

## ZXMS6004FF

### 60V N-channel self protected enhancement mode Intellifet MOSFET

#### Summary

Continuous drain source voltage	60 V
On-state resistance	500 mΩ
Nominal load current ( $V_{IN} = 5V$ )	1.3 A
Clamping energy	90mJ



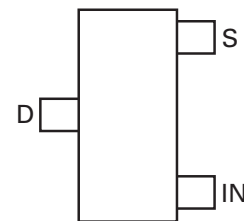
SOT23F

#### Description

The ZXMS6004FF is a self protected low side MOSFET with logic level input. It integrates over-temperature, over-current, over-voltage (active clamp) and ESD protected logic level functionality. The ZXMS6004FF is ideal as a general purpose switch driven from 3.3V or 5V microcontrollers in harsh environments where standard MOSFETs are not rugged enough.

#### Features

- Compact high power dissipation package
- Low input current
- Logic Level Input (3.3V and 5V)
- Short circuit protection with auto restart
- Over voltage protection (active clamp)
- Thermal shutdown with auto restart
- Over-current protection
- Input Protection (ESD)
- High continuous current rating



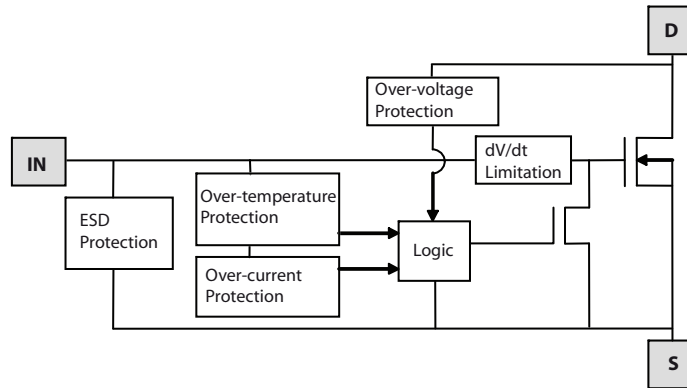
Pinout - top view

#### Ordering information

Device	Part mark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXMS66004FFTA	1K6	7	12 embossed	3,000 units

# ZXMS6004FF

## Functional block diagram



## Application 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  $V_{\text{DS}}$  to minimise on state power dissipation. The maximum 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 product's ability to self-protect at low  $V_{\text{DS}}$ .

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## Absolute maximum ratings

Parameter	Symbol	Limit	Unit
Continuous Drain-Source voltage	$V_{DS}$	60	V
Drain-Source voltage for short circuit protection	$V_{DS(SC)}$	36	V
Continuous input voltage	$V_{IN}$	-0.5 ... +6	V
Continuous input current -0.2V ≤ $V_{IN}$ ≤ 6V $V_{IN} < -0.2V$ or $V_{IN} > 6V$	$I_{IN}$	No limit $ I_{IN}  \leq 2$	mA
Operating temperature range	$T_j$	-40 to +150	°C
Storage temperature range	$T_{stg}$	-55 to +150	°C
Power dissipation at $T_A = 25^\circ\text{C}$ (a)	$P_D$	0.83	W
Linear derating factor		6.66	mW/°C
Power dissipation at $T_A = 25^\circ\text{C}$ (b)	$P_D$	1.5	W
Linear derating factor		12.0	mW/°C
Pulsed drain current @ $V_{IN} = 3.3V$	$I_{DM}$	2	A
Pulsed drain current @ $V_{IN} = 5V$	$I_{DM}$	2.5	A
Continuous source current (Body Diode) (a)	$I_S$	1	A
Pulsed source current (Body Diode)	$I_{SM}$	5	A
Unclamped single pulse inductive energy, $T_j = 25^\circ\text{C}$ , $I_D = 0.5A$ , $V_{DD} = 24V$	$E_{AS}$	90	mJ
Electrostatic discharge (Human body model)	$V_{ESD}$	4000	V
Charged device model	$V_{CDM}$	1000	V

## Thermal resistance

Parameter	Symbol	Value	Unit
Junction to ambient (a)	$R_{\theta JA}$	150	°C/W
Junction to ambient (b)	$R_{\theta JA}$	83	°C/W
Junction to case (c)	$R_{\theta JC}$	44	°C/W

### NOTES

(a) For a device surface mounted on a 15mm x 15mm single sided 1oz weight copper on 1.6mm FR4 board, in still air conditions.

(b) For a device surface mounted on 50mm x 50mm single sided 2oz weight copper on 1.6mm FR4 board in still air conditions.

(c) Thermal resistance from junction to the mounting surface of the drain pin.

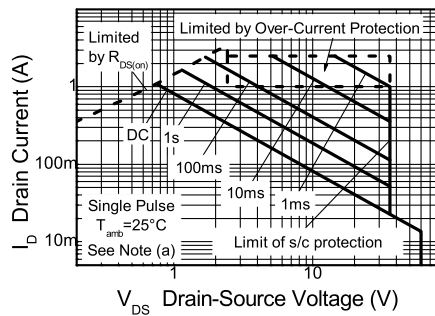
# ZXMS6004FF

## Recommended operating conditions

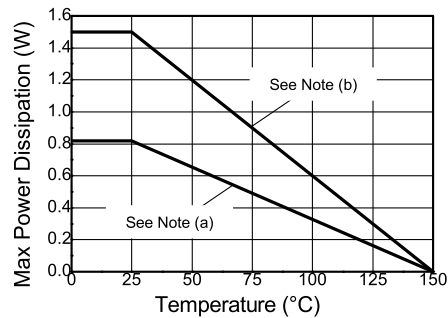
The ZXMS6004FF is optimised for use with  $\mu\text{C}$  operating from 3.3V and 5V supplies.

Symbol	Description	Min	Max	Units
$V_{IN}$	Input voltage range	0	5.5	V
$T_A$	Ambient temperature range	-40	125	$^{\circ}\text{C}$
$V_{IH}$	High level input voltage for MOSFET to be on	3	5.5	V
$V_{IL}$	Low level input voltage for MOSFET to be off	0	0.7	V
$V_P$	Peripheral supply voltage (voltage to which load is referred)	0	36	V

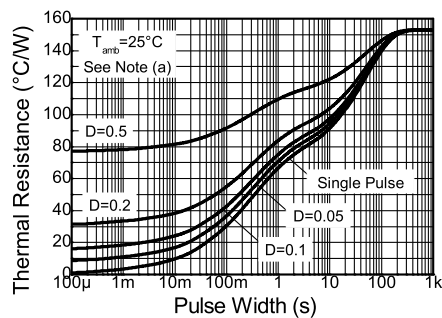
## Characteristics



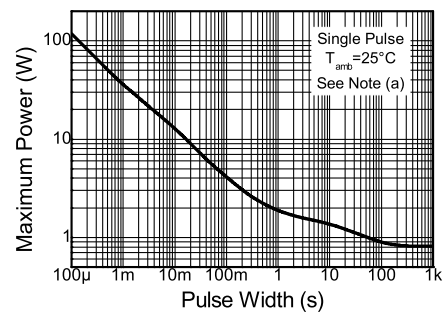
Safe Operating Area



Derating Curve



Transient Thermal Impedance



Pulse Power Dissipation

# ZXMS6004FF

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	65	70	V	$I_D=10\text{mA}$
Off-state drain Ccurrent	$I_{DSS}$			500	nA	$V_{DS}=12\text{V}, V_{IN}=0\text{V}$
Off-state drain current	$I_{DSS}$			1	$\mu\text{A}$	$V_{DS}=36\text{V}, V_{IN}=0\text{V}$
Input threshold voltage	$V_{IN(th)}$	0.7	1	1.5	V	$V_{DS}=V_{GS}, I_D=1\text{mA}$
Input current	$I_{IN}$		60	100	$\mu\text{A}$	$V_{IN}=+3\text{V}$
Input current	$I_{IN}$		120	200	$\mu\text{A}$	$V_{IN}=+5\text{V}$
Input current while over temperature active				220	$\mu\text{A}$	$V_{IN}=+5\text{V}$
Static Drain-Source on-state resistance	$R_{DS(on)}$		400	600	$\text{m}\Omega$	$V_{IN}=+3\text{V}, I_D=0.5\text{A}$
Static Drain-Source on-state resistance	$R_{DS(on)}$		350	500	$\text{m}\Omega$	$V_{IN}=+5\text{V}, I_D=0.5\text{A}$
Continuous drain current <sup>(a)</sup>	$I_D$	0.9			A	$V_{IN}=3\text{V}; T_A=25^{\circ}\text{C}$
Continuous drain cCurrent (a)	$I_D$	1.0			A	$V_{IN}=5\text{V}; T_A=25^{\circ}\text{C}$
Continuous drain current (b)	$I_D$	1.2			A	$V_{IN}=3\text{V}; T_A=25^{\circ}\text{C}$
Continuous drain current (b)	$I_D$	1.3			A	$V_{IN}=5\text{V}; T_A=25^{\circ}\text{C}$
Current limit	$I_{D(LIM)}$	0.7	1.7		A	$V_{IN}=+3\text{V},$
Current limit (c)	$I_{D(LIM)}$	1	2.2		A	$V_{IN}=+5\text{V}$
<b>Dynamic characteristics</b>						
Turn-on delay time	$t_{d(on)}$		5		$\mu\text{s}$	$V_{DD}=12\text{V}, I_D=0.5\text{A},$ $V_{GS}=5\text{V}$
Rise time	$t_r$		10		$\mu\text{s}$	
Turn-off delay time	$t_{d(off)}$		45		$\mu\text{s}$	
Fall time	$f_f$		15		$\mu\text{s}$	

**Notes:**

(d) The drain current is restricted only when the device is in saturation (see graph 'typical output characteristic'). This allows the device to be used in the fully on state without interference from the current limit. The device is fully protected at all drain currents, as the low power dissipation generated outside saturation makes current limit unnecessary.

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## Electrical characteristics - continued

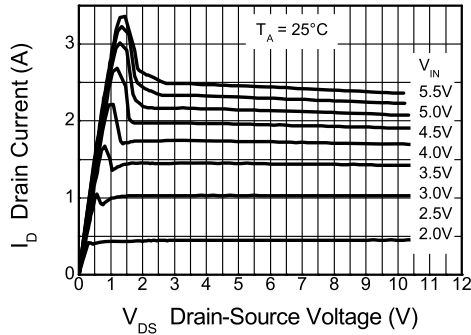
Parameter	Symbol	Min	Typ	Max	Unit	Conditions
<b>Over-temperature protection</b>						
Thermal overload trip temperature <sup>(a)</sup>	TJT	150	175		°C	
Thermal hysteresis <sup>(a)</sup>			10		°C	

**Note:**

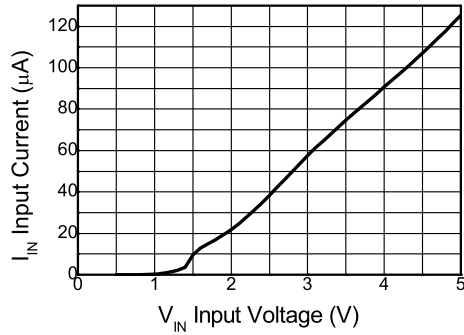
(a) Over-temperature protection is designed to prevent device destruction under fault conditions. Fault conditions are considered as "outside" normal operating range, so this part is not designed to withstand over-temperature for extended periods..

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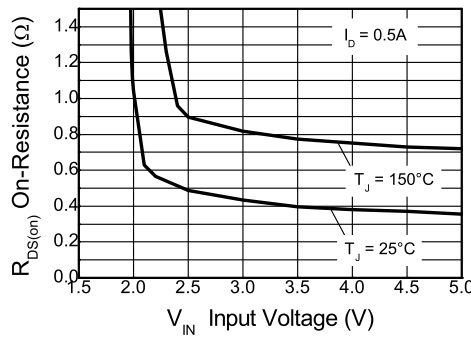
## Typical characteristics



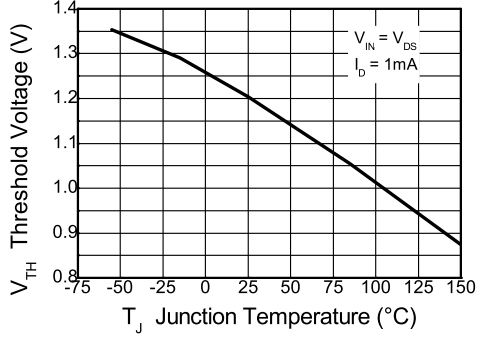
Typical Output Characteristic



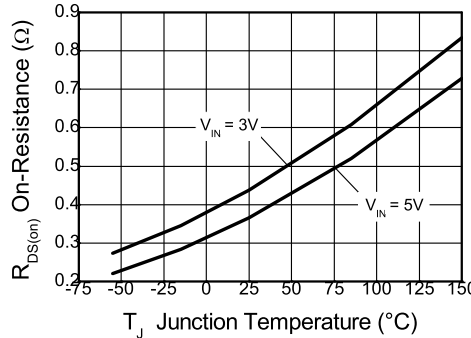
Input Current vs Input Voltage



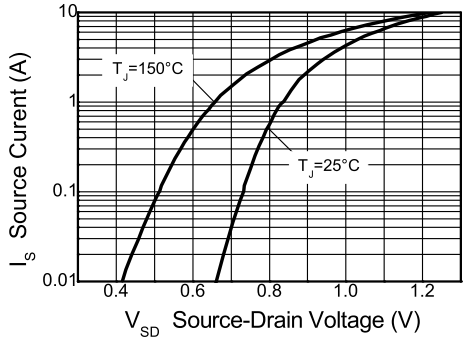
On-Resistance vs Input Voltage



Threshold Voltage vs Temperature

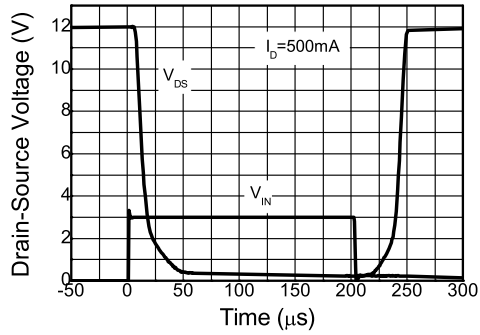


On-Resistance vs Temperature

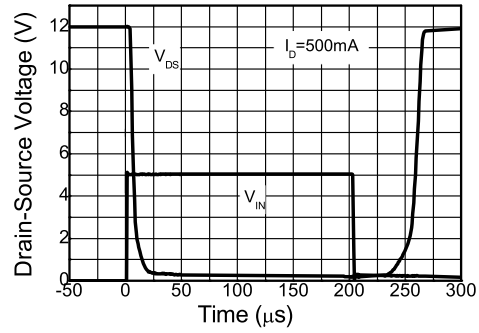


Reverse Diode Characteristic

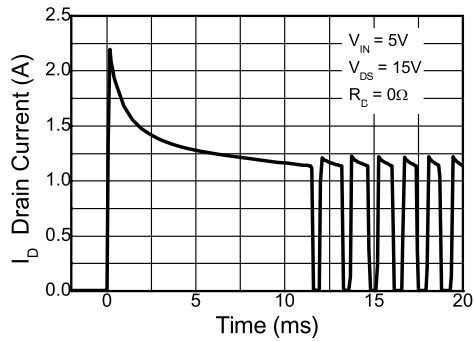
# ZXMS6004FF



**Switching Speed**



**Switching Speed**

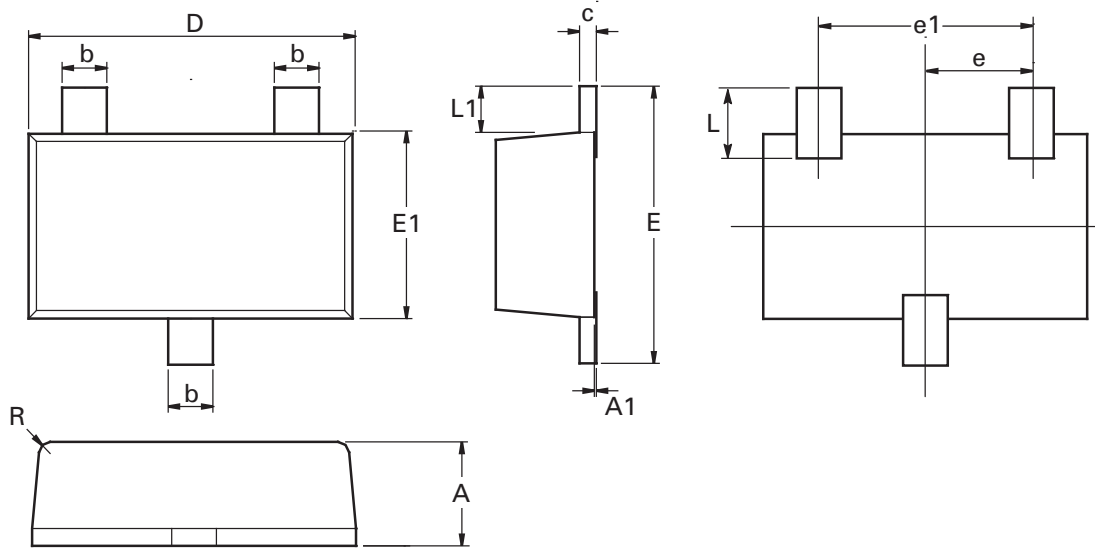


**Typical Short Circuit Protection**



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## Package information - SOT23F



Dim.	Millimeters		Inches		Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
A	0.80	1.00	0.0315	0.0394	E	2.30	2.50	0.0906	0.0984
A1	0.00	0.10	0.00	0.0043	E1	1.50	1.70	0.0590	0.0669
b	0.35	0.45	0.0153	0.0161	L	0.48	0.68	0.0189	0.0268
c	0.10	0.20	0.0043	0.0079	L1	0.30	0.50	0.0153	0.0161
D	2.80	3.00	0.1102	0.1181	R	0.05	0.15	0.0019	0.0059
e	0.95 ref		0.0374 ref		O	0°	12°	0°	12°
e1	1.80	2.00	0.0709	0.0787	-	-	-	-	-

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

# ZXMS6004FF

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or

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"Active"	Product status recommended for new designs
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