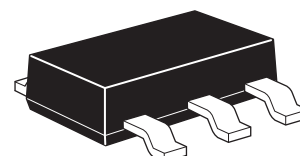


# ZXMS6003G

## 60V N-channel self protected enhancement mode IntelliFET™ MOSFET with programmable current limit

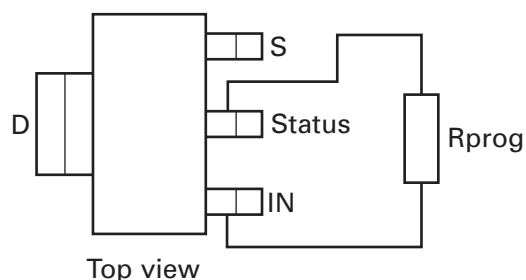
### Summary

|                                        |                |
|----------------------------------------|----------------|
| Continuous drain source voltage        | $V_{DS} = 60V$ |
| On-state resistance                    | 500m $\Omega$  |
| Nominal load current ( $V_{IN} = 5V$ ) | 1.4A           |
| Clamping energy                        | 550mJ          |



### Description

Self protected low side MOSFET. Monolithic over temperature, over current, over voltage (active clamp) and ESD protected logic level functionality. Intended as a general purpose switch, with status indication and programmable current limit.



**Note:** Rprog must be connected between the Status and IN pins

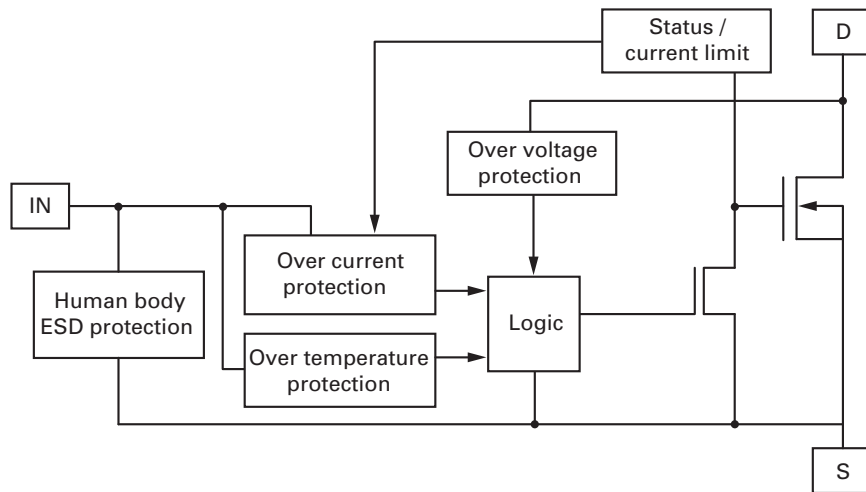
### Features

- Current limit programmable via external resistor
- Status pin (analog status indication)
- Short circuit protection with auto restart
- Over voltage protection (active clamp)
- Thermal shutdown with auto restart
- Over-current protection
- Input Protection (ESD)
- Load dump protection (actively protects load)
- Logic Level Input
- High continuous current rating

### Ordering information

| Device      | Part mark | Reel size (inches) | Tape width (mm) | Quantity per reel |
|-------------|-----------|--------------------|-----------------|-------------------|
| ZXMS6003GTA | ZXMS6003  | 7                  | 12              | 1,000             |

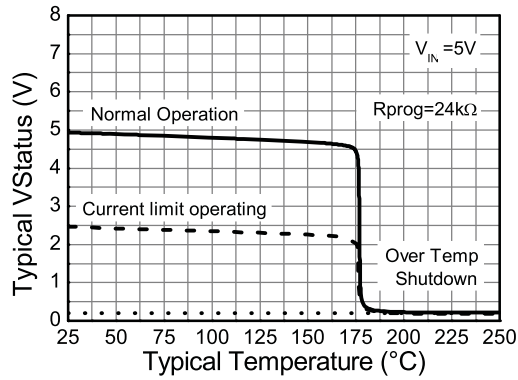
## Functional block diagram



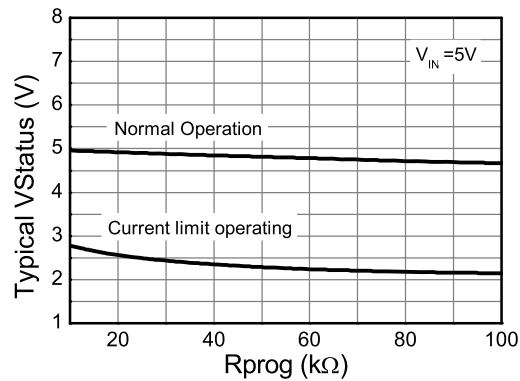
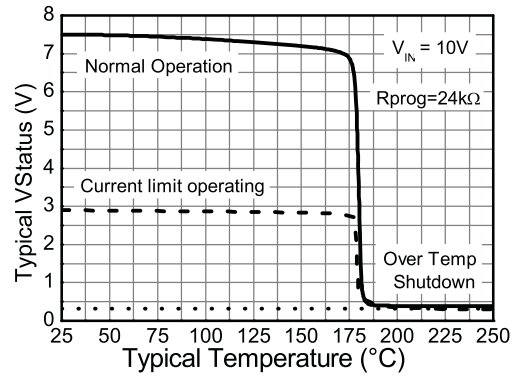
## Applications and information

- 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.
- $\mu\text{C}$  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  $V_{\text{DS}}$ , 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  $R_{\text{prog}}$  connected between Status and IN pins.
- Status pin voltage reflects the gate drive being applied internally to the power MOSFET.  
With  $V_{\text{IN}} = 5\text{V}$  and  $R_{\text{prog}} = 24\text{k}\Omega$ :  
Status voltage  $\sim 5\text{V}$  indicates normal operation.  
Status voltage  $\sim (2-3)\text{V}$  indicates that the device is in current-limiting mode.  
Status voltage  $< 1\text{V}$  indicates that the device is in thermal shutdown.

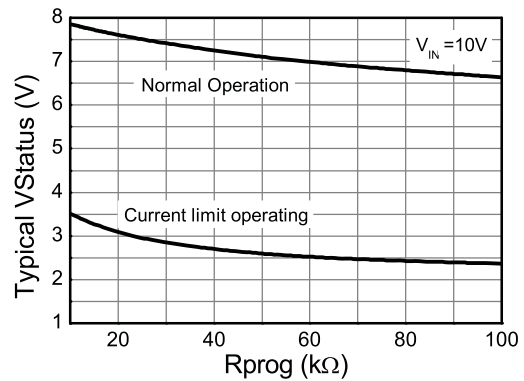
**Current Limiting and Over Temp Shutdown  
Status Indication at Vin=5V**



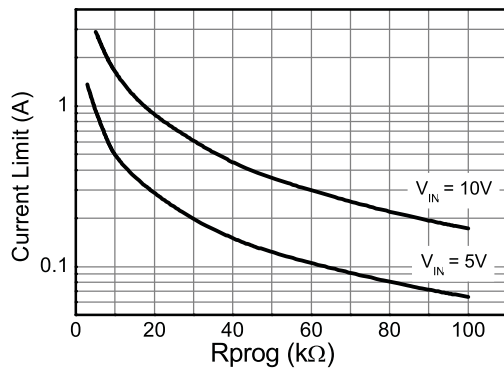
**Current Limiting and Over Temp Shutdown  
Status Indication at Vin=10V**



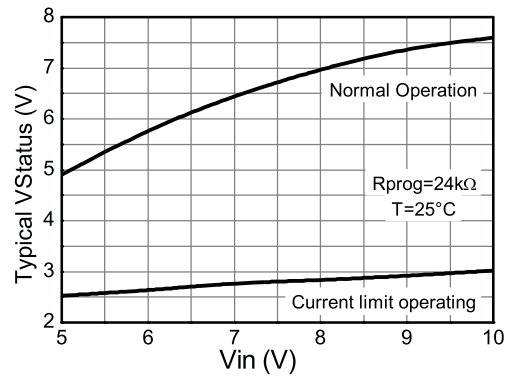
**VStatus vs Rprog @ Vin=5V**



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



**Current Limit vs Rprog**



**VStatus vs Vin**

**Absolute maximum ratings**

| Parameter                                                             | Symbol         | Limit        | Unit |
|-----------------------------------------------------------------------|----------------|--------------|------|
| Continuous drain-source voltage                                       | $V_{DS}$       | 60           | V    |
| Drain-source voltage for short circuit protection $V_{IN}=5V^{(a)}$   | $V_{DS(SC)}$   | 36           | V    |
| Drain-source voltage for short circuit protection $V_{IN}=10V^{(a)}$  | $V_{DS(SC)}$   | 20           | V    |
| Continuous input voltage                                              | $V_{IN}$       | -0.2 ... +10 | V    |
| Peak input voltage                                                    | $V_{IN}$       | -0.2 ... +20 | V    |
| Operating temperature range                                           | $T_{j'}$       | -40 to +150  | °C   |
| Storage temperature range                                             | $T_{stg}$      | -55 to +150  | °C   |
| Power dissipation @ $T_{amb}=25^{\circ}C^{(a)}$                       | $P_D$          | 2.5          | W    |
| Continuous drain current @ $V_{IN}=10V$ ; $T_{amb}=25^{\circ}C^{(b)}$ | $I_D$          | 1.6          | A    |
| Continuous drain current @ $V_{IN}=5V$ ; $T_{amb}=25^{\circ}C^{(b)}$  | $I_D$          | 1.4          | A    |
| Continuous source current (body diode) <sup>(b)</sup>                 | $I_S$          | 3            | A    |
| Pulsed source current (body diode) <sup>(c)</sup>                     | $I_S$          | 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**

| Parameter           | Symbol          | Limit | Unit |
|---------------------|-----------------|-------|------|
| Junction to ambient | $R_{\theta JA}$ | 50    | °C/W |
| Junction to ambient | $R_{\theta JA}$ | 28    | °C/W |

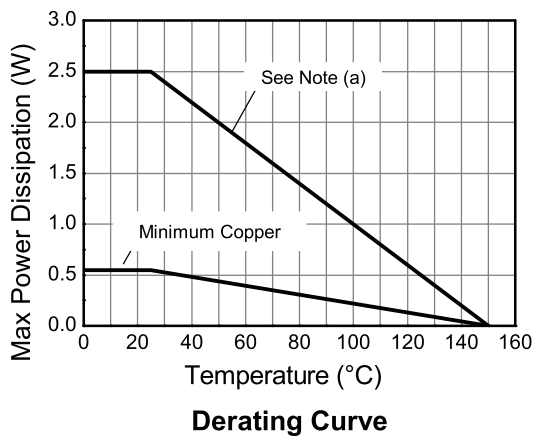
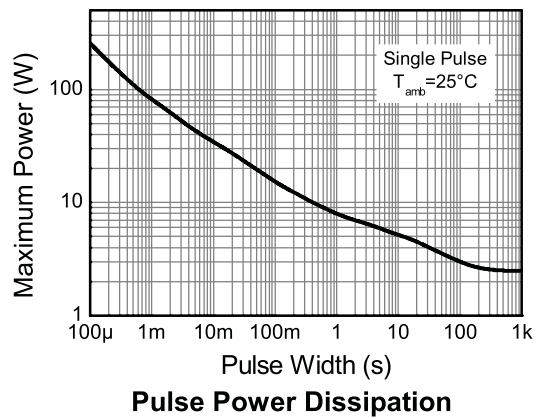
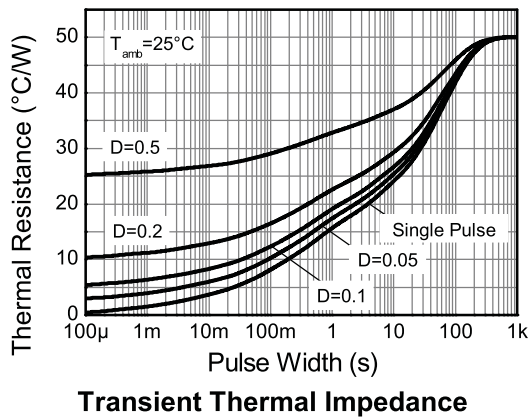
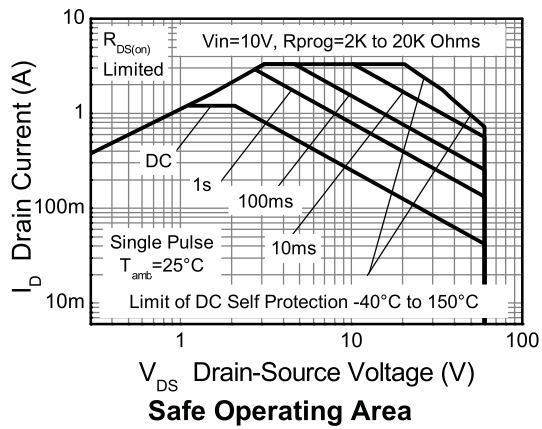
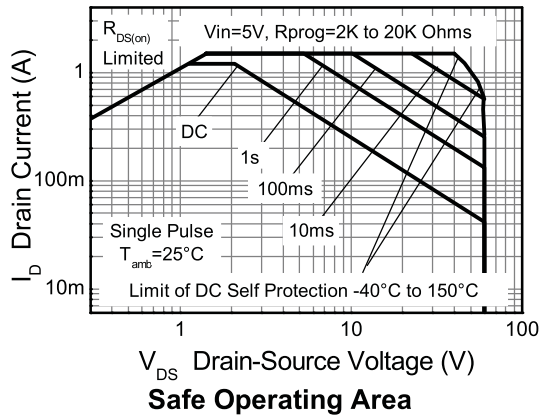
**NOTES:**

(a) For  $I_{D(LIM)} < 1.2A$  (see safe operating area curve).

(b) For a device surface mounted on 50mm x 50mm x 1.6mm FR4 board with a high coverage of single sided 2oz weight copper.

(c) For a device surface mounted on FR4 board and measured at  $t \leq 10s$ .

## Characteristics



# ZXMS6003G

## Electrical characteristics (at $T_{amb} = 25^{\circ}\text{C}$ unless otherwise stated)

| Parameter                               | Symbol             | Min | Typ | Max | Unit                   | Conditions                                                                                           |
|-----------------------------------------|--------------------|-----|-----|-----|------------------------|------------------------------------------------------------------------------------------------------|
| <b>Static Characteristics</b>           |                    |     |     |     |                        |                                                                                                      |
| Drain-source clamp voltage              | $V_{DS(AZ)}$       | 60  | 70  | 75  | V                      | $I_D=10\text{mA}$                                                                                    |
| Off state drain current                 | $I_{DSS}$          |     | 0.1 | 3   | $\mu\text{A}$          | $V_{DS}=12\text{V}, V_{IN}=0\text{V}$                                                                |
| Off state drain current                 | $I_{DSS}$          |     | 3   | 15  | $\mu\text{A}$          | $V_{DS}=32\text{V}, V_{IN}=0\text{V}$                                                                |
| Input threshold voltage (*)             | $V_{IN(th)}$       | 1   | 2.1 |     | V                      | $V_{DS}=V_{GS}, I_D=1\text{mA}$                                                                      |
| Input current                           | $I_{IN}$           |     | 0.7 | 1.2 | mA                     | $V_{IN}=+5\text{V}$                                                                                  |
| Input current                           | $I_{IN}$           |     | 1.5 | 2.7 | mA                     | $V_{IN}=+7\text{V}$                                                                                  |
| Input current                           | $I_{IN}$           |     | 4   | 7   | mA                     | $V_{IN}=+10\text{V}$                                                                                 |
| Static drain-source on-state resistance | $R_{DS(on)}$       |     | 520 | 675 | $\text{m}\Omega$       | $V_{IN}=5\text{V}, I_D=0.2\text{A}$                                                                  |
| Static drain-source on-state resistance | $R_{DS(on)}$       |     | 385 | 500 | $\text{m}\Omega$       | $V_{IN}=10\text{V}, I_D=0.5\text{A}$                                                                 |
| Current limit (†)                       | $I_{D(LIM)}$       | 0.2 | 0.3 | 0.4 | A                      | $V_{IN}=5\text{V}, V_{DS}=10\text{V}$<br>$R_{prog}=20\text{k}$                                       |
| Current limit(†)                        | $I_{D(LIM)}$       | 0.7 | 0.9 | 1.2 | A                      | $V_{IN}=10\text{V}, V_{DS}=10\text{V}$ ,<br>$R_{prog}=20\text{k}$                                    |
| <b>Dynamic characteristics</b>          |                    |     |     |     |                        |                                                                                                      |
| Turn-on time ( $V_{IN}$ to 90% $I_D$ )  | $t_{on}$           |     | 3.0 | 10  | $\mu\text{s}$          | $R_{prog}=20\text{k}, R_L=22\Omega$ ,<br>$V_{IN}=0$ to $10\text{V}$ ,<br>$V_{DD}=12\text{V}$         |
| Turn-off time ( $V_{IN}$ to 90% $I_D$ ) | $t_{off}$          |     | 13  | 20  | $\mu\text{s}$          | $R_{prog}=20\text{k}, R_L=22\Omega$ ,<br>$V_{IN}=10\text{V}$ to $0\text{V}$ ,<br>$V_{DD}=12\text{V}$ |
| Slew rate on (70 to 50% $V_{DD}$ )      | $-dV_{DS}/dt_{on}$ |     | 8   | 20  | $\text{V}/\mu\text{s}$ | $R_{prog}=20\text{k}, R_L=22\Omega$ ,<br>$V_{IN}=0$ to $10\text{V}$ ,<br>$V_{DD}=12\text{V}$         |
| Slew rate off (50 to 70% $V_{DD}$ )     | $DV_{DS}/dt_{on}$  |     | 3.2 | 10  | $\text{V}/\mu\text{s}$ | $R_{prog}=20\text{k}, R_L=22\Omega$ ,<br>$V_{IN}=10\text{V}$ to $0\text{V}$ ,<br>$V_{DD}=12\text{V}$ |

### NOTES:

(\*) Protection features may operate outside spec for  $V_{IN}<4.5\text{V}$

(†) The drain current is limited to a reduced value when  $V_{DS}$  exceeds a safe level.

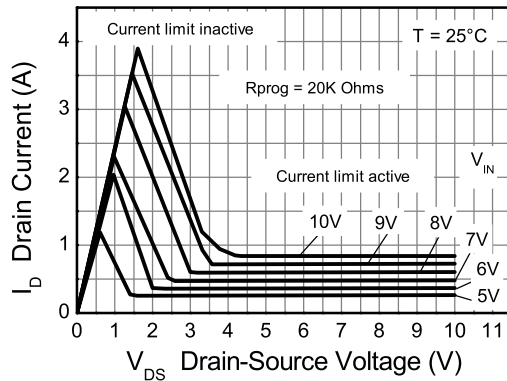
## Electrical characteristics (at $T_{amb} = 25^{\circ}\text{C}$ unless otherwise stated) (cont.)

| Parameter                                                            | Symbol       | Min | Typ  | Max | Unit               | Conditions                                        |
|----------------------------------------------------------------------|--------------|-----|------|-----|--------------------|---------------------------------------------------|
| <b>Protection functions<sup>(‡)</sup></b>                            |              |     |      |     |                    |                                                   |
| Required input voltage for over temperature protection               | $V_{PROT}$   | 4.5 |      |     | V                  |                                                   |
| Thermal overload trip temperature                                    | $T_{JT}$     | 150 | 175  |     | $^{\circ}\text{C}$ |                                                   |
| Thermal hysteresis                                                   |              |     | 1    |     | $^{\circ}\text{C}$ |                                                   |
| Unclamped single pulse inductive energy<br>$T_j=25^{\circ}\text{C}$  | $E_{AS}$     | 550 |      |     | mJ                 | $I_{D(ISO)}=0.7\text{A}$ ,<br>$V_{DD}=32\text{V}$ |
| Unclamped single pulse inductive energy<br>$T_j=150^{\circ}\text{C}$ | $E_{AS}$     | 200 |      |     | mJ                 | $I_{D(ISO)}=0.7\text{A}$ ,<br>$V_{DD}=32\text{V}$ |
| <b>Status flag</b>                                                   |              |     |      |     |                    |                                                   |
| Normal operation                                                     | $V_{STATUS}$ |     | 4.95 |     | V                  | $V_{IN} = 5\text{V}$                              |
| Current limit operating                                              | $V_{STATUS}$ |     | 2.5  |     | V                  | $V_{IN} = 5\text{V}$                              |
| Thermal shutdown activated                                           | $V_{STATUS}$ |     | 0.2  | 1   | V                  | $V_{IN} = 5\text{V}$                              |
| Normal operation                                                     | $V_{STATUS}$ |     | 8.0  |     | V                  | $V_{IN} = 10\text{V}$                             |
| Current limit operation                                              | $V_{STATUS}$ |     | 3.0  |     | V                  | $V_{IN} = 10\text{V}$                             |
| Thermal shutdown activated                                           | $V_{STATUS}$ |     | 0.35 | 1   | V                  | $V_{IN} = 10\text{V}$                             |
| <b>Inverse diode</b>                                                 |              |     |      |     |                    |                                                   |
| Source drain voltage                                                 | $V_{SD}$     |     |      | 1   | V                  | $V_{IN}=0\text{V}$ , $-I_D=1.4\text{A}$           |

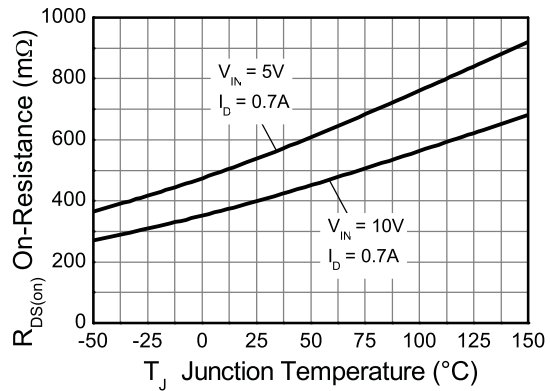
### NOTES:

(‡) 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.

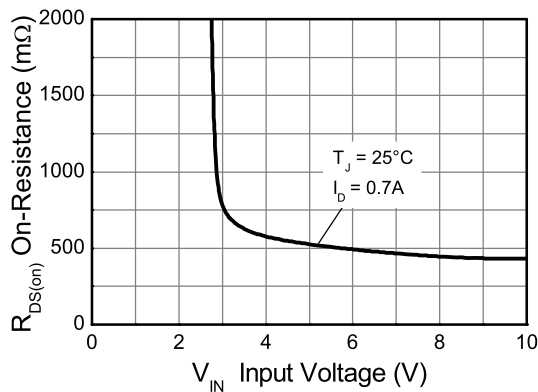
## Typical characteristics



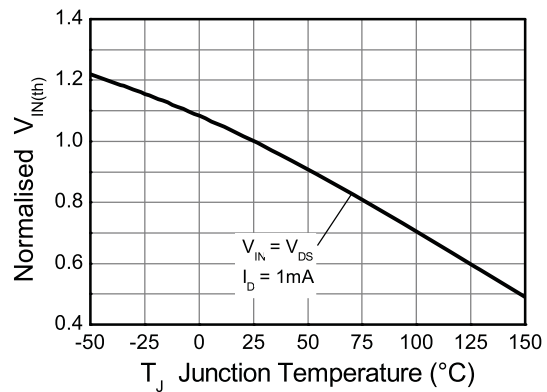
**Typical Output Characteristic**



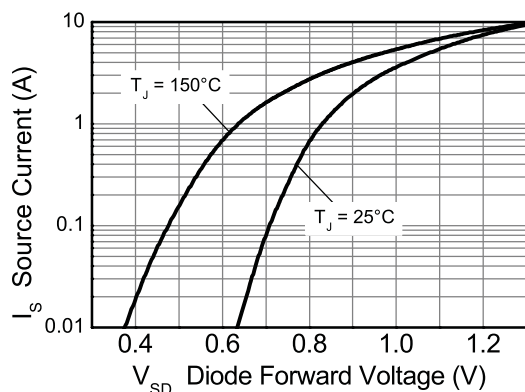
**On-state Resistance vs Temperature**



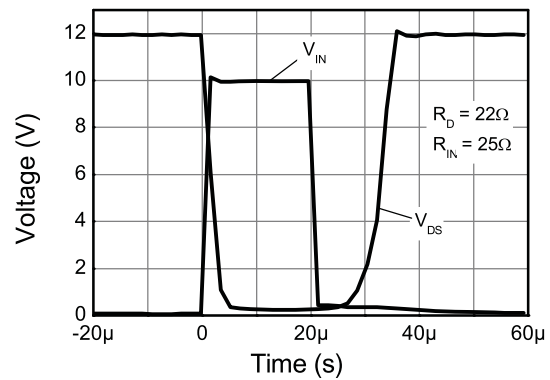
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**



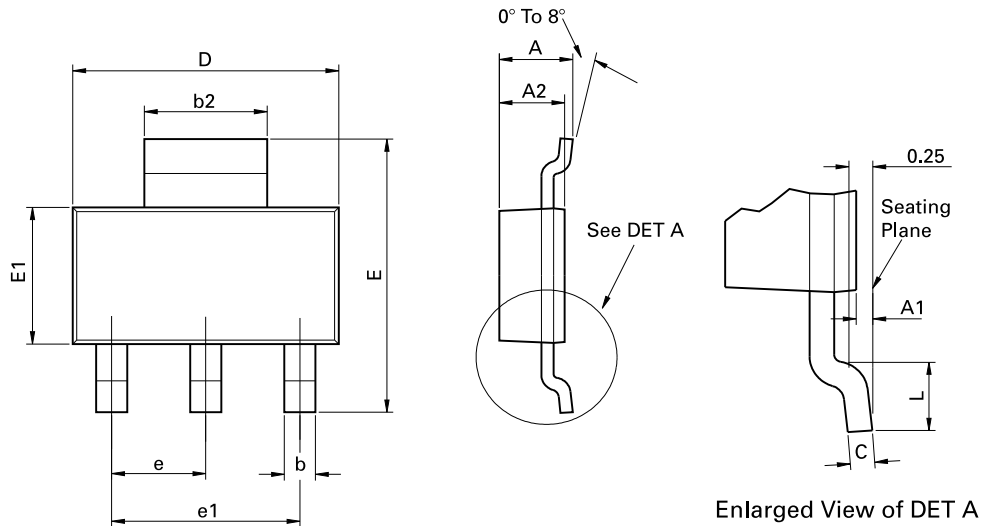
**Source-Drain Diode Forward Voltage**



**Switching Speed**

# ZXMS6003G

## Package outline - SOT223



Conforms to JEDEC TO-261 AA Issue B

| DIM | Millimeters |      | Inches |       | DIM | Millimeters |      | Inches     |       |
|-----|-------------|------|--------|-------|-----|-------------|------|------------|-------|
|     | Min         | Max  | Min    | Max   |     | Min         | Max  | Min        | Max   |
| A   | -           | 1.80 | -      | 0.071 | e   | 2.30 BSC    |      | 0.0905 BSC |       |
| A1  | 0.02        | 0.10 | 0.0008 | 0.004 | e1  | 4.60 BSC    |      | 0.181 BSC  |       |
| b   | 0.66        | 0.84 | 0.026  | 0.033 | E   | 6.70        | 7.30 | 0.264      | 0.287 |
| b2  | 2.90        | 3.10 | 0.114  | 0.122 | E1  | 3.30        | 3.70 | 0.130      | 0.146 |
| C   | 0.23        | 0.33 | 0.009  | 0.013 | L   | 0.90        | -    | 0.355      | -     |
| D   | 6.30        | 6.70 | 0.248  | 0.264 | -   | -           | -    | -          | -     |

**Note:** Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

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### Product status key:

|                                   |                                                                                |
|-----------------------------------|--------------------------------------------------------------------------------|
| "Preview"                         | Future device intended for production at some point. Samples may be available  |
| "Active"                          | Product status recommended for new designs                                     |
| "Last time buy (LTB)"             | Device will be discontinued and last time buy period and delivery is in effect |
| "Not recommended for new designs" | Device is still in production to support existing designs and production       |
| "Obsolete"                        | Production has been discontinued                                               |

### Datasheet status key:

|                       |                                                                                                                                                                                                             |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| "Draft version"       | This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.                                                                |
| "Provisional version" | This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice. |
| "Issue"               | This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.                                                    |

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