

## Product Summary

• Continuous Drain Source Voltage	60V
• On-State Resistance	500mΩ
• Nominal Load Current (V <sub>IN</sub> = 5V)	1.3A
• Clamping Energy	90mJ

## 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.

## Applications

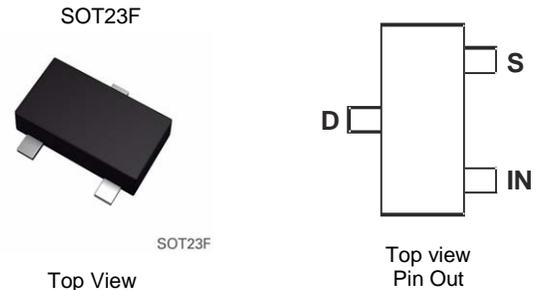
- Especially suited for loads with a high in-rush current such as lamps and motors
- All types of resistive, inductive and capacitive loads in switching applications
- μC compatible power switch for 12V and 24V DC applications
- Automotive rated
- Replaces electromechanical relays and discrete circuits
- Linear Mode capability - the current-limiting protection circuitry is designed to de-activate at low V<sub>DS</sub> to minimize 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<sub>DS</sub>

## Features and Benefits

- 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
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **Qualified to AEC-Q101 Standards for High Reliability**

## Mechanical Data

- Case: SOT-23F
- 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
- Weight: 0.012 grams (Approximate)

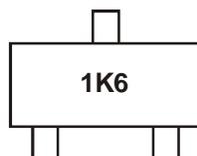


## Ordering Information (Note 4)

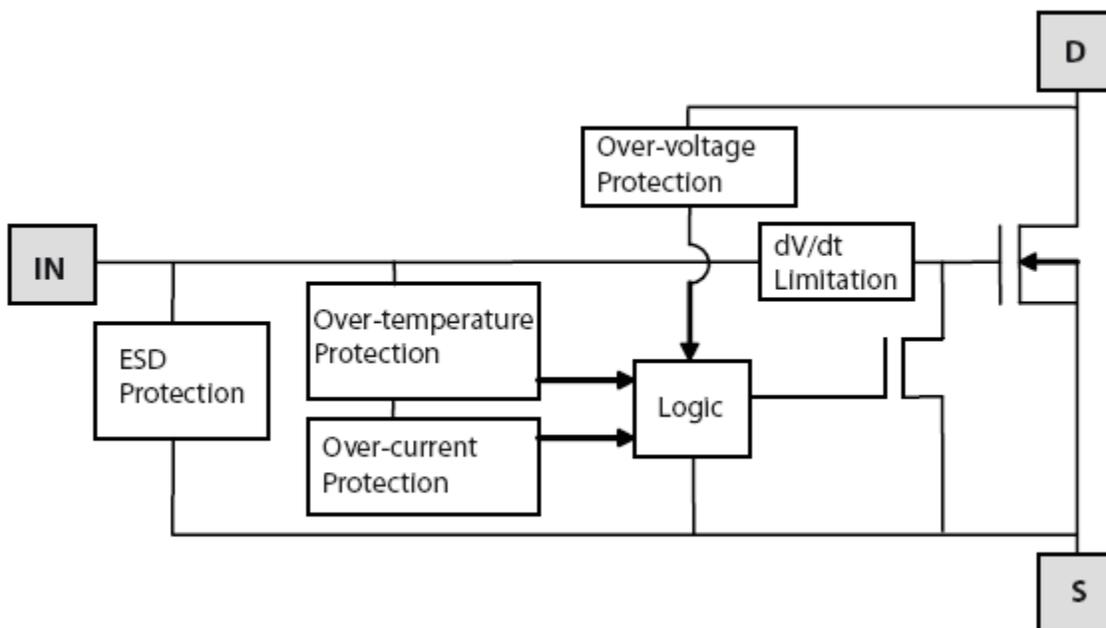
Product	Marking	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXMS6004FFTA	1K6	7	12	3,000

- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) 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.
  4. For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

## Marking Information



1K6 = Product type Marking Code

**Functional Block Diagram**

**Maximum Ratings** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Units
Continuous Drain-Source Voltage	V <sub>DS</sub>	60	V
Drain-Source Voltage for Short Circuit Protection	V <sub>DS(SC)</sub>	36	V
Continuous Input Voltage	V <sub>IN</sub>	-0.5 to +6	V
Continuous Input Current @ -0.2V ≤ V <sub>IN</sub> ≤ 6V	I <sub>IN</sub>	No limit	mA
Continuous Input Current @ V <sub>IN</sub> < -0.2V or V <sub>IN</sub> > 6V	I <sub>IN</sub>	I <sub>IN</sub>   ≤ 2	mA
Pulsed Drain Current @ V <sub>IN</sub> = 3.3V	I <sub>DM</sub>	2	A
Pulsed Drain Current @ V <sub>IN</sub> = 5V	I <sub>DM</sub>	2.5	A
Continuous Source Current (Body Diode) (Note 5)	I <sub>S</sub>	1	A
Pulsed Source Current (Body Diode)	I <sub>SM</sub>	5	A
Unclamped Single Pulse Inductive Energy, T <sub>J</sub> = +25°C, I <sub>D</sub> = 0.5A, V <sub>DD</sub> = 24V	E <sub>AS</sub>	90	mJ
Electrostatic Discharge (Human Body Model)	V <sub>ESD</sub>	4000	V
Charged Device Model	V <sub>CDM</sub>	1000	V

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

Characteristic	Symbol	Value	Units
Power Dissipation at T <sub>A</sub> = +25°C (Note 5)	P <sub>D</sub>	0.83	W
Linear Derating Factor		6.66	mW/°C
Power Dissipation at T <sub>A</sub> = +25°C (Note 6)	P <sub>D</sub>	1.5	W
Linear Derating Factor		12.0	mW/°C
Thermal Resistance, Junction to Ambient (Note 5)	R <sub>θJA</sub>	150	°C/W
Thermal Resistance, Junction to Ambient (Note 6)	R <sub>θJA</sub>	83	°C/W
Thermal Resistance, Junction to Case (Note 7)	R <sub>θJC</sub>	44	°C/W
Operating Temperature Range	T <sub>J</sub>	-40 to +150	°C
Storage Temperature Range	T <sub>STG</sub>	-55 to +150	°C

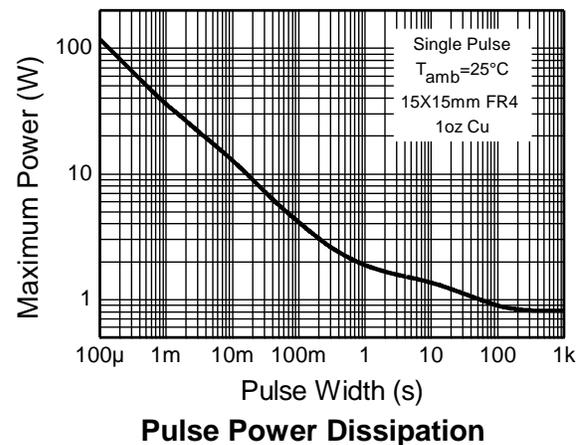
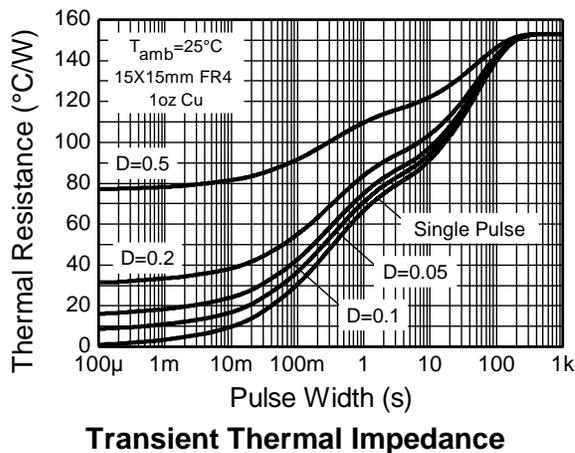
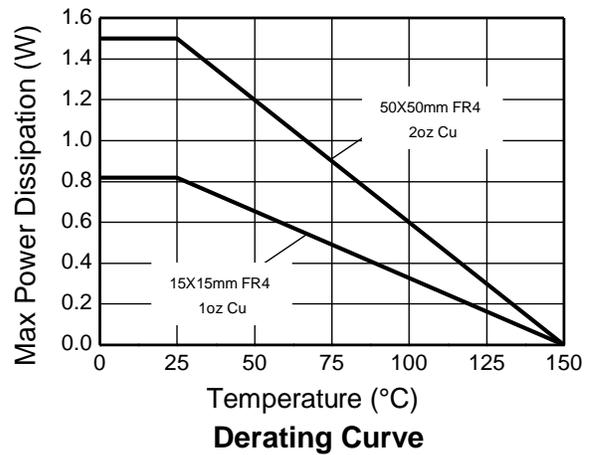
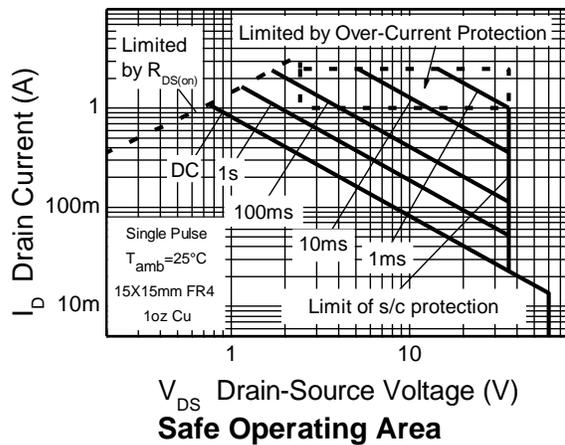
- Notes:
- For a device surface mounted on 15mm x 15mm single sided, 1oz weight copper on 1.6mm FR4 board, in still air conditions.
  - For a device surface mounted on 50mm x 50mm single sided, 2oz weight copper on 1.6mm FR4 board, in still air conditions.
  - Thermal resistance from junction and the mounting surfaces of the drain pins.

## Recommended Operating Conditions

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

Characteristic	Symbol	Min	Max	Unit
Input Voltage Range	$V_{\text{IN}}$	0	5.5	V
Ambient Temperature Range	$T_{\text{A}}$	-40	+125	$^{\circ}\text{C}$
High Level Input Voltage for MOSFET to be On	$V_{\text{IH}}$	3	5.5	V
Low Level Input Voltage for MOSFET to be Off	$V_{\text{IL}}$	0	0.7	V
Peripheral Supply Voltage (voltage to which load is referred)	$V_{\text{P}}$	0	36	V

## Thermal Characteristics

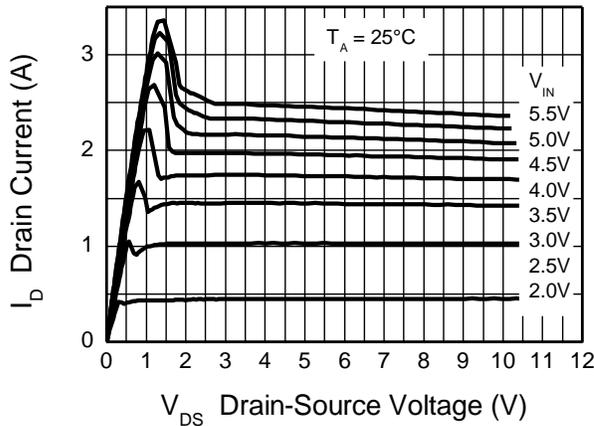


**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

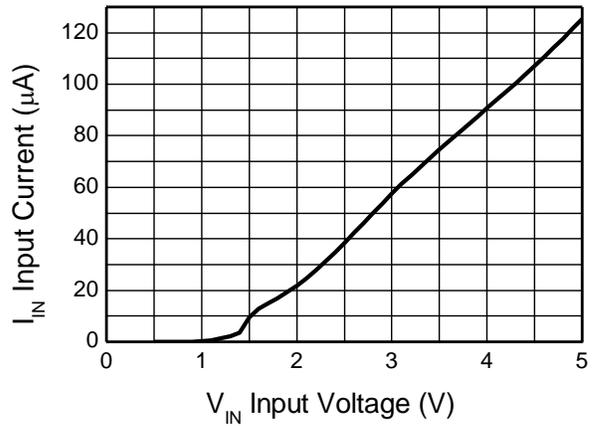
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
<b>Static Characteristics</b>						
Drain-Source Clamp Voltage	V <sub>DS(AZ)</sub>	60	65	70	V	I <sub>D</sub> = 10mA
Off State Drain Current	I <sub>DSS</sub>	—	—	500	nA	V <sub>DS</sub> = 12V, V <sub>IN</sub> = 0V
		—	—	1	μA	V <sub>DS</sub> = 36V, V <sub>IN</sub> = 0V
Input Threshold Voltage	V <sub>IN(th)</sub>	0.7	1	1.5	V	V <sub>DS</sub> = V <sub>GS</sub> , I <sub>D</sub> = 1mA
Input Current	I <sub>IN</sub>	—	60	100	μA	V <sub>IN</sub> = +3V
		—	120	200		V <sub>IN</sub> = +5V
Input Current While Over Temperature Active	—	—	—	220	μA	V <sub>IN</sub> = +5V
Static Drain-Source On-State Resistance	R <sub>DS(on)</sub>	—	400	600	mΩ	V <sub>IN</sub> = +3V, I <sub>D</sub> = 0.5A
		—	350	500		V <sub>IN</sub> = +5V, I <sub>D</sub> = 0.5A
Continuous Drain Current (Note 5)	I <sub>D</sub>	0.9	—	—	A	V <sub>IN</sub> = 3V; T <sub>A</sub> = +25°C
Continuous Drain Current (Note 6)		1.0	—	—		V <sub>IN</sub> = 5V; T <sub>A</sub> = +25°C
		1.2	—	—		V <sub>IN</sub> = 3V; T <sub>A</sub> = +25°C
		1.3	—	—		V <sub>IN</sub> = 5V; T <sub>A</sub> = +25°C
Current Limit (Note 8)	I <sub>D(LIM)</sub>	0.7	1.7	—	A	V <sub>IN</sub> = +3V
		1	2.2	—		V <sub>IN</sub> = +5V
<b>Dynamic Characteristics</b>						
Turn On Delay Time	t <sub>d(on)</sub>	—	5	—	μs	V <sub>DD</sub> = 12V, I <sub>D</sub> = 0.5A, V <sub>GS</sub> = 5V
Rise Time	t <sub>r</sub>	—	10	—		
Turn Off Delay Time	t <sub>d(off)</sub>	—	45	—		
Fall Time	t <sub>f</sub>	—	15	—		
<b>Over-Temperature Protection</b>						
Thermal Overload Trip Temperature (Note 9)	T <sub>JT</sub>	+150	+175	—	°C	—
Thermal Hysteresis (Note 9)	f <sub>t</sub>	—	+10	—	°C	—

- Notes:
- The drain current is restricted only when the device is in saturation (see graph 'typical output characteristic'). This allows the device to be used fully in the 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.
  - 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.

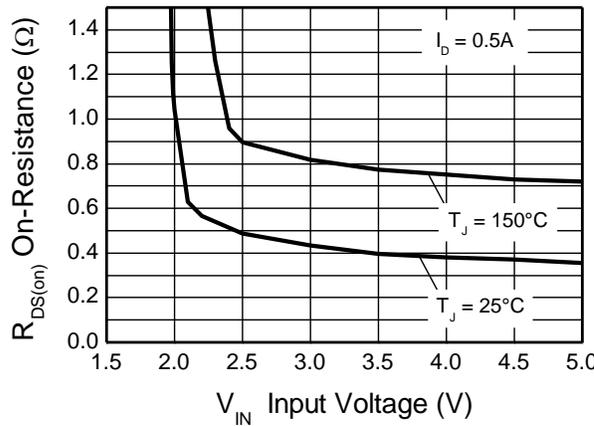
**Typical Characteristics**



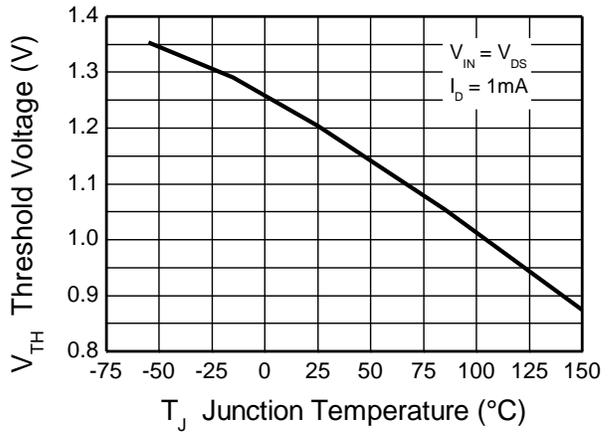
**Typical Output Characteristic**



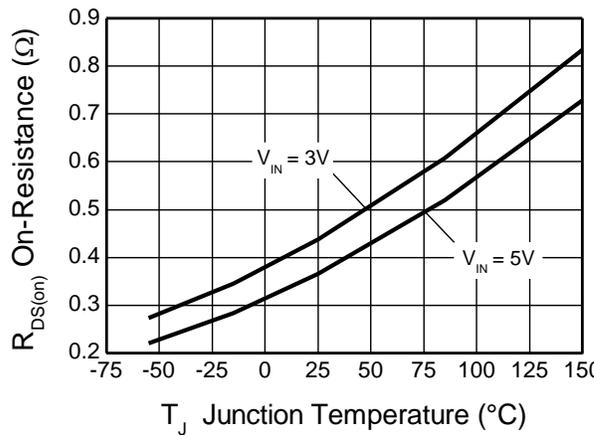
**Input Current vs Input Voltage**



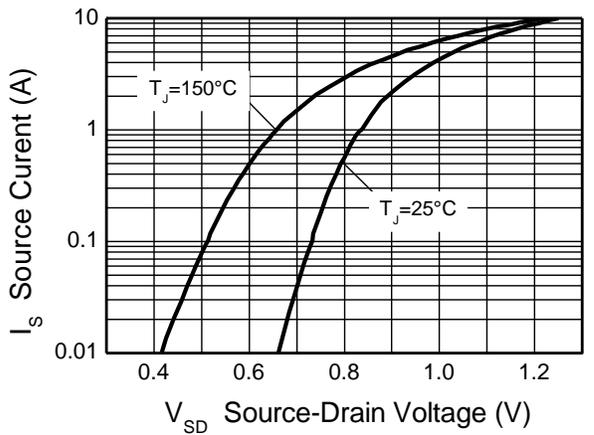
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**

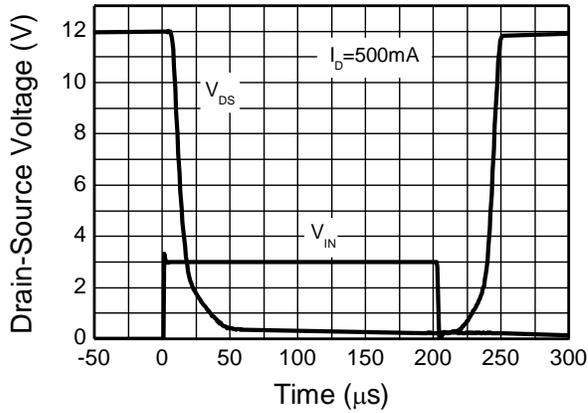


**On-Resistance vs Temperature**

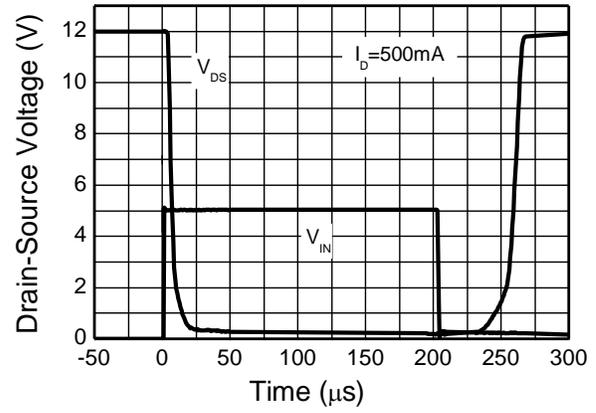


**Reverse Diode Characteristic**

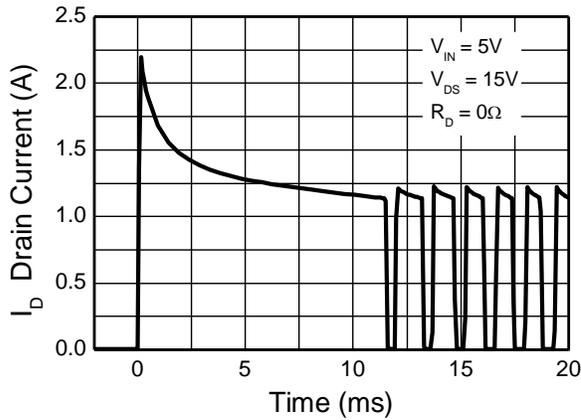
**Typical Characteristics (cont.)**



**Switching Speed**



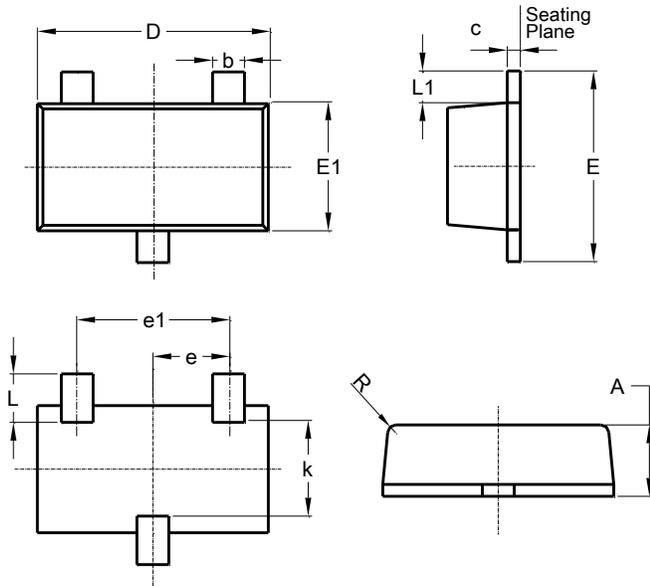
**Switching Speed**



**Typical Short Circuit Protection**

## Package Outline Dimensions

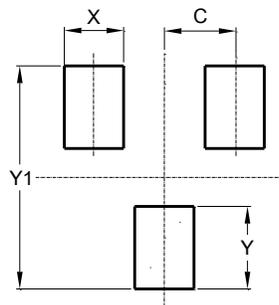
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.



SOT23F			
Dim	Min	Max	Typ
A	0.80	1.00	0.90
b	0.35	0.45	0.40
c	0.06	0.16	0.11
D	2.80	3.00	2.90
e	-	-	0.95
e1	-	-	1.90
E	2.30	2.50	2.40
E1	1.50	1.70	1.60
k	1.10	1.26	1.18
L	0.48	0.68	0.58
L1	0.39	0.41	0.40
R	0.05	0.15	0.10
All Dimensions in mm			

## Suggested Pad Layout

Please see AP02001 at <http://www.diodes.com/datasheets/ap02001.pdf> for the latest version.



Dimensions	Value (in mm)
C	0.95
X	0.80
Y	1.110
Y1	3.000

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