

## Product Summary

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

## Description

The DIODES™ ZXMS6004FF-7 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-7 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

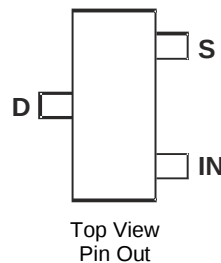
- Especially suited for loads with a high in-rush current such as lamps and motors
- All types of resistive, inductive and capacitive loads in switching applications
- $\mu C$  compatible power switches for 12V and 24V DC applications
- Automotive rated
- Replaces electromechanical relays and discrete 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  $V_{DS}$ .

## 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)**
- **For automotive applications requiring specific change control (i.e.: parts qualified to AEC-Q100/101/104/200, PPAP capable, and manufactured in IATF 16949 certified facilities), please refer to the related automotive grade (Q-suffix) part. A listing can be found at <https://www.diodes.com/products/automotive/automotive-products/>.**
- **This part is qualified to JEDEC standards (as references in AEC-Q) for High Reliability. <https://www.diodes.com/quality/product-definitions/>**

## 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 (63)
- Weight: 0.012 grams (Approximate)



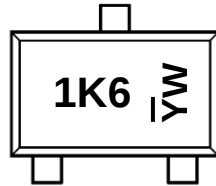
## Ordering Information (Note 4)

| 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/>.

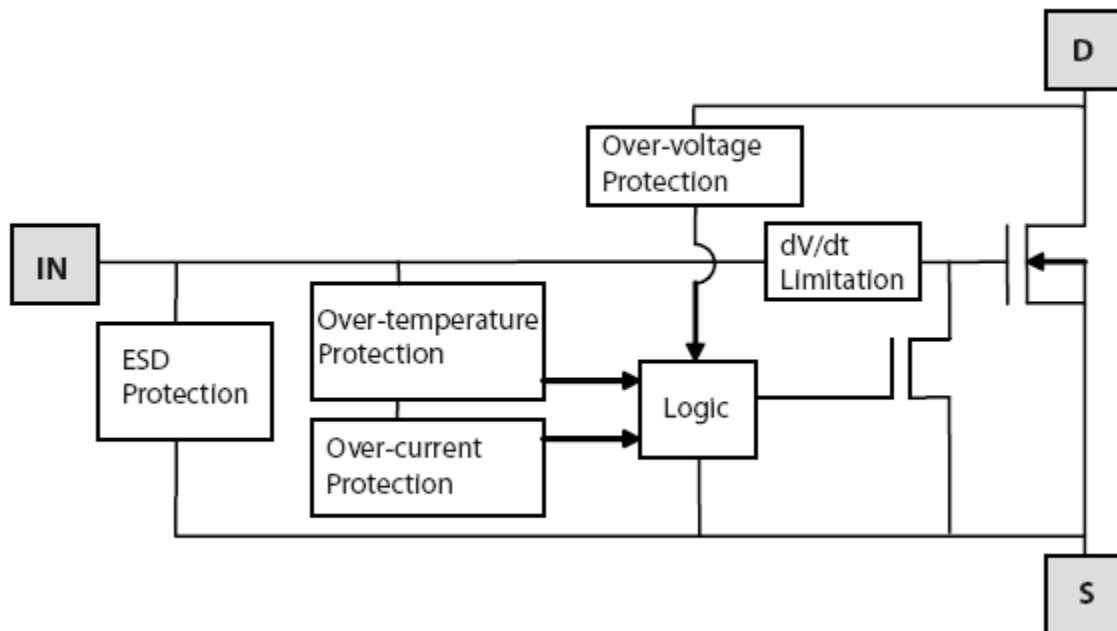
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## Marking Information



1K6 = Product Type Marking Code  
Y or Y: Year: 0 to 9 (ex: 2 = 2022)  
W or W: Week: A to Z: Week 1 to 26  
a to z: Week 27 to 52  
z: Represents Week 52 & 53

## Functional Block Diagram



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

| Characteristic                                                                                                  | Symbol              | Value                 | Unit |
|-----------------------------------------------------------------------------------------------------------------|---------------------|-----------------------|------|
| 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              | mA   |
| Continuous Input Current @V <sub>IN</sub> < -0.2V or V <sub>IN</sub> > 6V                                       |                     | I <sub>IN</sub>   ≤ 2 |      |
| 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<br>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       | Unit  |
|----------------------------------------------------|------------------|-------------|-------|
| Power Dissipation @T <sub>A</sub> = +25°C (Note 5) | P <sub>D</sub>   | 0.83        | W     |
| Linear Derating Factor                             |                  | 6.66        | mW/°C |
| Power Dissipation @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    |

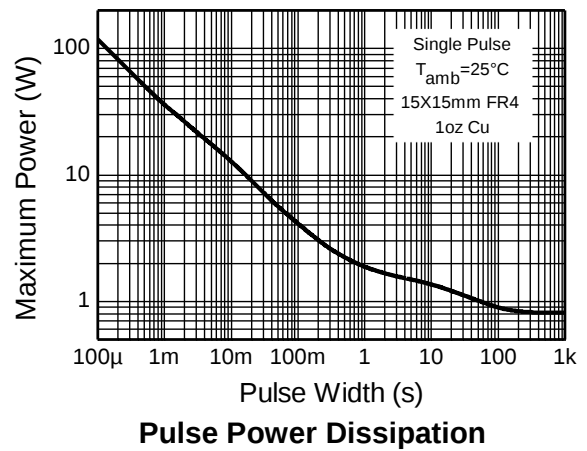
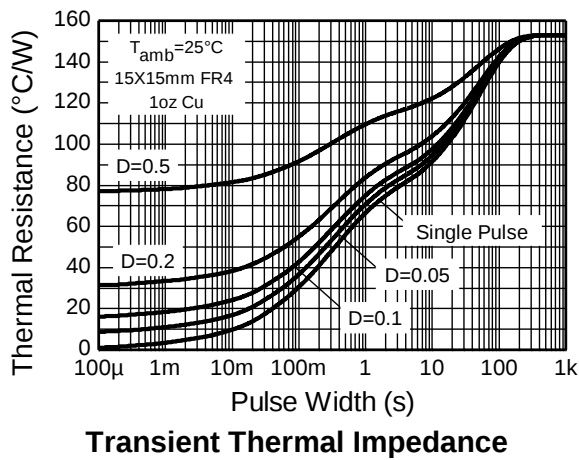
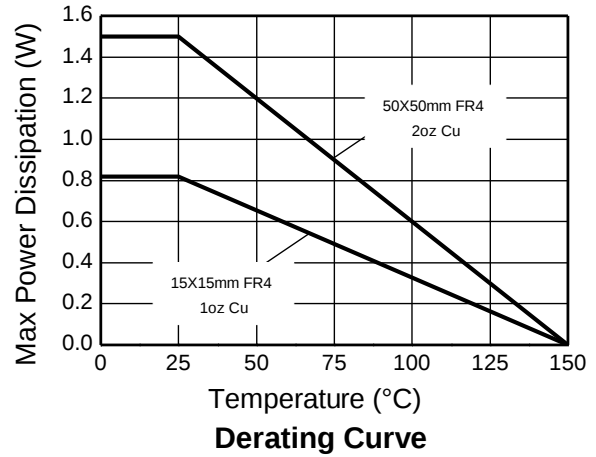
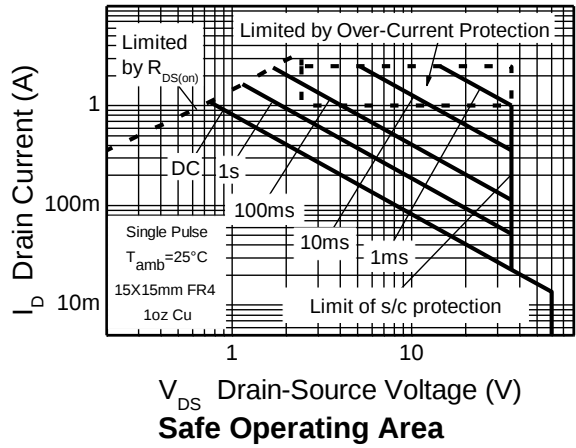
## Recommended Operating Conditions

The ZXMS6004FF-7 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    |

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

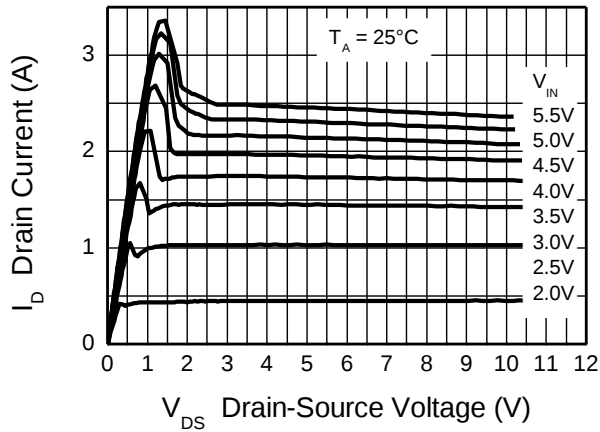


**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise specified.)

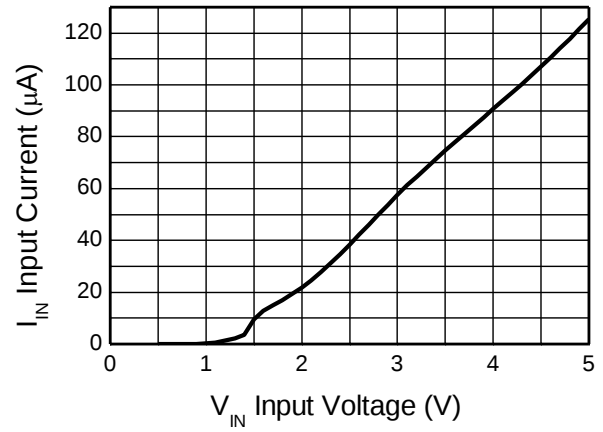
| Characteristic                             | Symbol              | Min  | Typ  | Max | Unit | Test Condition                                                     |
|--------------------------------------------|---------------------|------|------|-----|------|--------------------------------------------------------------------|
| Static Characteristics                     |                     |      |      |     |      |                                                                    |
| 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 5)          | 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 6)          |                     | 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                                              |
| Dynamic Characteristics                    |                     |      |      |     |      |                                                                    |
| 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   | —   |      |                                                                    |
| Overtemperature Protection                 |                     |      |      |     |      |                                                                    |
| Thermal Overload Trip Temperature (Note 9) | T <sub>JT</sub>     | +150 | +175 | —   | °C   | —                                                                  |
| Thermal Hysteresis (Note 9)                | f <sub>F</sub>      | —    | +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.

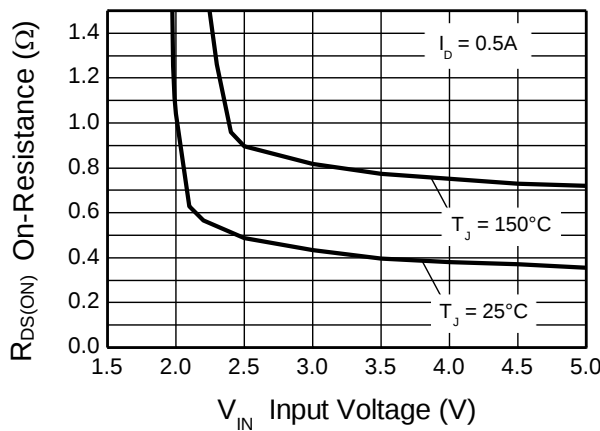
## Typical Performance Characteristics



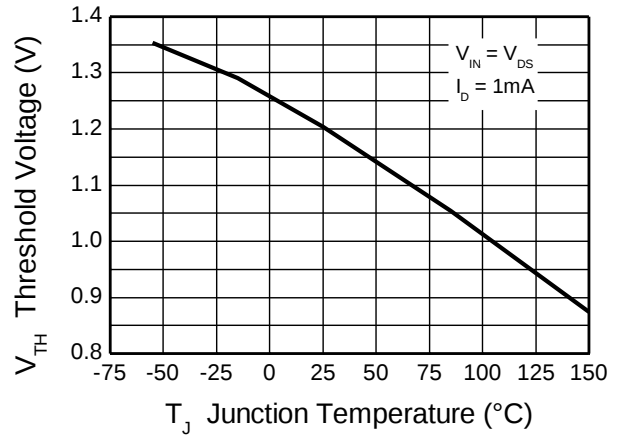
**Typical Output Characteristic**



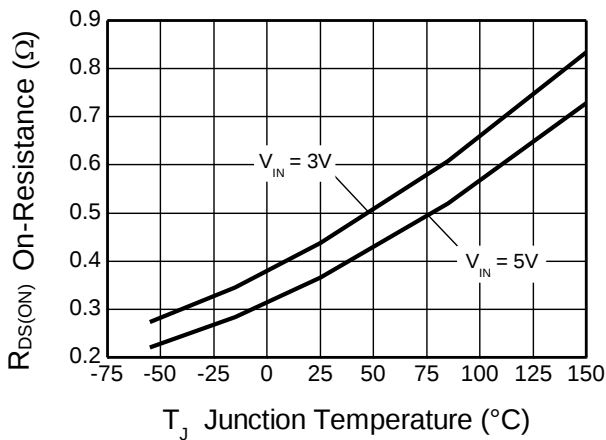
**Input Current vs Input Voltage**



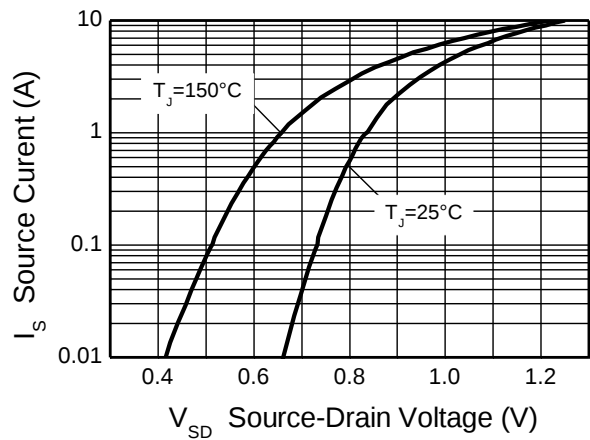
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**

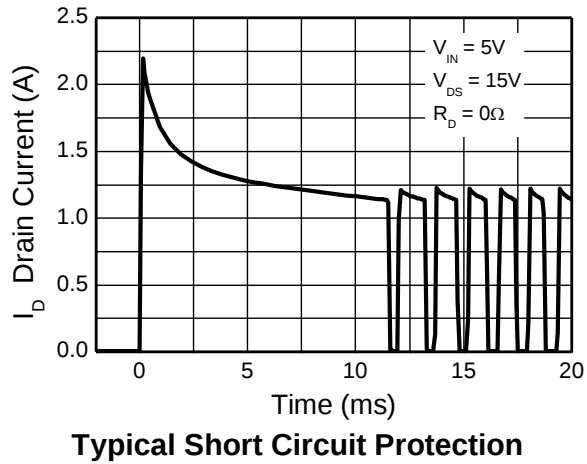
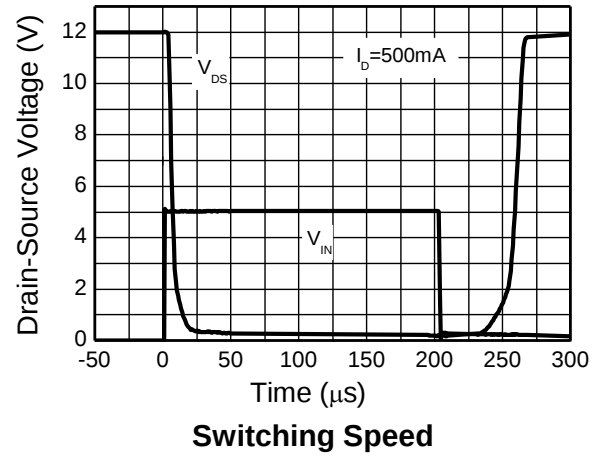
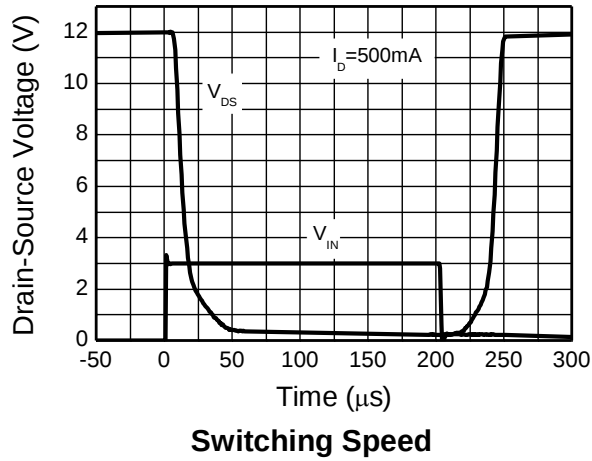


**On-Resistance vs Temperature**



**Reverse Diode Characteristic**

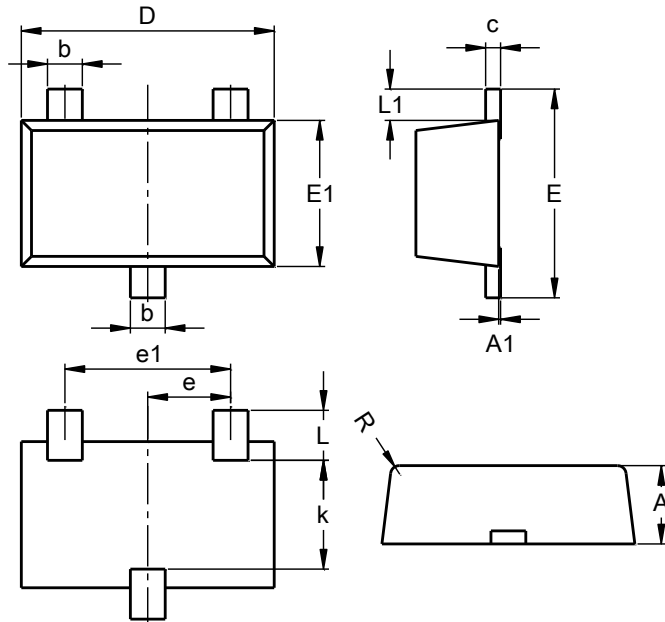
## Typical Performance Characteristics (continued)



## Package Outline Dimensions

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

### SOT23F

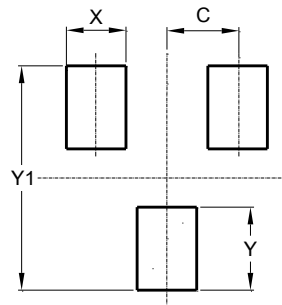


| SOT23F               |          |      |      |
|----------------------|----------|------|------|
| Dim                  | Min      | Max  | Typ  |
| A                    | 0.80     | 1.00 | 0.90 |
| A1                   | 0.00     | 0.10 | 0.01 |
| b                    | 0.35     | 0.50 | 0.44 |
| 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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