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 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
- 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_{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

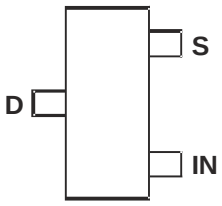
- Compact High Power Dissipation Package
- Low Input Current
- Logic Level Input (3.3V and 5V)
- Short Circuit Protection with Auto Restart
- Over Voltage Protection (Active Clamp)
- Thermal Shutdown with Auto Restart
- Overcurrent Protection
- Input Protection (ESD)
- High Continuous Current Rating
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The ZXMS6004FFQ is suitable for automotive applications requiring specific change control; this part is AEC-Q101 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

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 e3
- Weight: 0.012 grams (Approximate)

SOT23F

Top View



Top view
Pin Out

Ordering Information (Note 4)

Part Number	Marking	Reel Size (inches)	Tape Width (mm)	Quantity per Reel
ZXMS6004FFQTA	1K6	7	12	3,000
ZXMS6004FFQ-7	1K6	7	8	3,000

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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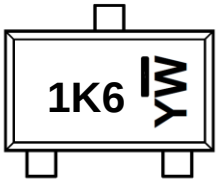
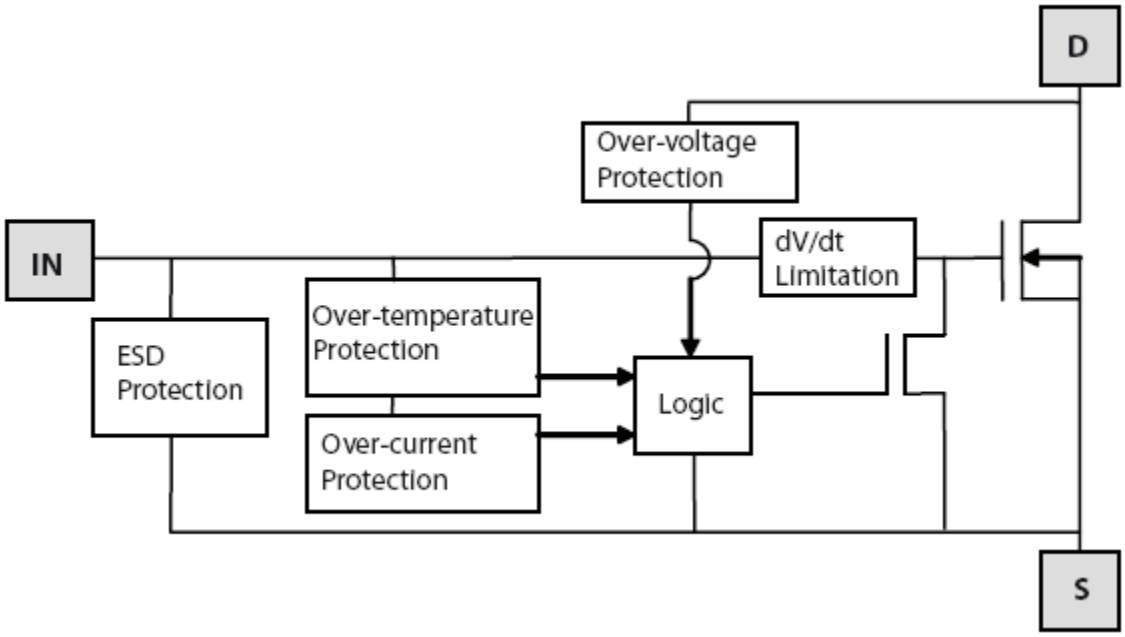
Marking Information



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

Functional Block Diagram



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 ... +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 $\lvert I_{IN} \rvert \leq 2$	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

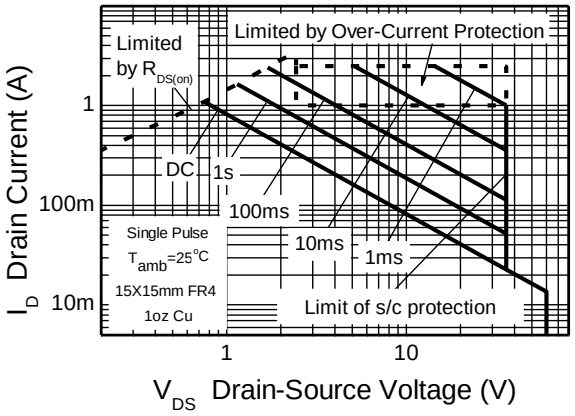
Recommended Operating Conditions

The ZXMS6004FFQ is optimized for use with µC operating from 3.3V and 5V supplies.

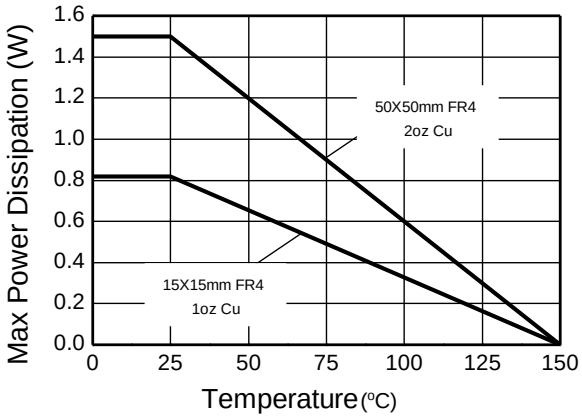
Characteristic	Symbol	Min	Max	Unit
Input Voltage Range	V_{IN}	0	5.5	V
Ambient Temperature Range	T_A	-40	+125	°C
High Level Input Voltage for MOSFET to be On	V_{IH}	3	5.5	V
Low Level Input Voltage for MOSFET to be Off	V_{IL}	0	0.7	V
Peripheral Supply Voltage (Voltage to Which Load is Referred)	V_P	0	36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

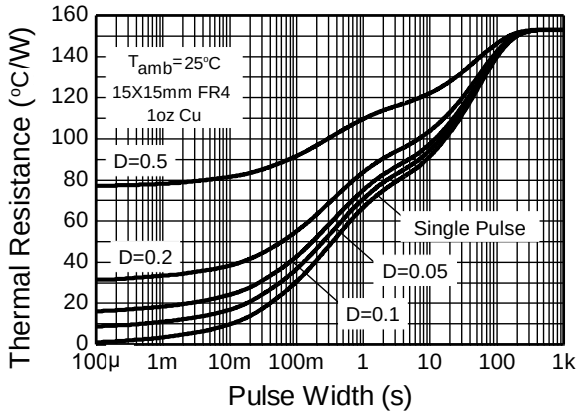
Typical Thermal Characteristics



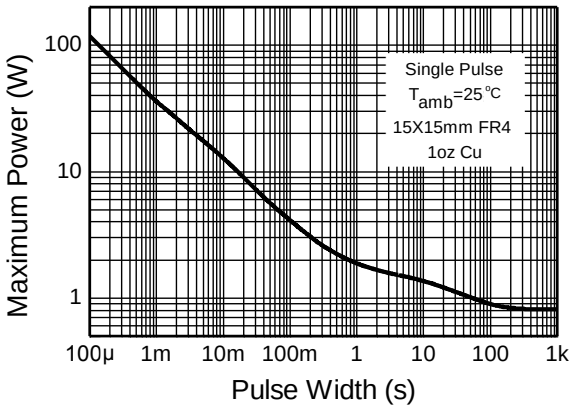
Safe Operating Area



Derating Curve



Transient Thermal Impedance



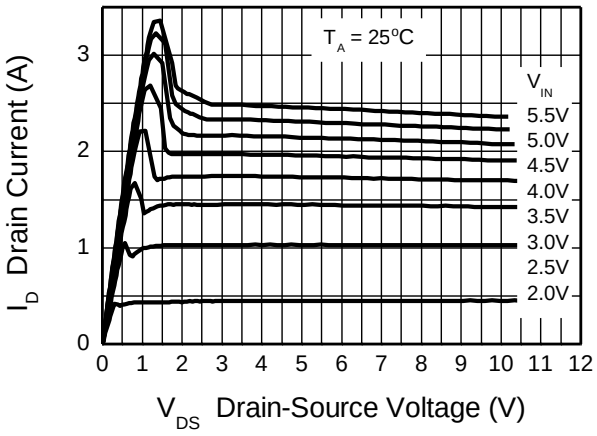
Pulse Power Dissipation

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

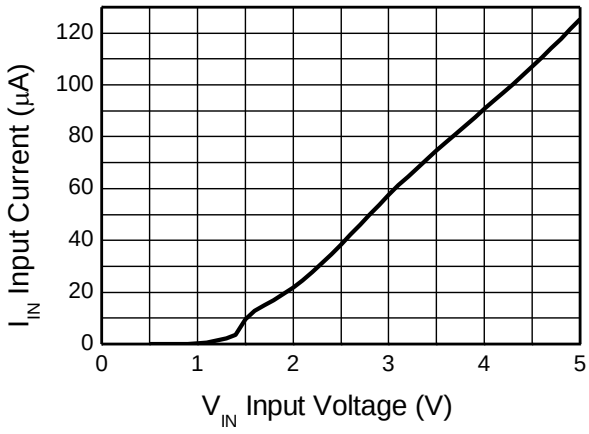
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Static Characteristics						
Drain-Source Clamp Voltage	$V_{DS(AZ)}$	60	65	70	V	I_D = 10mA
Off-State Drain Current	I_{DSS}	—	—	500	nA	V_{DS} = 12V, V_{IN} = 0V
		—	—	1	µA	V_{DS} = 36V, V_{IN} = 0V
Input Threshold Voltage	$V_{IN(TH)}$	0.7	1	1.5	V	V_{DS} = 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	f_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 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.

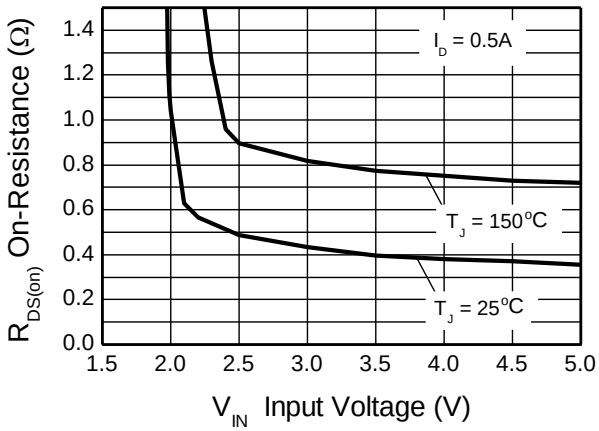
Typical Performance Characteristics



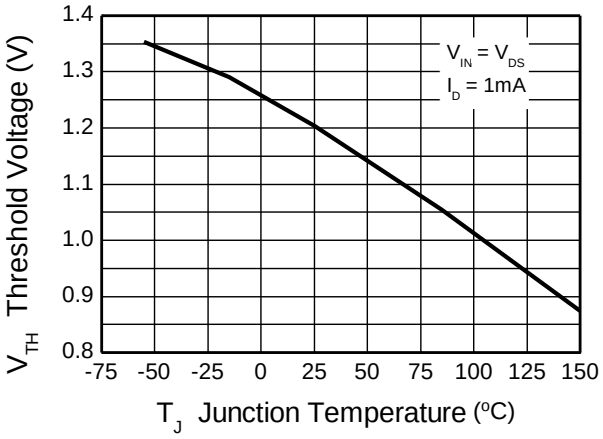
Typical Output Characteristic



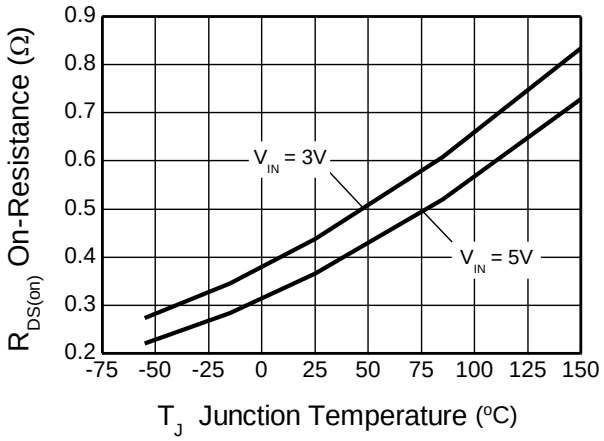
Input Current vs Input Voltage



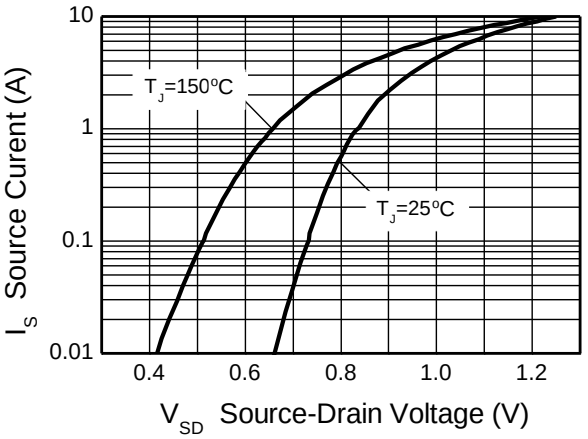
On-Resistance vs Input Voltage



Threshold Voltage vs Temperature

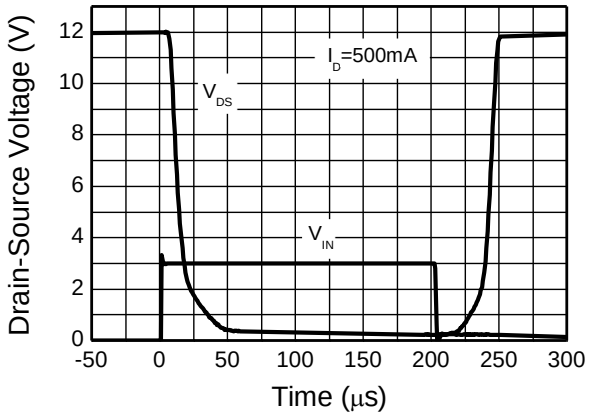


On-Resistance vs Temperature

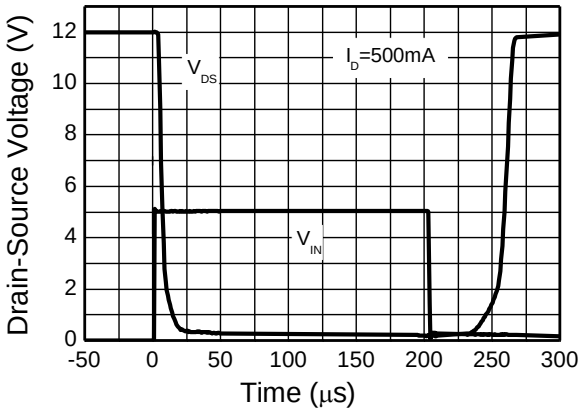


Reverse Diode Characteristic

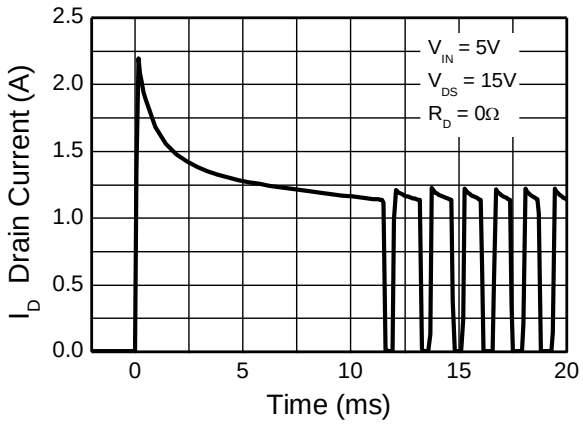
Typical Performance Characteristics (Continued)



Switching Speed



Switching Speed

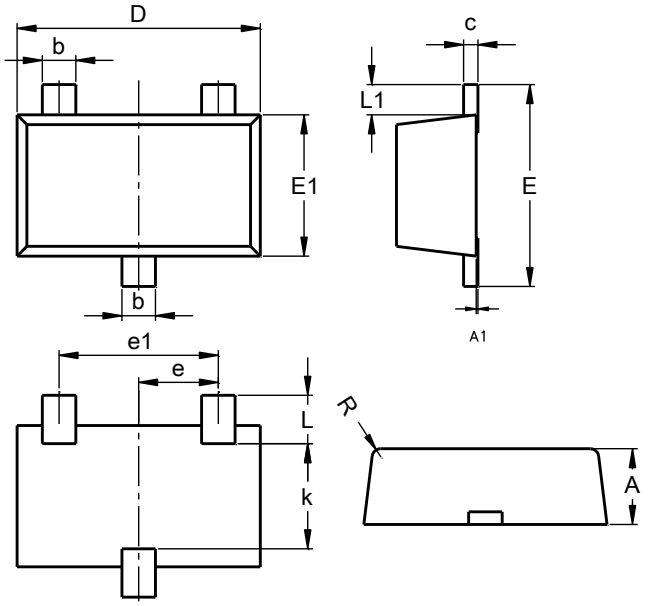


Typical Short Circuit Protection

Package Outline Dimensions

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

SOT23F

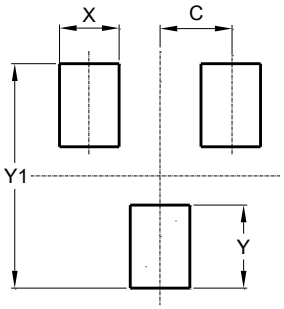


SOT23F			
Dim	**Min**	**Max**	**Typ**
A	0.80	1.00	0.90
A1	0.00	0.10	0.01
b	0.35	0.50	0.44
c	0.10	0.20	0.16
D	2.80	3.00	2.90
e	0.95 REF		
e1	1.90 REF		
E	2.30	2.50	2.40
E1	1.50	1.70	1.65
k	1.20	-	-
L	0.30	0.65	0.50
L1	0.30	0.50	0.40
R	0.05	0.15	-
All Dimensions in mm			

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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