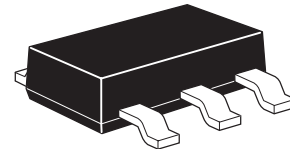


# ZXMS6001N3

## 60V N-channel self protected enhancement mode INTELLIFET™ MOSFET

### Summary

Continuous drain source voltage	$V_{DS} = 60V$
On-state resistance	675mΩ
Max nominal load current (a)	1.1A ( $V_{IN} = 5V$ )
Min nominal load current (c)	0.7A ( $V_{IN} = 5V$ )
Clamping Energy	550mJ

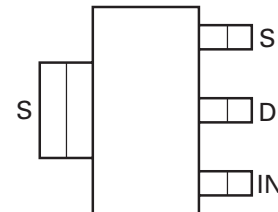


### Description

Low input current self protected low side MOSFET intended for  $V_{in}=5V$  applications. Monolithic over temperature, over current, over voltage (active clamp) and ESD protected logic level functionality. Intended as a general purpose switch.

### Note:

The tab is connected to the source pin and must be electrically isolated from the drain pin. Connection of significant copper to the drain pin is recommended for best thermal performance.



SOT223

### Features

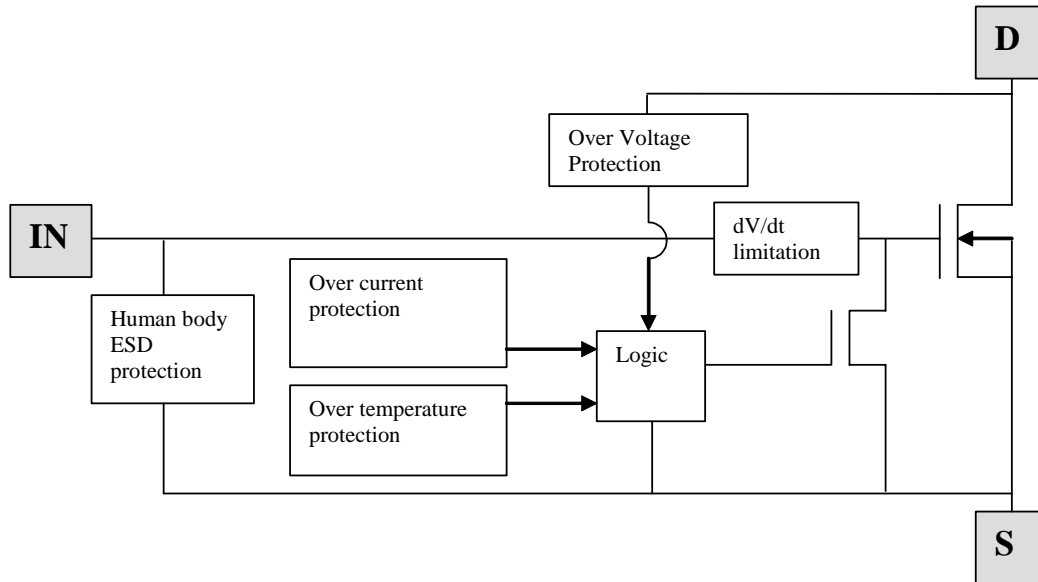
- Short circuit protection with auto restart
- Over voltage protection (active clamp)
- Thermal shutdown with auto restart
- Over-current protection
- Input protection (ESD)
- Load dump protection (actively protects load)
- Low input current

### Ordering information

Device	Package	Part mark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXMS6001N3TA	SOT223	ZXMS6001	7	12 embossed	1,000

# ZXMS6001N3

## 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. This does not compromise the products ability to self protect itself at low  $V_{\text{DS}}$ .

# ZXMS6001N3

## Absolute maximum ratings

Parameter	Symbol	Limit	Unit
Continuous Drain-Source Voltage	$V_{DS}$	60	V
Drain-Source Voltage for short circuit protection $V_{IN} = 5V$	$V_{DS(SC)}$	36	V
Continuous Input Voltage	$V_{IN}$	-0.2 ... +10	V
Peak Input Voltage	$V_{IN}$	-0.2 ... +20	V
Continuous Input Current -0.2V= $V_{IN}$ =10V $V_{IN}<-0.2V$ or $V_{IN}>10V$	$I_{IN}$	No limit $ I_{IN}  \leq 2$	mA
Operating Temperature Range	$T_{jr}$	-40 to +150	°C
Storage Temperature Range	$T_{stg}$	-55 to +150	°C
Power Dissipation at $T_A = 25^\circ C^{(a)}$	$P_D$	1.5	W
Power Dissipation at $T_A = 25^\circ C^{(c)}$	$P_D$	0.6	W
Continuous Drain Current @ $V_{IN}=5V$ ; $T_A=25^\circ C^{(a)}$	$I_D$	1.1	A
Continuous Drain Current @ $V_{IN}=5V$ ; $T_A=25^\circ C^{(c)}$	$I_D$	0.7	A
Continuous Source Current (Body Diode) <sup>(a)</sup>	$I_S$	2.0	A
Pulsed Source Current (Body Diode) <sup>(b)</sup>	$I_S$	3.3	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	Value	Unit
Junction to ambient <sup>(a)</sup>	$R_{\theta JA}$	83	°C/W
Junction to ambient <sup>(b)</sup>	$R_{\theta JA}$	45	°C/W
Junction to ambient <sup>(c)</sup>	$R_{\theta JA}$	208	°C/W

### NOTES:

(a) For a device surface mounted on 25mm x 25mm x 1.6mm FR4 board with a high coverage of single sided 2oz weight copper. Allocation of 6cm<sup>2</sup> copper 33% to source tab and 66% to drain pin with source tab and drain pin electrically isolated.

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

(c) For a device surface mounted on FR4 board with the minimum copper required for electrical connections.

# ZXMS6001N3

## Recommended operating conditions

The ZXMS6001 is optimized for use with  $\mu\text{C}$  operating from 5V supplies.

Symbol	Description	Min	Max	Units
$V_{\text{IN}}$	Input voltage range	0	6	V
$T_{\text{A}}$	Ambient temperature range	-40	125	$^{\circ}\text{C}$
$V_{\text{IH}}$	High level input voltage for MOSFET <sup>(d)</sup>	4	6	V
$V_{\text{P}}$	Peripheral supply voltage (voltage to which load is referred)		60	V

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

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
<b>Static Characteristics</b>						
Drain-Source Clamp Voltage	$V_{\text{DS(AZ)}}$	60	70	75	V	$I_{\text{D}}=10\text{mA}$
Off state Drain Current	$I_{\text{DSS}}$		0.1	3	$\mu\text{A}$	$V_{\text{DS}}=12\text{V}, V_{\text{IN}}=0\text{V}$
Off state Drain Current	$I_{\text{DSS}}$		3	15	$\mu\text{A}$	$V_{\text{DS}}=32\text{V}, V_{\text{IN}}=0\text{V}$
Input Threshold Voltage <sup>(d)</sup>	$V_{\text{IN(th)}}$	1	1.8	2.5	V	$V_{\text{DS}}=V_{\text{GS}}, I_{\text{D}}=10\text{mA}$
Input Current	$I_{\text{IN}}$		150		$\mu\text{A}$	$V_{\text{IN}}=+3\text{V}$
Input Current	$I_{\text{IN}}$		335	500	$\mu\text{A}$	$V_{\text{IN}}=+5\text{V}$ , all circumstances
Static Drain-Source On-State Resistance	$R_{\text{DS(on)}}$		1	2	$\Omega$	$V_{\text{IN}}=3\text{V}, I_{\text{D}}=0.1\text{A}$
Static Drain-Source On-State Resistance	$R_{\text{DS(on)}}$		520	675	$\text{m}\Omega$	$V_{\text{IN}}=5\text{V}, I_{\text{D}}=0.7\text{A}$
Current Limit <sup>(e)</sup>	$I_{\text{D(LIM)}}$	1	1.8	3	A	$V_{\text{IN}}=5\text{V}, V_{\text{DS}}>5\text{V}$
<b>Dynamic Characteristics</b>						
Turn-On Time ( $V_{\text{IN}}$ to 90% $I_{\text{D}}$ )	$t_{\text{on}}$		27	40	$\mu\text{s}$	$R_{\text{L}}=22\Omega, V_{\text{IN}}=0$ to 5V, $V_{\text{DD}}=12\text{V}$
Turn-Off time ( $V_{\text{IN}}$ to 90% $I_{\text{D}}$ )	$t_{\text{off}}$		26	40	$\mu\text{s}$	$R_{\text{L}}=22\Omega, V_{\text{IN}}=5\text{V}$ to 0V, $V_{\text{DD}}=12\text{V}$
Slew Rate On (70 to 50% $V_{\text{DD}}$ )	$-dV_{\text{DS}}/dt_{\text{on}}$		1.4	10	$\text{V}/\mu\text{s}$	$R_{\text{L}}=22\Omega, V_{\text{IN}}=0$ to 5V, $V_{\text{DD}}=12\text{V}$
Slew Rate Off (50 to 70% $V_{\text{DD}}$ )	$dV_{\text{DS}}/dt_{\text{on}}$		1.2	10	$\text{V}/\mu\text{s}$	$R_{\text{L}}=22\Omega, V_{\text{IN}}=5\text{V}$ to 0V, $V_{\text{DD}}=12\text{V}$

### NOTES:

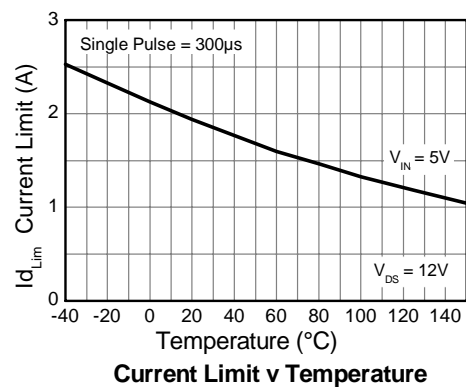
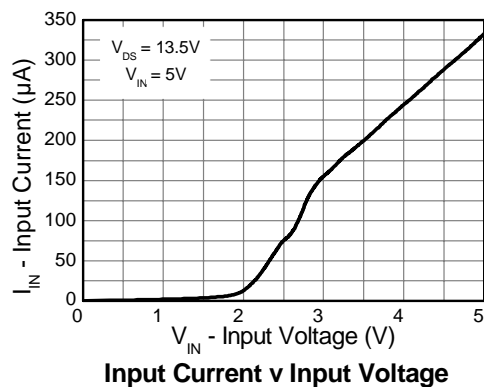
(d) Recommended input voltage range over which protection circuits function as specified.

(e) The drain current is limited to a reduced value when  $V_{\text{ds}}$  exceeds a safe level

# ZXMS6001N3

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
<b>Protection Functions (f)</b>						
Minimum input voltage for over temperature protection	$V_{PROT}$	4	3.5		V	$T_{trip} > 150^{\circ}C$
Maximum input voltage for over temperature protection	$V_{PROT}$		7	6	V	$T_{trip} > 150^{\circ}C$
Thermal Overload Trip Temperature	$T_{JT}$	150	175		$^{\circ}C$	
Thermal hysteresis			8		$^{\circ}C$	
Unclamped single pulse inductive energy $T_j = 25^{\circ}C$	$E_{AS}$	550			mJ	$I_{D(ISO)} = 0.7A, V_{DD} = 32V$
Unclamped single pulse inductive energy $T_j = 150^{\circ}C$	$E_{AS}$	200			mJ	$I_{D(ISO)} = 0.7A, V_{DD} = 32V$
<b>Inverse Diode</b>						
Source drain voltage	$V_{SD}$			1	V	$V_{IN} = 0V, -I_D = 1.4A$

- f 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.



## Application information

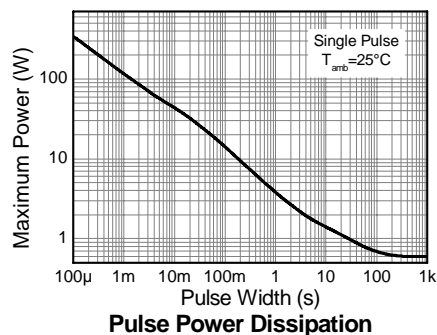
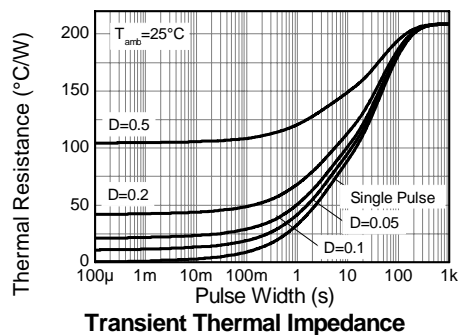
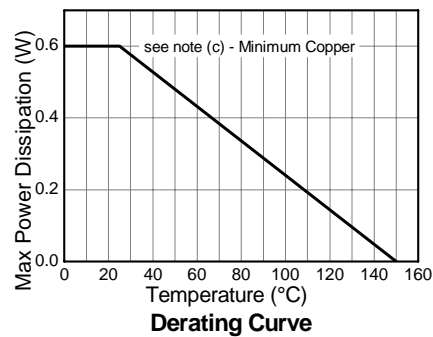
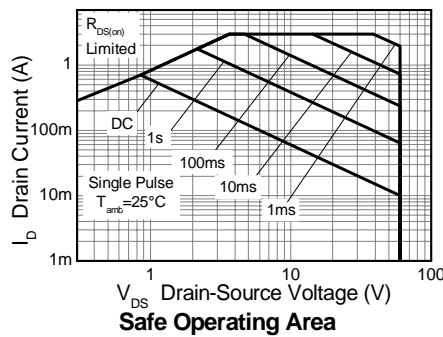
The current-limit protection circuitry is designed to de-activate at low  $V_{DS}$  to prevent the load current from being unnecessarily restricted during normal operation. The design max DC operating current is therefore determined by the thermal capability of the package/board combination, rather than by the protection circuitry (see graph page 8 'typical output characteristic'). This does not compromise the products ability to self protect at low  $V_{DS}$ .

The overtemperature protection circuit trips at a minimum of 150°C. So the available package dissipation reduces as the maximum required ambient temperature increases. This leads to the following maximum recommended continuous operating currents.

## Minimum copper area characteristics

For minimum copper condition as described in note (c)

Max Ambient Temperature $T_A$	Maximum continuous current $V_{IN}=5V$
25°C at $V_{in}=5V$	720
70°C at $V_{in}=5V$	575
85°C at $V_{in}=5V$	520
125°C at $V_{in}=5V$	320

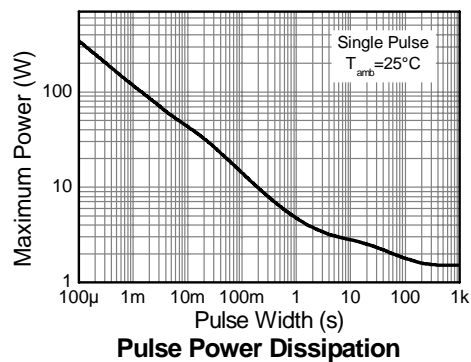
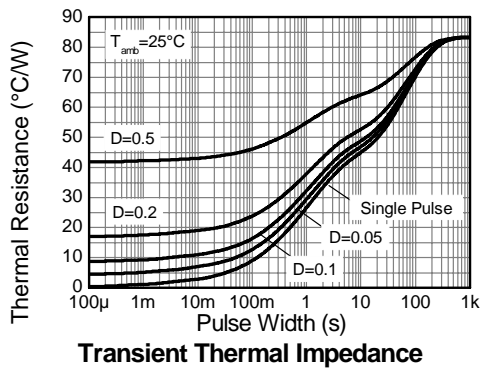
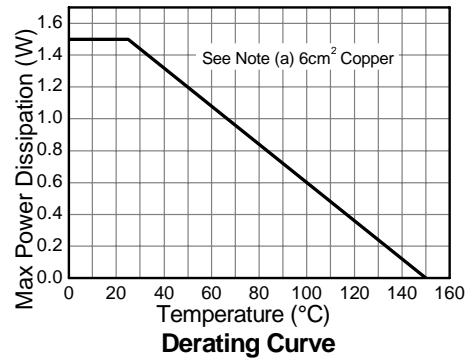
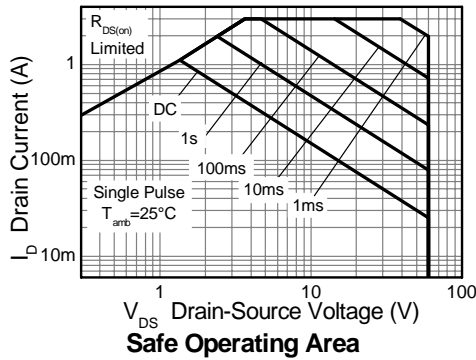


# ZXMS6001N3

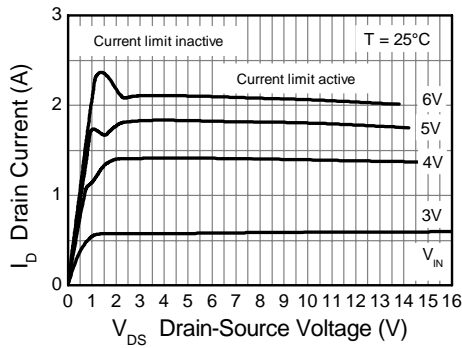
## Large copper area characteristics

For large copper area as described in note (a)

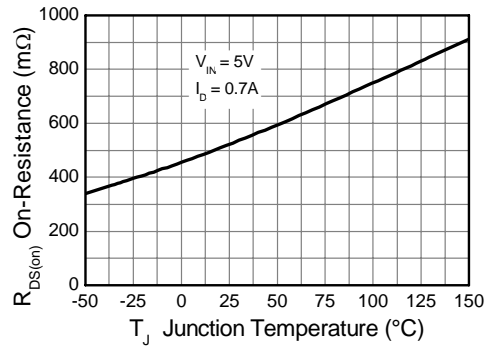
Max Ambient Temperature $T_A$	Maximum continuous current $V_{IN}=5V$
25°C at $V_{in}=5V$	1140
70°C at $V_{in}=5V$	915
85°C at $V_{in}=5V$	825
125°C at $V_{in}=5V$	510



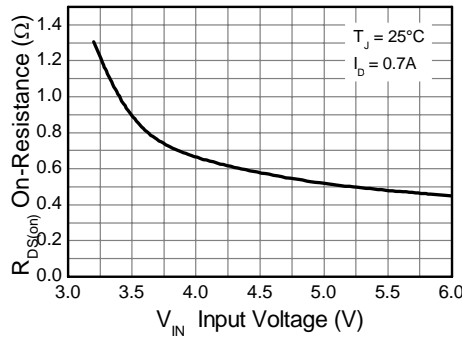
# ZXMS6001N3



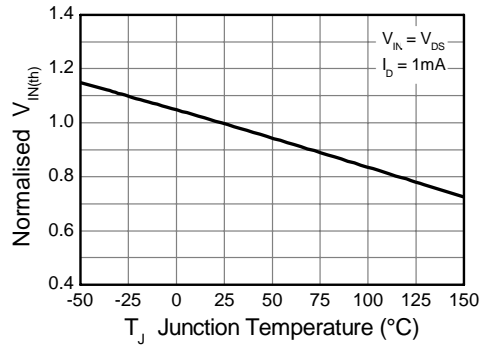
**Typical Output Characteristic**



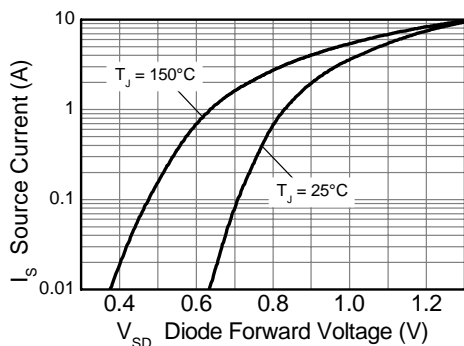
**On-state Resistance vs Temperature**



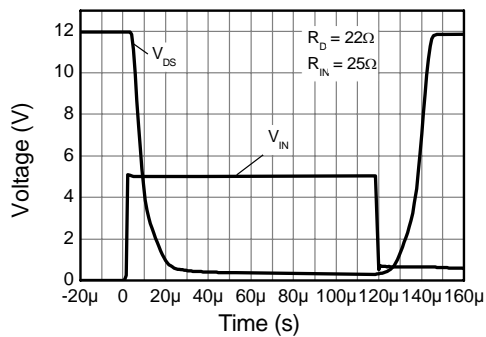
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**



**Source-Drain Diode Forward Voltage**

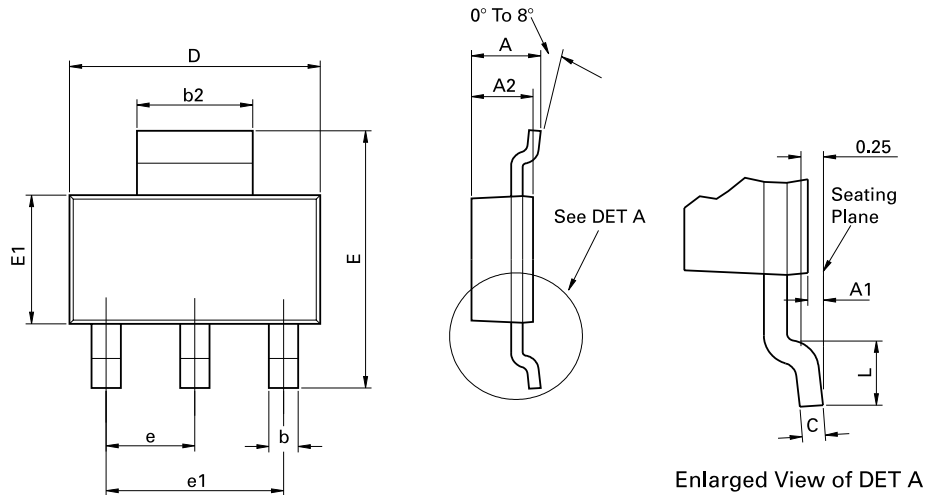


**Switching Speed**



# ZXMS6001N3

## 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	D	6.30	6.70	0.248	0.264
A1	0.02	0.10	0.0008	0.004	e	2.30 BSC		0.0905 BSC	
A2	1.55	1.65	0.0610	0.0649	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	-

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

# ZXMS6001N3

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"Not recommended for new designs"	Device is still in production to support existing designs and production
"Obsolete"	Production has been discontinued

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