

## Product Summary

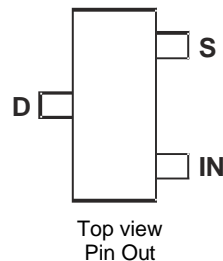
- Continuous Drain Source Voltage: 60V
- On-State Resistance: 500mΩ
- Nominal Load Current ( $V_{IN} = 5V$ ): 1.3A
- Clamping Energy: 90mJ

## Description

The ZXMS6004FFQ is a self-protected low side IntelliFET™ MOSFET with logic level input. It integrates overtemperature, overcurrent, overvoltage (active clamp) and ESD protected logic level functionality. The ZXMS6004FFQ 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
- $\mu$ 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  $V_{DS}$  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  $V_{DS}$ .



## Features and Benefits

- Compact High Power Dissipation Package
- Low Input Current
- Logic Level Input (3.3V and 5V)
- Short Circuit Protection with Auto Restart
- Overvoltage Protection (Active Clamp)
- Thermal Shutdown with Auto Restart
- Overcurrent 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**
- **PPAP Capable (Note 4)**

## Mechanical Data

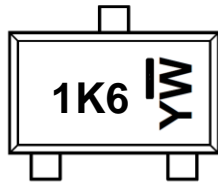
- Case: SOT23F
- Case Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Matte Tin Finish  $\text{Ⓜ}$
- Weight: 0.012 grams (Approximate)

## Ordering Information (Note 5)

Product	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
ZXMS6004FFQTA	1K6	7	12	3,000

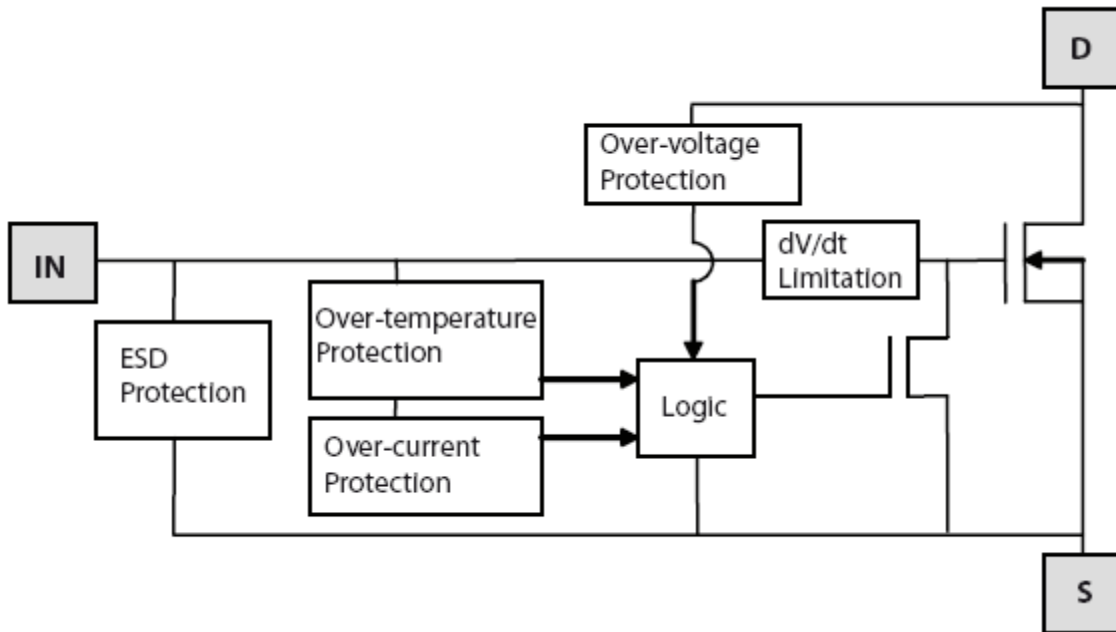
- Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
  2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "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. Automotive products are AEC-Q10x qualified and are PPAP capable. Refer to [http://www.diodes.com/quality/product\\_compliance\\_definitions/](http://www.diodes.com/quality/product_compliance_definitions/).
  5. For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

**Marking Information**



Y: Year: 0~9  
 W: Week: A-Z : 1~26  
 a-z: 27~52  
 z: Represents 52 & 53 Week  
 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 ... +6	V
Continuous Input Current @ -0.2V ≤ V <sub>IN</sub> ≤ 6V	I <sub>IN</sub>	No limit  I <sub>IN</sub>   ≤ 2	mA
Continuous Input Current @ V <sub>IN</sub> < -0.2V or V <sub>IN</sub> > 6V			
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)	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>	4,000	V
Charged Device Model	V <sub>CDM</sub>	1,000	V

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

Characteristic	Symbol	Value	Units
Power Dissipation @T <sub>A</sub> = +25°C (Note 6)	P <sub>D</sub>	0.83	W
Linear Derating Factor		6.66	mW/°C
Power Dissipation @T <sub>A</sub> = +25°C (Note 7)	P <sub>D</sub>	1.5	W
Linear Derating Factor		12.0	mW/°C
Thermal Resistance, Junction to Ambient (Note 6)	R <sub>θJA</sub>	150	°C/W
Thermal Resistance, Junction to Ambient (Note 7)	R <sub>θJA</sub>	83	°C/W
Thermal Resistance, Junction to Case (Note 8)	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

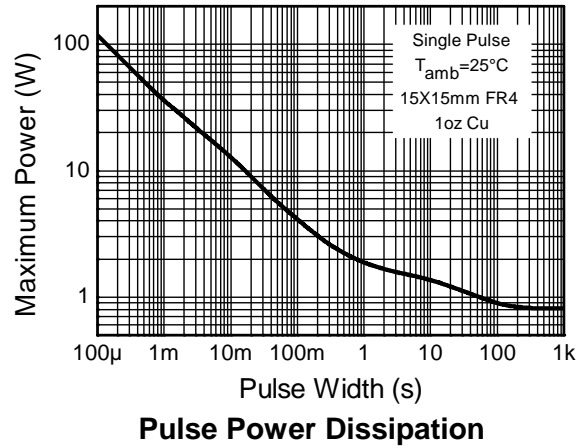
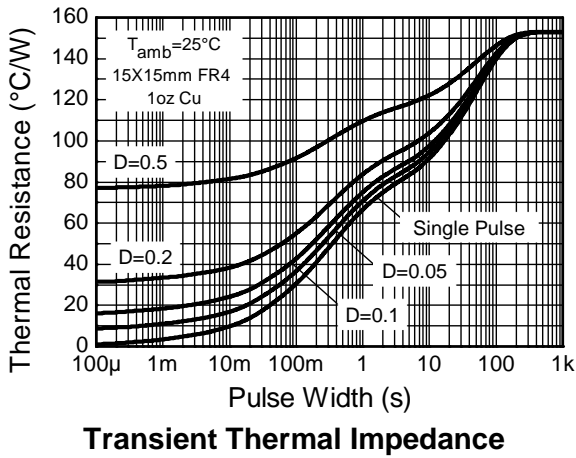
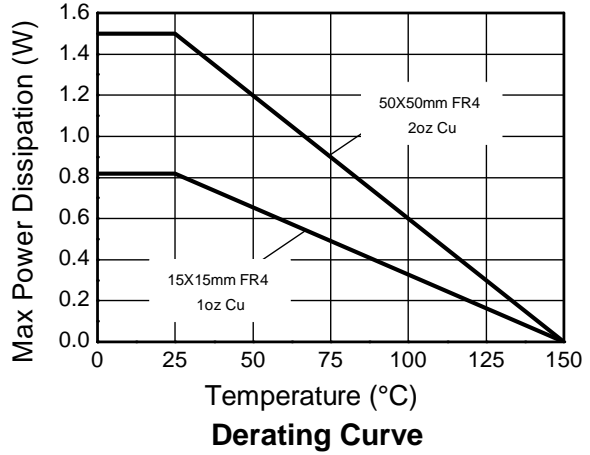
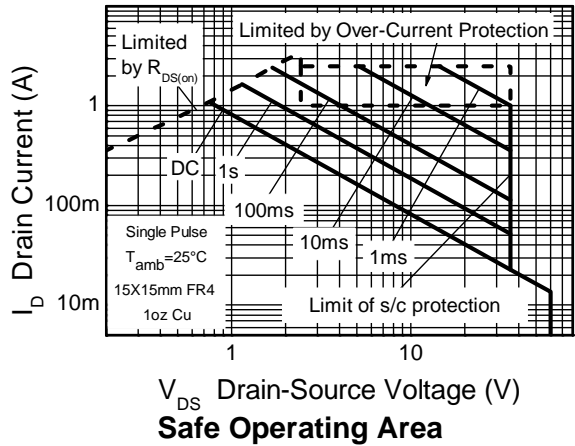
- Notes:
6. For a device surface mounted on 15mm x 15mm single sided, 1oz weight copper on 1.6mm FR4 board, in still air conditions.
  7. For a device surface mounted on 50mm x 50mm single sided, 2oz weight copper on 1.6mm FR4 board, in still air conditions.
  8. Thermal resistance from junction and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

**Recommended Operating Conditions**

The ZXMS6004FF is optimized for use with μC operating from 3.3V and 5V supplies.

Characteristic	Symbol	Min	Max	Unit
Input Voltage Range	V <sub>IN</sub>	0	5.5	V
Ambient Temperature Range	T <sub>A</sub>	-40	+125	°C
High Level Input Voltage for MOSFET to be On	V <sub>IH</sub>	3	5.5	V
Low Level Input Voltage for MOSFET to be Off	V <sub>IL</sub>	0	0.7	V
Peripheral Supply Voltage (Voltage to which Load is Referred)	V <sub>P</sub>	0	36	V

**Typical Thermal Characteristics**

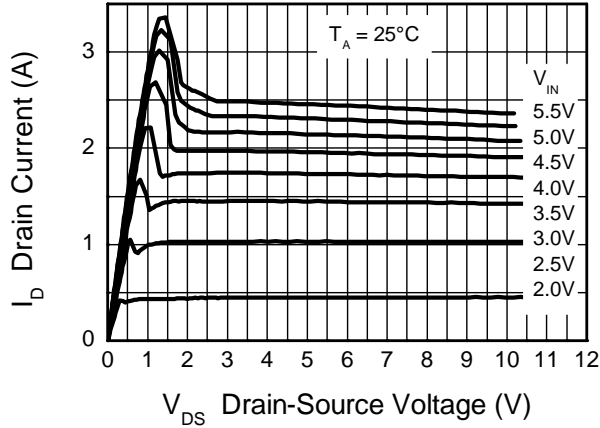


**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

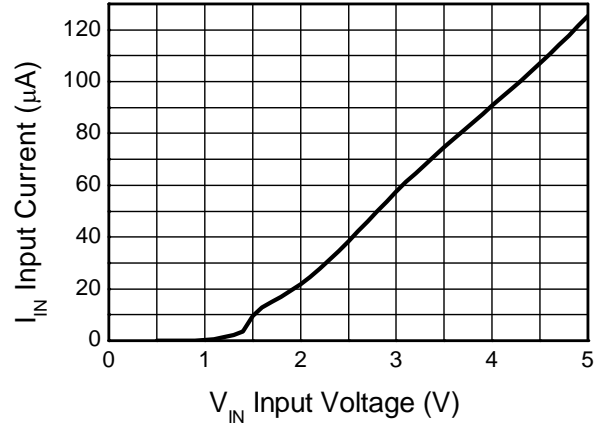
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
<b>Static Characteristics</b>						
Drain-Source Clamp Voltage	V <sub>DS(AZ)</sub>	60	65	70	V	I <sub>D</sub> = 10mA
Off-State Drain Current	I <sub>DSS</sub>	—	—	500	nA	V <sub>DS</sub> = 12V, V <sub>IN</sub> = 0V
		—	—	1	μA	V <sub>DS</sub> = 36V, V <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 Overtemperature 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 6)	I <sub>D</sub>	0.9	—	—	A	V <sub>IN</sub> = 3V; T <sub>A</sub> = +25°C
		1.0	—	—		V <sub>IN</sub> = 5V; T <sub>A</sub> = +25°C
Continuous Drain Current (Note 7)		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 9)	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>Overtemperature Protection</b>						
Thermal Overload Trip Temperature (Note 10)	T <sub>JT</sub>	+150	+175	—	°C	—
Thermal Hysteresis (Note 10)	f <sub>F</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 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.
  - Overtemperature 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.

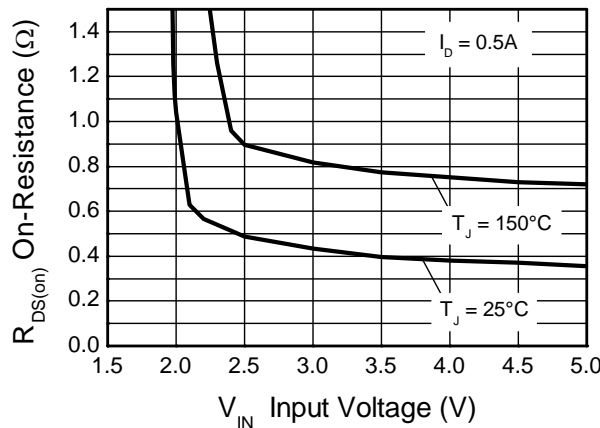
**Typical Performance Characteristics**



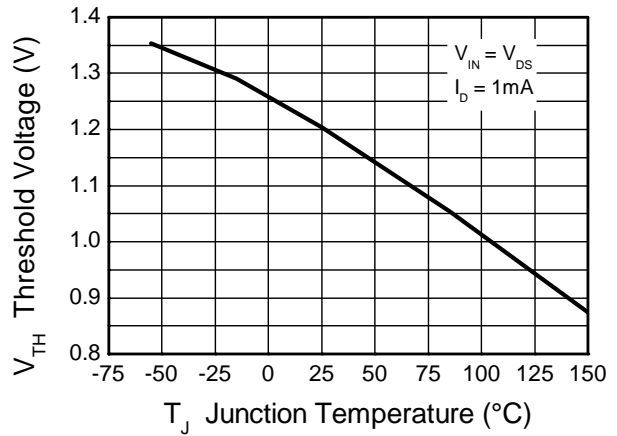
**Typical Output Characteristic**



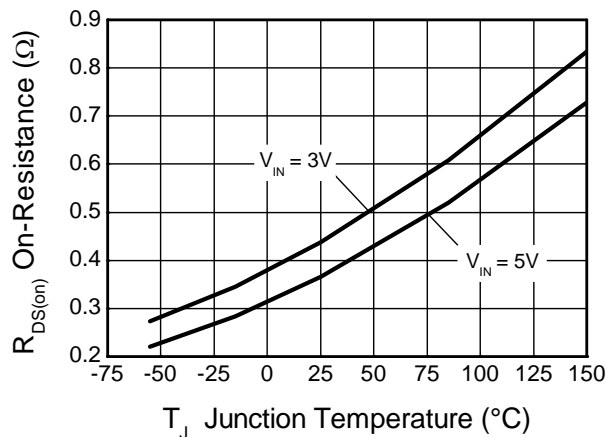
**Input Current vs Input Voltage**



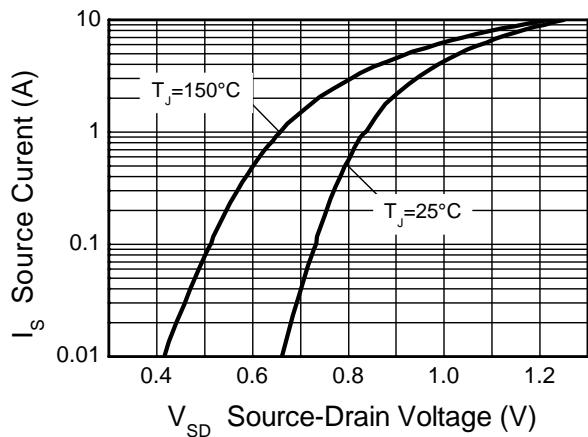
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**

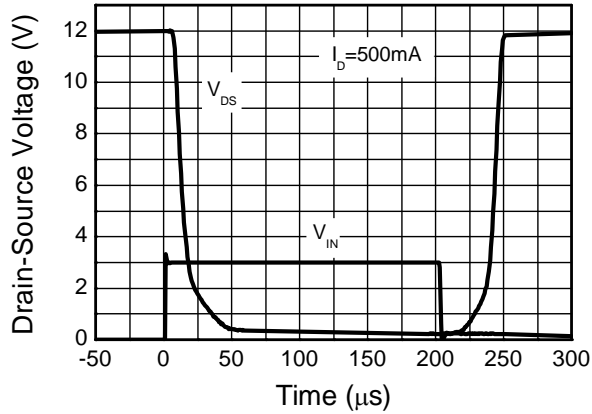


**On-Resistance vs Temperature**

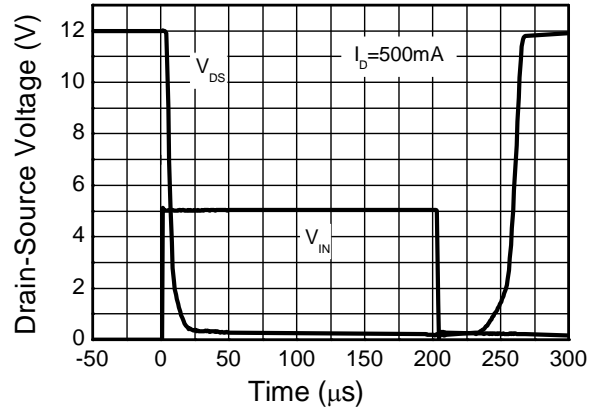


**Reverse Diode Characteristic**

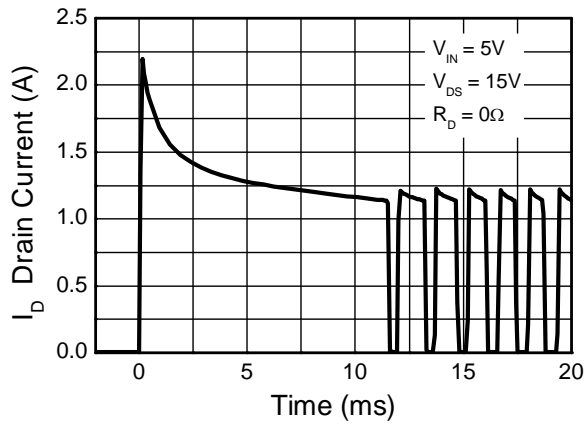
**Typical Performance Characteristics** (continued)



**Switching Speed**



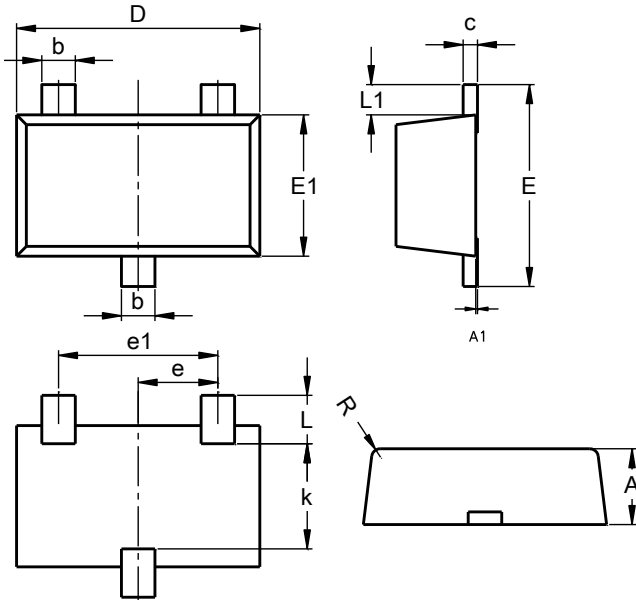
**Switching Speed**



**Typical Short Circuit Protection**

**Package Outline Dimensions**

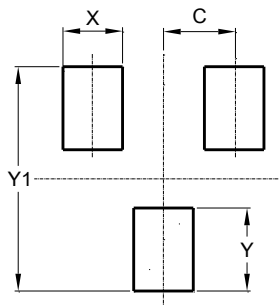
Please see AP02001 at [http://www.diodes.com/\\_files/datasheets/ap02001.pdf](http://www.diodes.com/_files/datasheets/ap02001.pdf) for the latest version.



SOT23F			
Dim	Min	Max	Typ
A	0.80	1.00	0.90
b	0.35	0.50	0.44
c	0.10	0.20	0.16
D	2.80	3.00	2.90
e	0.95 REF		
e1	0.190 REF		
E	2.30	2.50	2.40
E1	1.50	1.70	1.65
k	1.20	-	-
L	0.30	0.65	0.50
L1	0.30	0.50	0.40
R	0.05	0.15	-
All Dimensions in mm			

**Suggested Pad Layout**

Please see AP02001 at [http://www.diodes.com/\\_files/datasheets/ap02001.pdf](http://www.diodes.com/_files/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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