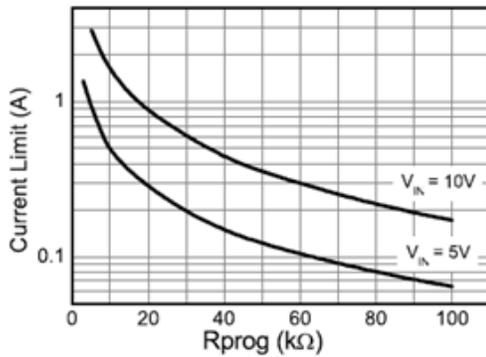
Current Limiting and Over Temp Shutdown Status Indication at Vin=10V



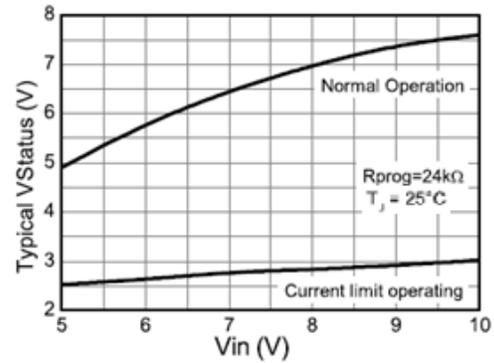
VStatus vs Rprog @ Vin=5V



VStatus vs Rprog @ Vin=10V



Current Limit vs Rprog

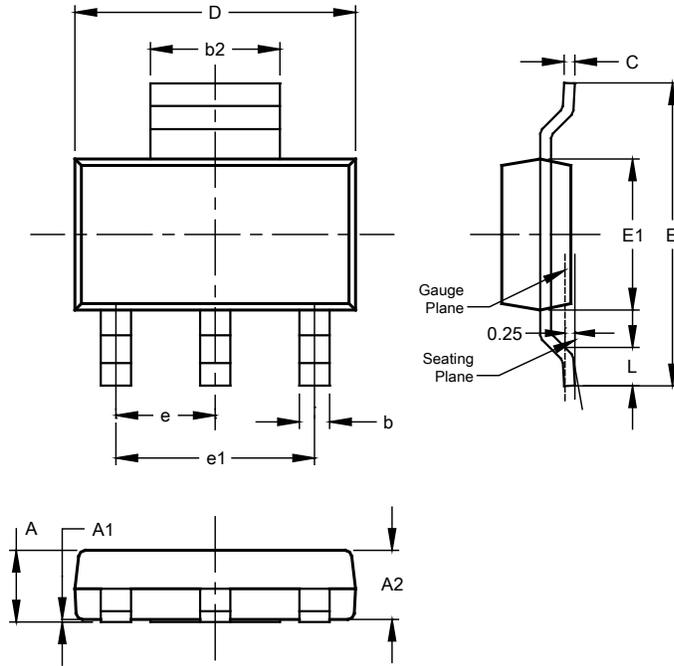


VStatus vs Vin

Package Outline Dimensions

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

SOT223 (Type DN)

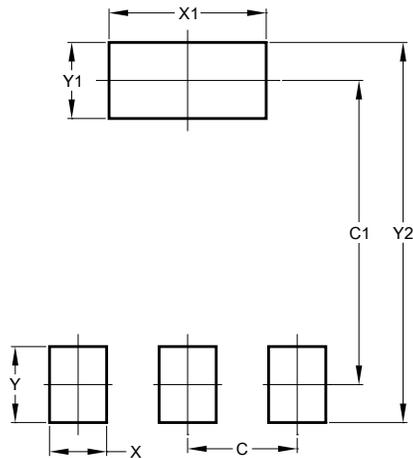


| SOT223 (Type DN) | | | |
|----------------------|------|------|------|
| Dim | Min | Max | Typ |
| A | -- | 1.70 | -- |
| A1 | 0.01 | 0.15 | -- |
| A2 | 1.50 | 1.68 | 1.60 |
| b | 0.60 | 0.80 | 0.70 |
| b2 | 2.90 | 3.10 | -- |
| c | 0.20 | 0.32 | -- |
| D | 6.30 | 6.70 | -- |
| E | 6.70 | 7.30 | -- |
| E1 | 3.30 | 3.70 | -- |
| e | -- | -- | 2.30 |
| e1 | -- | -- | 4.60 |
| L | 0.85 | -- | -- |
| All Dimensions in mm | | | |

Suggested Pad Layout

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

SOT223 (Type DN)



| 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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