60V N-CHANNEL SELF-PROTECTED ENHANCEMENT MODE IntelliFET MOSFET

Product Summary

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

Description

The ZXMS6004FF 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 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 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)**
- **This part is qualified to JEDEC standards (as references in AEC-Q) for High Reliability. https://www.diodes.com/quality/product-definitions/**
- **An automotive-compliant part is available under a separate datasheet (ZXMS6004FFQ)**

Applications

- Especially suited for loads with a high inrush current such as lamps and motors
- All types of resistive, inductive and capacitive loads in switching applications
- µC compatible power switches for 12V and 24V DC applications
- Automotive rated
- Replaces electromechanical relays and discrete circuits
- Linear mode capabilities – 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}.

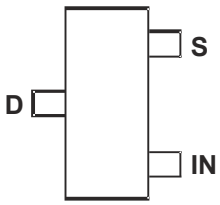
Mechanical Data

- Package: SOT23F
- Package Material: Molded Plastic, "Green" Molding Compound. UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Finish – Matte Tin Plated Leads, Solderable per MIL-STD-202, Method 208 e3
- Weight: 0.012 grams (Approximate)

SOT23F



Top View



Top View
Pinout

Ordering Information (Note 4)

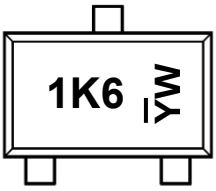
Orderable Part Number	Package	Marking	Reel Size (inches)	Tape Width (mm)	Packing	
					Qty.	Carrier
ZXMS6004FF-7	SOT23F	1K6	7	8	3,000	Reel

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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 https://www.diodes.com/design/support/packaging/diodes-packaging/.

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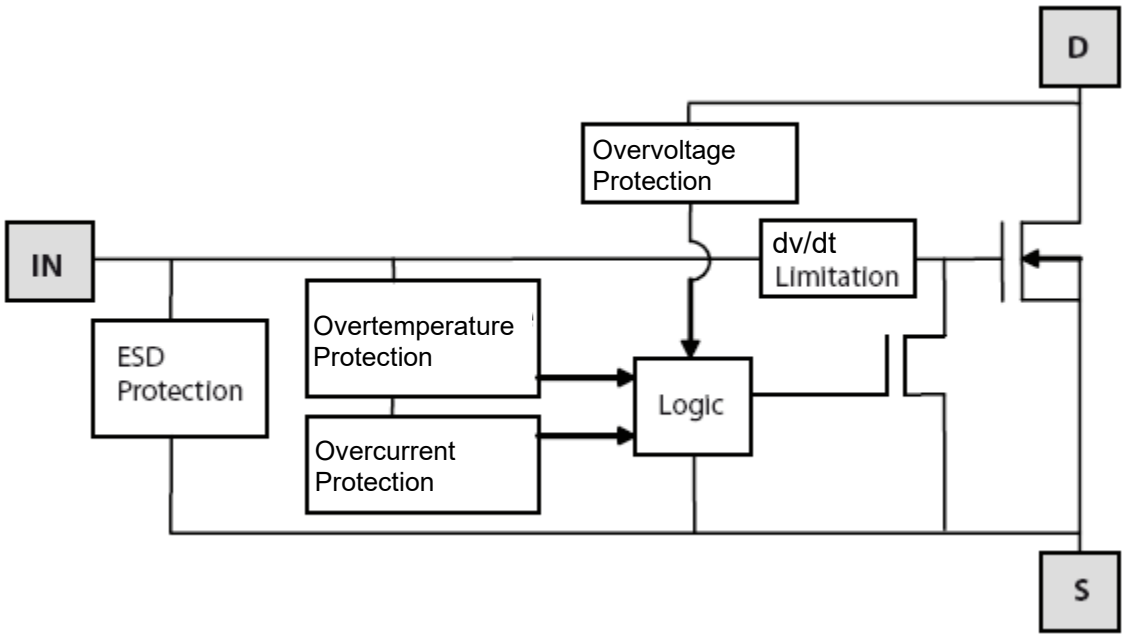
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Marking Information



1K6 = Product Type Marking Code
Y or $\overline{Y}$: Year: 0 to 9 (ex: 6 = 2026)
W or $\overline{W}$: Week: A to Z: Week 1 to 26
a to z: Week 27 to 52
z: Represents Week 52 & 53

Functional Block Diagram



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Absolute Maximum Ratings (@T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	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 to +6	V
Continuous Input Current @-0.2V ≤ V_{IN} ≤ 6V Continuous Input Current @V_{IN} < -0.2V or V_{IN} > 6V	I_{IN}	No Limit $\lvert I_{IN} \rvert \le 2$	mA
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)	I_S	1	A
Pulsed Source Current (Body Diode)	I_{SM}	5	A
Unclamped Single Pulse Inductive Energy T_J = +25°C, I_D = 0.5A, V_{DD} = 24V	E_{AS}	90	mJ
Electrostatic Discharge (Human Body Model)	V_{ESD}	4,000	V
Charged Device Model	V_{CDM}	1,000	V

Thermal Characteristics (@T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Value	Unit
Power Dissipation @T_A = +25°C (Note 5) Linear Derating Factor	P_D	0.83 6.66	W mW/°C
Power Dissipation @T_A = +25°C (Note 6) Linear Derating Factor	P_D	1.5 12.0	W mW/°C
Thermal Resistance, Junction to Ambient (Note 5)	$R_{\theta JA}$	150	°C/W
Thermal Resistance, Junction to Ambient (Note 6)	$R_{\theta JA}$	83	°C/W
Thermal Resistance, Junction to Case (Note 7)	$R_{\theta JC}$	44	°C/W
Operating Temperature Range	T_J	-40 to +150	°C
Storage Temperature Range	T_{STG}	-55 to +150	°C

Recommended Operating Conditions

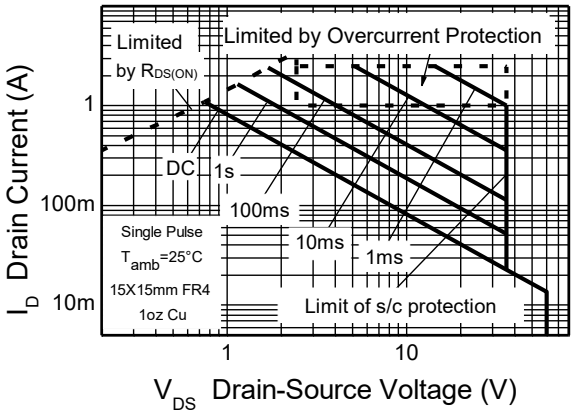
The ZXMS6004FF is optimized for use with µC operating from 3.3V and 5V supplies.

Characteristic	Symbol	Min	Max	Unit
Input Voltage Range	V_{IN}	0	5.5	V
Ambient Temperature Range	T_A	-40	+125	°C
High-Level Input Voltage for MOSFET to be On	V_{IH}	3	5.5	V
Low-Level Input Voltage for MOSFET to be Off	V_{IL}	0	0.7	V
Peripheral Supply Voltage (Voltage to Which Load is Referred)	V_P	0	36	V

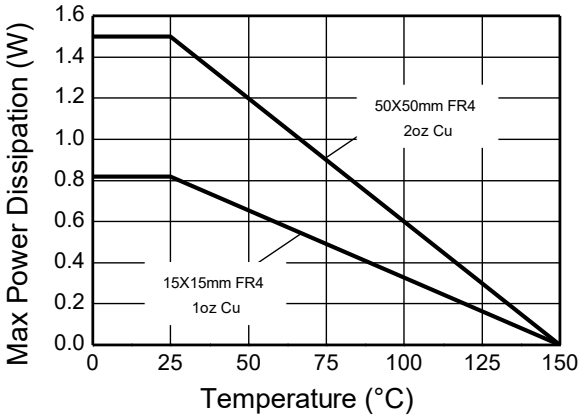
Notes: 5. For a device surface-mounted on 15mm x 15mm single-sided, 1oz weight copper on 1.6mm FR4 board, in still air conditions.
6. For a device surface-mounted on 50mm x 50mm single-sided, 2oz weight copper on 1.6mm FR4 board, in still air conditions.
7. Thermal resistance from junction and the mounting surfaces of the drain pins.

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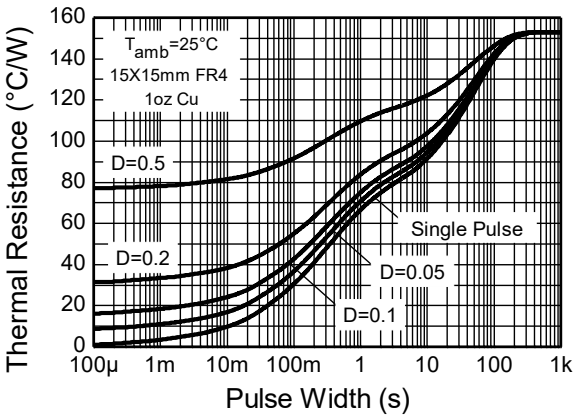
Typical Thermal Characteristics



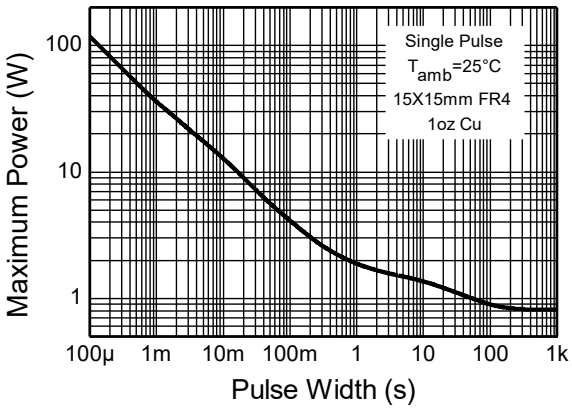
Safe Operating Area



Derating Curve



Transient Thermal Impedance



Pulse Power Dissipation

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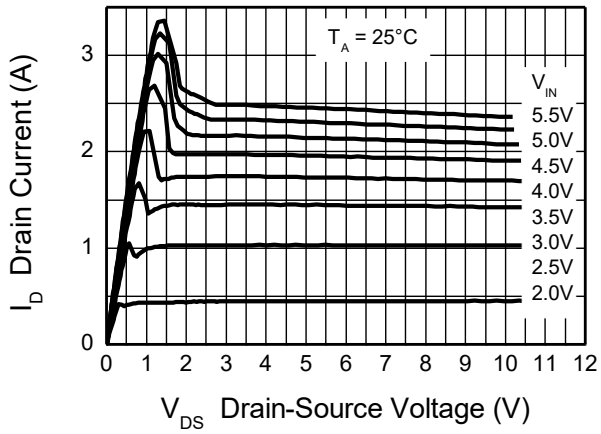
Electrical Characteristics (@T_A = +25°C, unless otherwise specified.)

Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Static Characteristics						
Drain-Source Clamp Voltage	$V_{DS(AZ)}$	60	65	70	V	I_D = 10mA
Off-State Drain Current	I_{DSS}	—	—	500	nA	V_{DS} = 12V, V_{IN} = 0
		—	—	1	µA	V_{DS} = 36V, V_{IN} = 0
Input Threshold Voltage	$V_{IN(TH)}$	0.7	1	1.5	V	V_{DS} = V_{GS}, I_D = 1mA
Input Current	I_{IN}	—	60	100	µA	V_{IN} = +3V
		—	120	200		V_{IN} = +5V
Input Current while Overtemperature Active	—	—	—	220	µA	V_{IN} = +5V
Static Drain-Source On-State Resistance	$R_{DS(ON)}$	—	400	600	mΩ	V_{IN} = +3V, I_D = 0.5A
		—	350	500		V_{IN} = +5V, I_D = 0.5A
Continuous Drain Current (Note 5)	I_D	0.9	—	—	A	V_{IN} = 3V, T_A = +25°C
		1.0	—	—		V_{IN} = 5V, T_A = +25°C
Continuous Drain Current (Note 6)		1.2	—	—		V_{IN} = 3V, T_A = +25°C
		1.3	—	—		V_{IN} = 5V, T_A = +25°C
Current Limit (Note 8)	$I_{D(LIM)}$	0.7	1.7	—	A	V_{IN} = +3V
		1	2.2	—		V_{IN} = +5V
Dynamic Characteristics						
Turn-On Delay Time	$t_{D(ON)}$	—	5	—	µs	V_{DD} = 12V, I_D = 0.5A, V_{GS} = 5V
Rise Time	t_R	—	10	—		
Turn-Off Delay Time	$t_{D(OFF)}$	—	45	—		
Fall Time	t_F	—	15	—		
Overtemperature Protection						
Thermal Overload Trip Temperature (Note 9)	T_{JT}	+150	+175	—	°C	—
Thermal Hysteresis (Note 9)	f_F	—	+10	—	°C	—

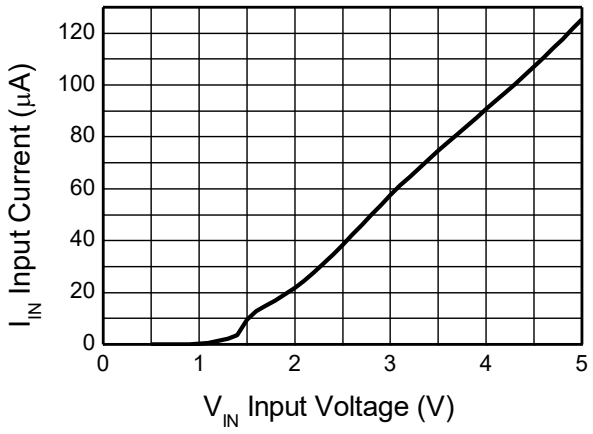
Notes:
5. For a device surface-mounted on 15mm x 15mm single-sided, 1oz weight copper on 1.6mm FR4 board, in still air conditions.
6. For a device surface-mounted on 50mm x 50mm single-sided, 2oz weight copper on 1.6mm FR4 board, in still air conditions.
7. Thermal resistance from junction and the mounting surfaces of the drain pins.
8. 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.
9. Overtemperature protection is designed to prevent device from destruction under fault conditions. Fault conditions are considered as "outside" normal operating range, so this part is not designed to withstand overtemperature for extended periods.

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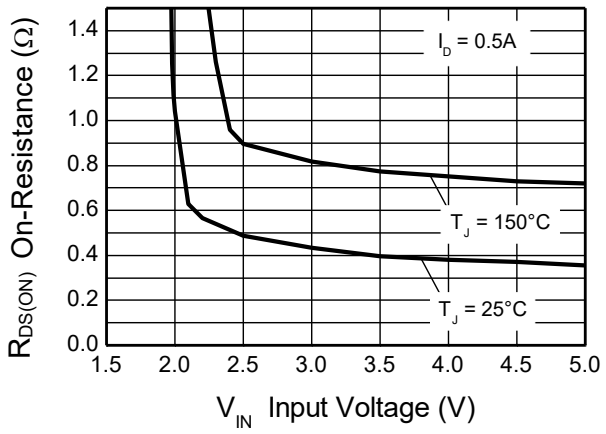
Typical Performance Characteristics



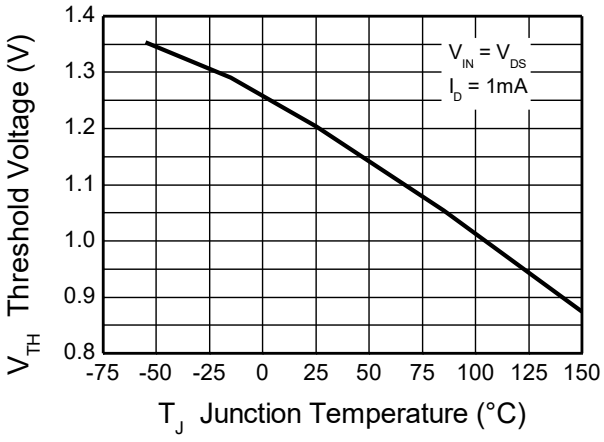
Typical Output Characteristic



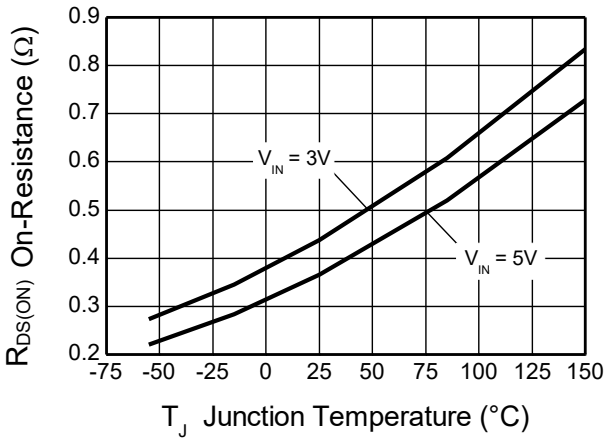
Input Current vs Input Voltage



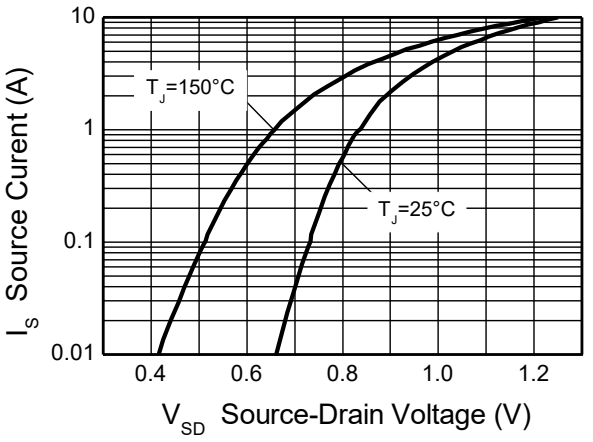
On-Resistance vs Input Voltage



Threshold Voltage vs Temperature



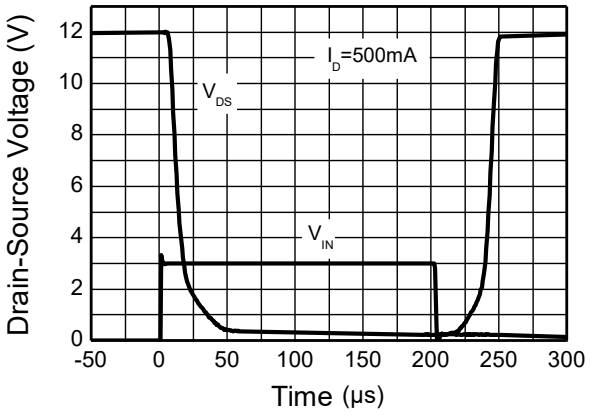
On-Resistance vs Temperature



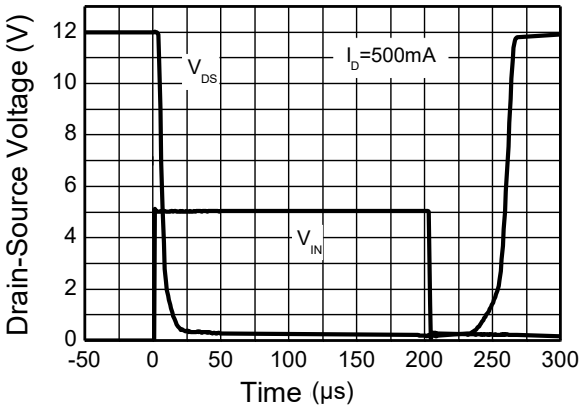
Reverse Diode Characteristic

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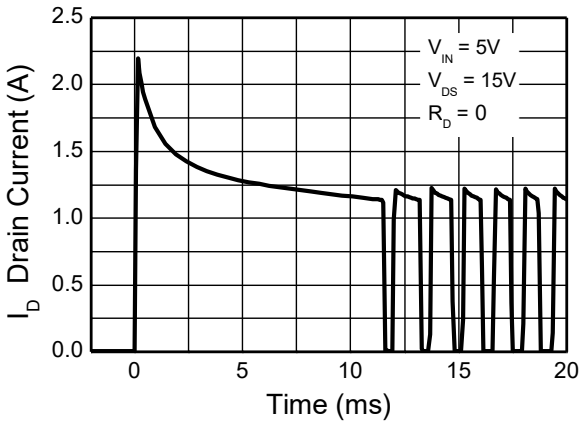
Typical Performance Characteristics (continued)



Switching Speed



Switching Speed



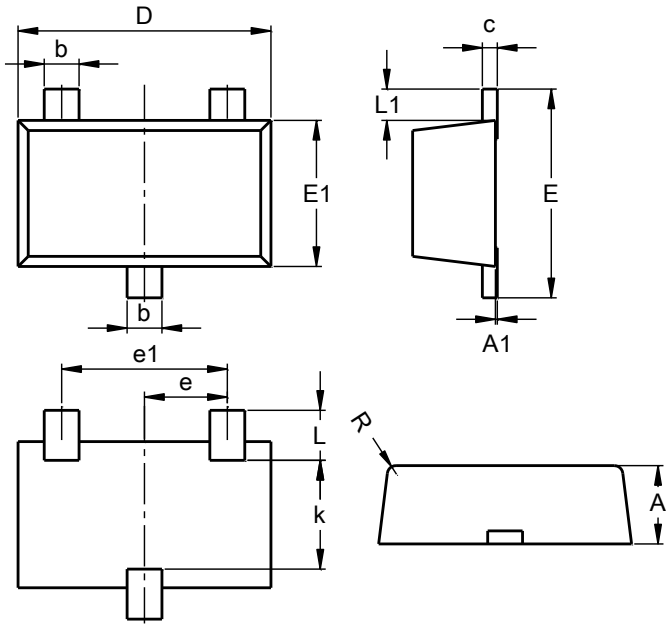
Typical Short-Circuit Protection

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Package Outline Dimensions

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23F

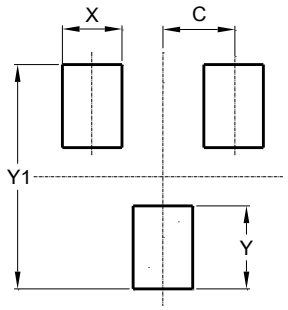


SOT23F			
Dim	**Min**	**Max**	**Typ**
A	0.80	1.00	0.90
A1	0.00	0.10	0.01
b	0.35	0.50	0.44
c	0.10	0.20	0.16
D	2.80	3.00	2.90
e	0.95 REF		
e1	1.90 REF		
E	2.30	2.50	2.40
E1	1.50	1.70	1.65
k	1.20	-	-
L	0.30	0.65	0.50
L1	0.30	0.50	0.40
R	0.05	0.15	-
All Dimensions in mm			

Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

SOT23F



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

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