

# 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 $\Omega$
- 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
  - $\mu C$  Compatible Power Switch for 12V and 24V DC Applications
  - Automotive Rated
  - Replaces electromechanical relays and discrete circuits
  - Linear mode capability - the current-limiting protection circuitry is designed to de-activate 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
- The current limit is programmable via an external resistor  $R_{PROG}$  connected between Status and IN pins
  - Status pin voltage reflects the gate drive being applied internally to the power MOSFET
  - With  $V_{IN} = 5V$  and  $R_{PROG} = 24k\Omega$ :
    - Status Voltage: 5V indicates normal operation.
    - Status Voltage: 2 to 3V indicates that the device is in current-limiting mode.
    - Status Voltage <1V indicates that 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.

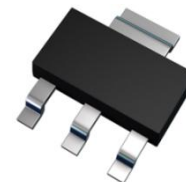
## Features and Benefits

- 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)**
- **An Automotive-Compliant Part is Available Under Separate Datasheet ([ZXMS6003GQ](#))**

## Mechanical Data

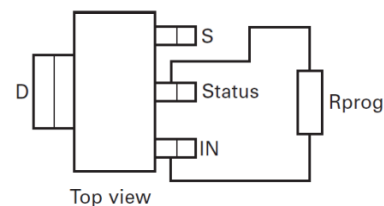
- Case: SOT223 (Type DN)
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Matte Tin Finish (e3)
- Weight: 0.112 grams (Approximate)

SOT223 (Type DN)



Top View

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



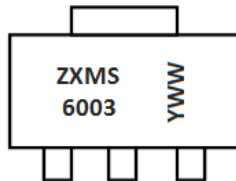
Top view

## Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
ZXMS6003GTA	ZXMS6003	7	12	1,000 Units

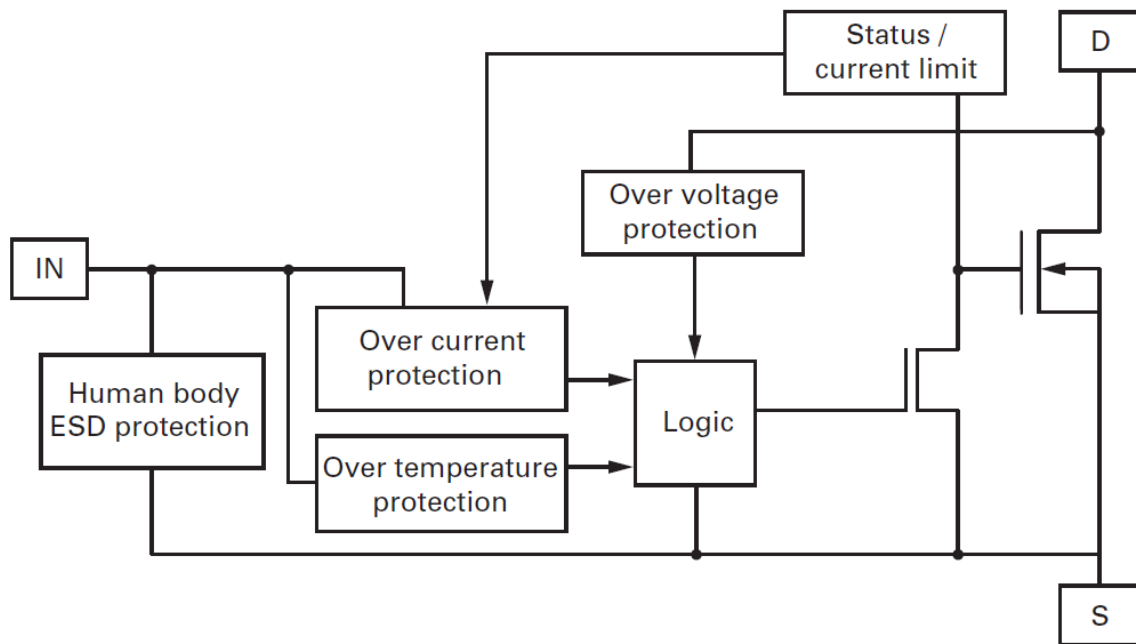
Note: 4. For packaging details, go to our website at <https://www.diodes.com/design/support/packaging/diodes-packaging/>.

## 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<sub>A</sub> = +25°C, unless otherwise stated.)

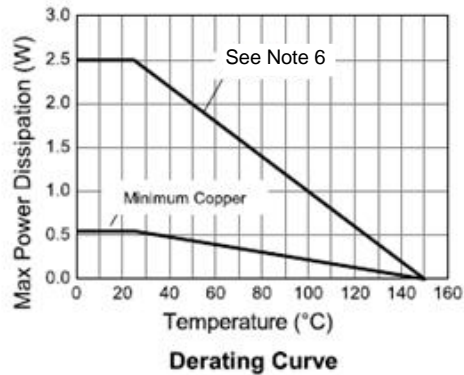
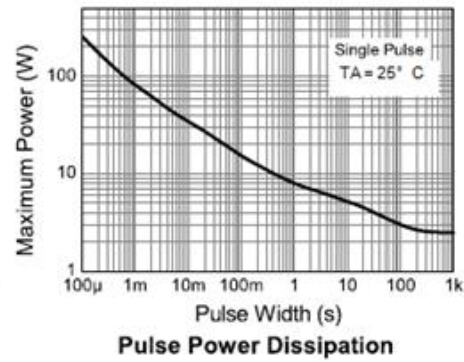
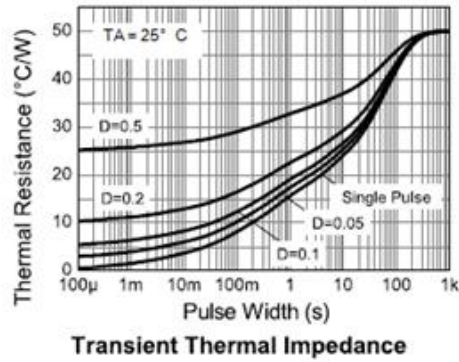
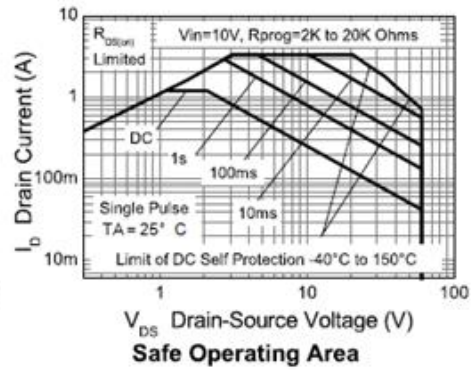
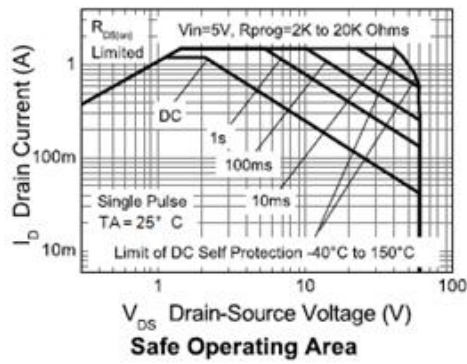
Parameter	Symbol	Limit	Unit
Continuous Drain-Source Voltage	V <sub>DS</sub>	60	V
Drain-Source Voltage for Short Circuit Protection V <sub>IN</sub> = 5V (Note 5)	V <sub>DS(SC)</sub>	36	V
Drain-Source Voltage for Short Circuit Protection V <sub>IN</sub> = 10V (Note 5)	V <sub>DS(SC)</sub>	20	V
Continuous Input Voltage	V <sub>IN</sub>	-0.2 to +10	V
Peak Input Voltage	V <sub>IN</sub>	-0.2 to +20	V
Operating Temperature Range	T <sub>J</sub>	-40 to +150	°C
Storage Temperature Range	T <sub>STG</sub>	-55 to +150	°C
Power Dissipation at @T <sub>A</sub> = +25°C (Note 6)	P <sub>D</sub>	2.5	W
Continuous Drain Current @V <sub>IN</sub> = 10V; T <sub>A</sub> = +25°C (Note 6)	I <sub>D</sub>	1.6	A
Continuous Drain Current @V <sub>IN</sub> = 5V; T <sub>A</sub> = +25°C (Note 6)	I <sub>D</sub>	1.4	A
Continuous Source Current (Body Diode) (Note 6)	I <sub>S</sub>	3	A
Pulsed Source Current (Body Diode) (Note 7)	I <sub>S</sub>	8	A
Unclamped Single Pulse Inductive Energy	E <sub>AS</sub>	550	mJ
Load Dump Protection	V <sub>LOADDUMP</sub>	80	V
Electrostatic Discharge (Human Body Model)	V <sub>ESD</sub>	4,000	V
DIN Humidity Category, DIN 40 040	—	E	—
IEC Climatic Category, DIN IEC 68-1	—	40/150/56	—

**Thermal Resistance** (@T<sub>A</sub> = +25°C, unless otherwise stated.)

Parameter	Symbol	Value	Unit
Junction to Ambient (Note 6)	R <sub>θJA</sub>	50	°C/W
Junction to Ambient (Note 7)	R <sub>θJA</sub>	28	°C/W

- Notes:
- For I<sub>D(LIM)</sub> < 1.2A (see safe operating area curve).
  - 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.
  - For a device surface mounted on FR-4 board and measured at t <= 10s.

## Thermal Characteristics

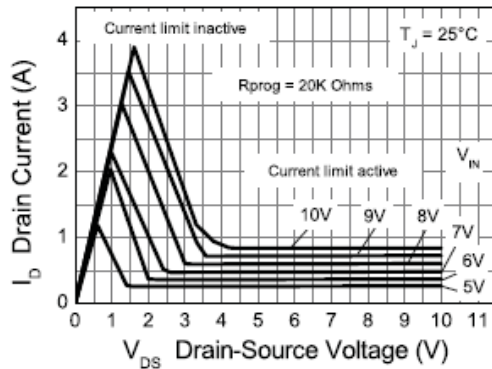


**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise stated.)

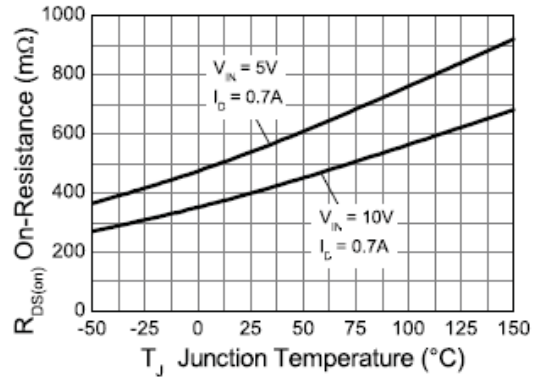
Parameter	Symbol	Min	Typ	Max	Unit	Conditions
<b>Static Characteristics</b>						
Drain-Source Clamp Voltage	V <sub>DS(AZ)</sub>	60	70	75	V	I <sub>D</sub> = 10mA
Off State Drain Current	I <sub>DSS</sub>	—	0.1	3	μA	V <sub>DS</sub> = 12V, V <sub>IN</sub> = 0V
Off State Drain Current	I <sub>DSS</sub>	—	3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

- Notes:
- Protection features may operate outside spec for V<sub>IN</sub> < 4.5V.
  - The drain current is limited to a reduced value when V<sub>DS</sub> 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.

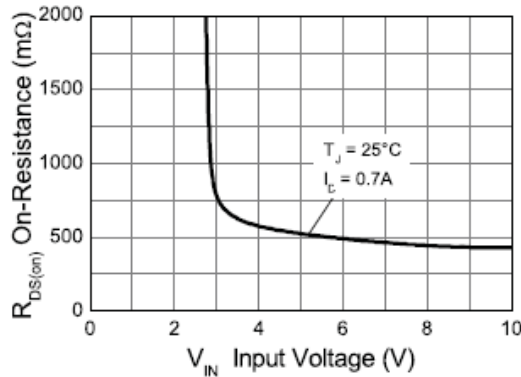
## Typical Characteristics



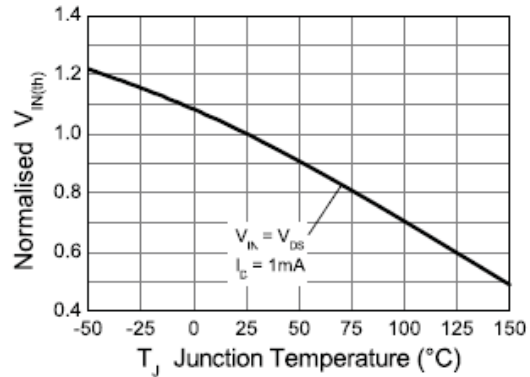
**Typical Output Characteristic**



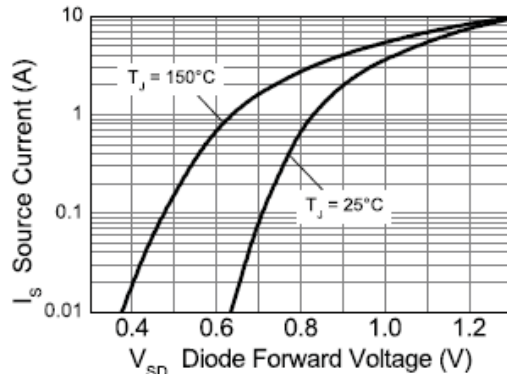
**On-state Resistance vs Temperature**



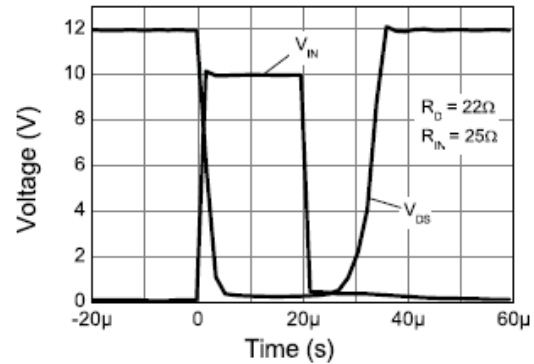
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**



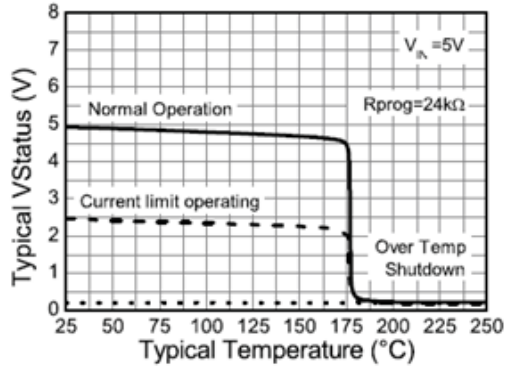
**Source-Drain Diode Forward Voltage**



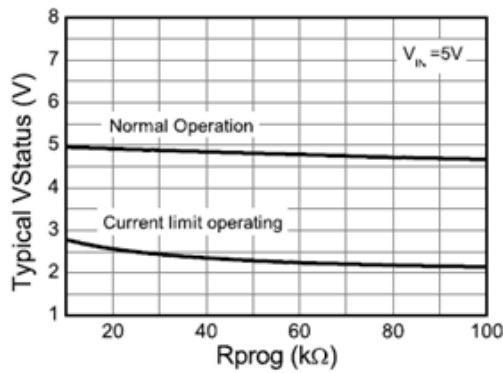
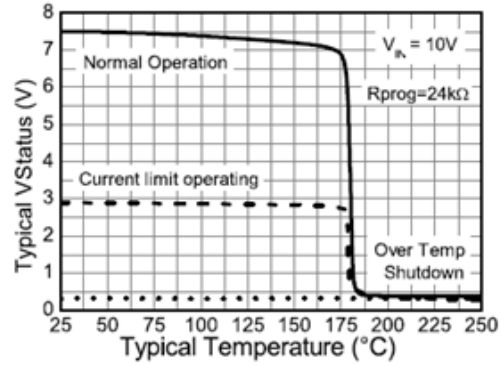
**Switching Speed**

**Typical Characteristics (Cont.)**

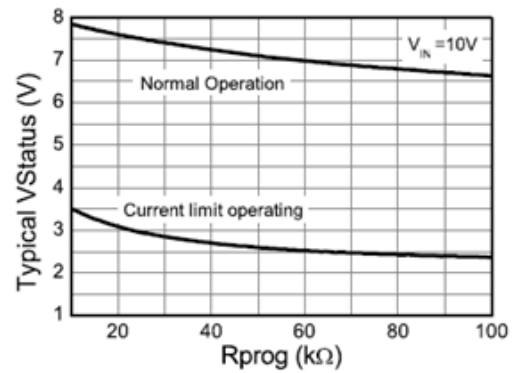
**Current Limiting and Over Temp Shutdown  
Status Indication at Vin=5V**



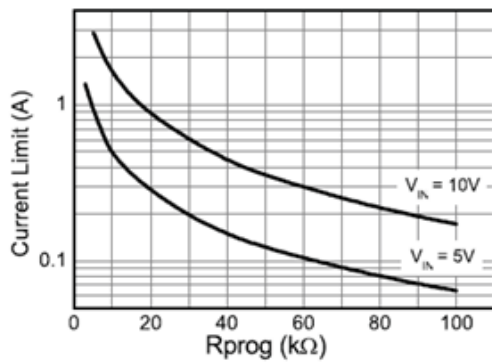
**Current Limiting and Over Temp Shutdown  
Status Indication at Vin=10V**



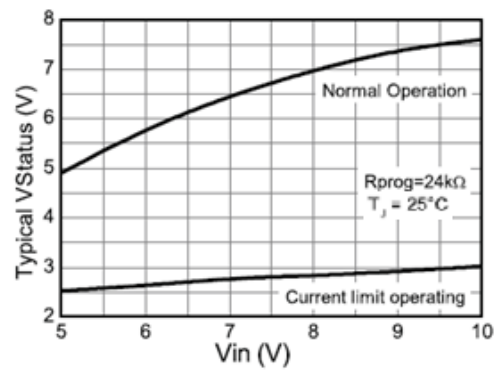
**VStatus vs Rprog @ Vin=5V**



**VStatus vs Rprog @ Vin=10V**



**Current Limit vs Rprog**

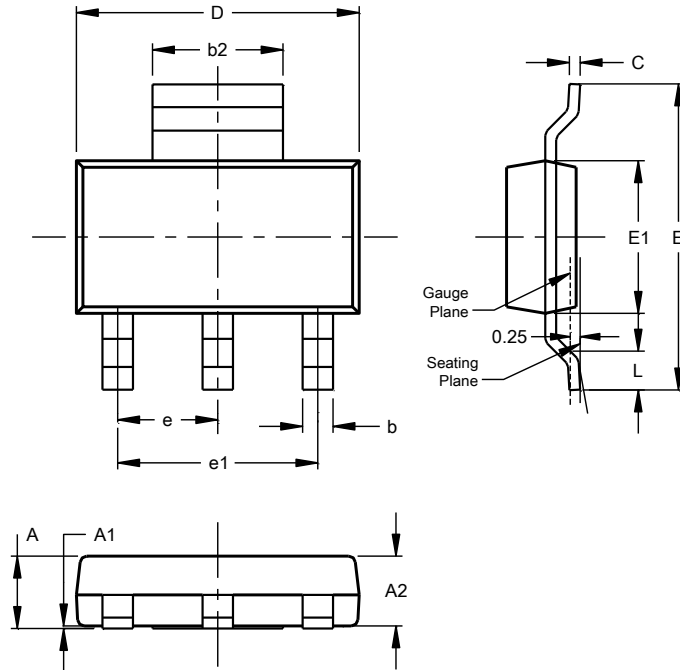


**VStatus vs Vin**

## Package Outline Dimensions

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

### SOT223 (Type DN)

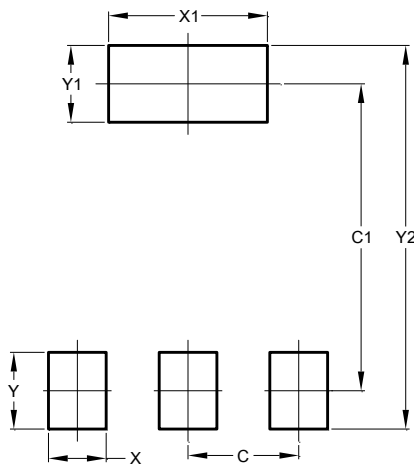


SOT223 (Type DN)			
Dim	Min	Max	Typ
A	--	1.70	--
A1	0.01	0.15	--
A2	1.50	1.68	1.60
b	0.60	0.80	0.70
b2	2.90	3.10	--
c	0.20	0.32	--
D	6.30	6.70	--
E	6.70	7.30	--
E1	3.30	3.70	--
e	--	--	2.30
e1	--	--	4.60
L	0.85	--	--
All Dimensions in mm			

## 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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