

## Product Summary

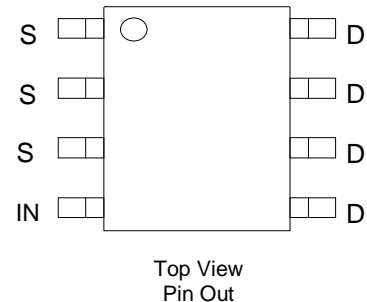
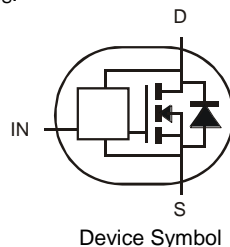
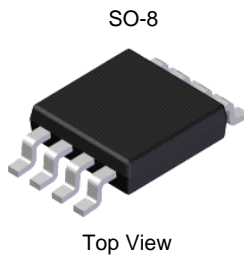
|  |       |
|--|-------|
| Continuous Drain Source Voltage        | 60V   |
| On-State Resistance                    | 500mΩ |
| Nominal Load Current ( $V_{IN} = 5V$ ) | 1.3A  |
| Clamping Energy                        | 120mJ |

## Description

The ZXMS6004N8 is a self-protected low side MOSFET with logic level input. It integrates over-temperature, overcurrent, overvoltage (active clamp) and ESD protected logic level functionality. The ZXMS6004N8 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.
- 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

- 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)**

## Mechanical Data

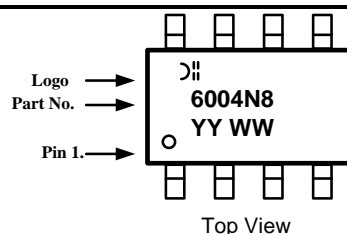
- Case: SO-8
- Case Material: Molded Plastic, "Green" Molding Compound
- UL Flammability Classification Rating 94V-0
- Moisture Sensitivity: Level 1 per J-STD-020
- Terminals: Matte Tin Finish <sup>③</sup>
- Weight: 80.2 mg (Approximate)

## Ordering Information (Note 4)

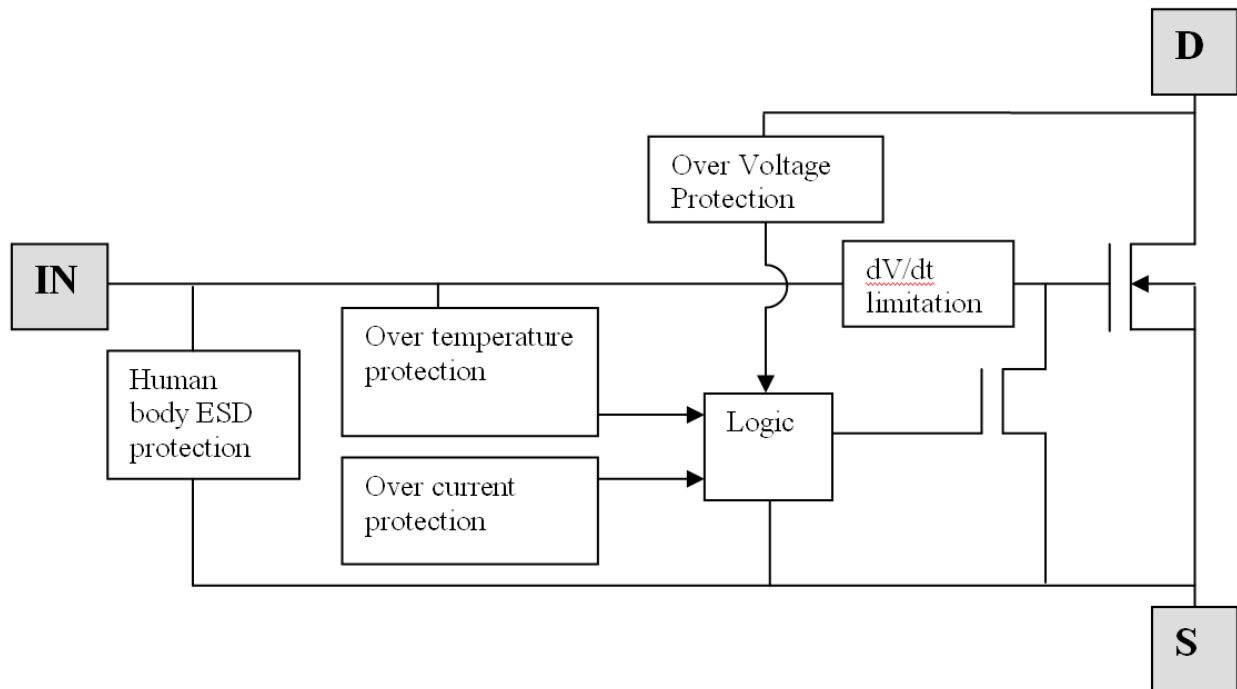
| Product       | Marking | Reel size (inches) | Tape width (mm) | Quantity per reel |
|---------------|---------|--------------------|-----------------|-------------------|
| ZXMS6004N8-13 | 6004N8  | 13                 | 12              | 2,500 units       |

- Notes:
- No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU.
  - 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.
  - Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.
  - For packaging details, go to our website at <http://www.diodes.com/products/packages.html>.

## Marking Information



6004N8 = Product Name  
YY: Year  
WW: Week: 01~52;  
52 represents 52 and 53 week

**Functional Block Diagram**

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

| 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>     | 120                   | mJ    |
| Electrostatic Discharge (Human Body Model)  | V <sub>HBM</sub>    | 4,000                 | V     |
| Charged Device Model  | V <sub>CDM</sub>    | 1,000                 | V     |

**Thermal Resistance** (@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>   | 1.28        | W     |
| Linear Derating Factor                               | P <sub>D</sub>   | 10          | mW/°C |
| Power Dissipation at T <sub>A</sub> = +25°C (Note 6) | P <sub>D</sub>   | 1.65        | W     |
| Linear Derating Factor                               | P <sub>D</sub>   | 12.4        | mW/°C |
| Thermal Resistance, Junction to Ambient (Note 5)     | R <sub>θJA</sub> | 98          | °C/W  |
| Thermal Resistance, Junction to Ambient (Note 6)     | R <sub>θJA</sub> | 76          | °C/W  |
| Thermal Resistance, Junction to Case (Note 7)        | R <sub>θJC</sub> | 12          | °C/W  |
| Operating Temperature Range                          | T <sub>J</sub>   | -40 to +150 | °C    |
| Storage Temperature Range                            | T <sub>STG</sub> | -55 to +150 | °C    |

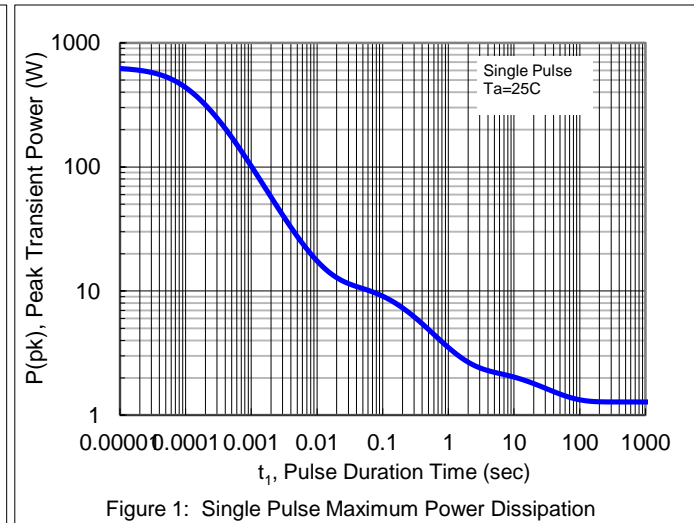
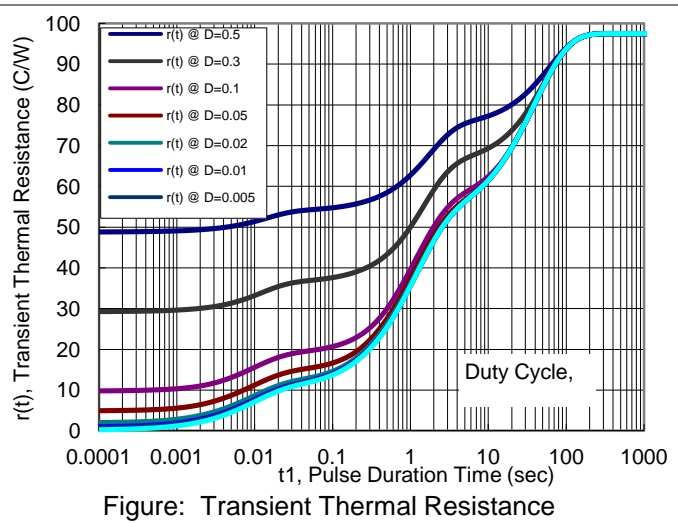
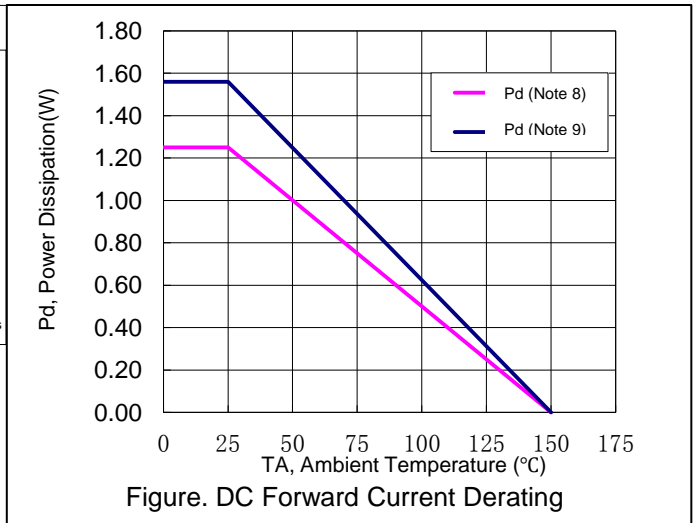
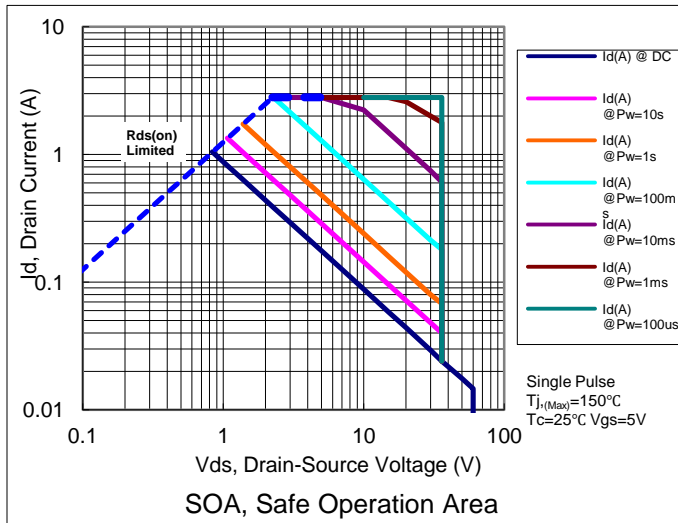
- Notes:
- Device mounted on FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout
  - Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch square copper plate.
  - Thermal resistance between junction and the mounting surfaces of drain and source pins.

## Recommended Operating Conditions

The ZXMS6004N8 is optimized for use with  $\mu\text{C}$  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 | $^{\circ}\text{C}$ |
| 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                  |

## Thermal Characteristics



Note: 8. Device mounted on FR-4 substrate PC board, 2oz copper, with minimum recommended pad layout  
 9. Device mounted on FR-4 substrate PC board, 2oz copper, with 1inch square copper plate.

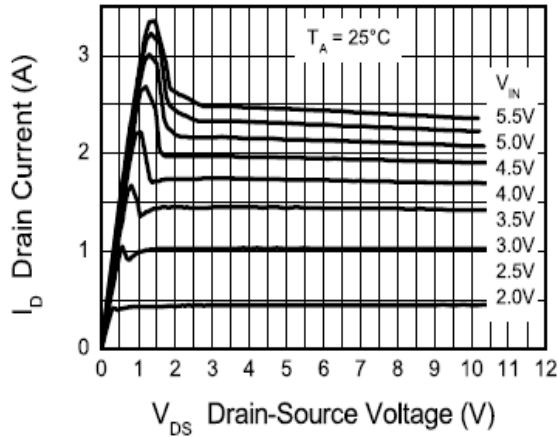
**Electrical Characteristics** (@T<sub>A</sub> = +25°C, unless otherwise stated.)

| 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>    | –   | –    | 0.5 | μA   | V <sub>DS</sub> = 12V, V <sub>IN</sub> = 0V                        |
|   |                     | –   | –    | 1   |      | 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 | –                   | –   | –    | 400 | 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 10)                     | 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 11) | T <sub>JT</sub>     | 150 | +175 | –   | °C   | –  |
| Thermal Hysteresis (Note 11)                | ΔT <sub>JT</sub>    | –   | +10  | –   | °C   | –  |

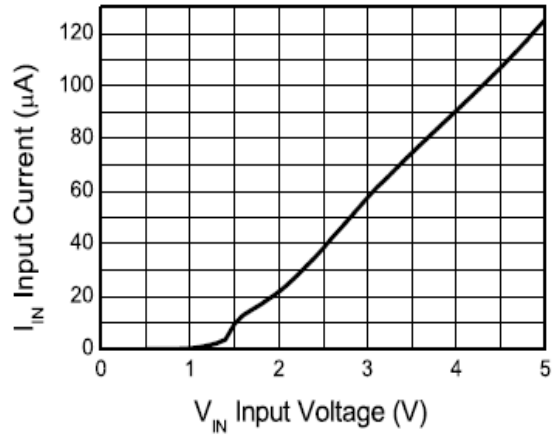
Notes: 10. The drain current is restricted only when the device is in saturation (see graph 'typical output characteristic'). This allows the device to be used in the fully on state without interference from the current limit. The device is fully protected at all drain currents, as the low power dissipation generated outside saturation makes current limit unnecessary.

11. 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.

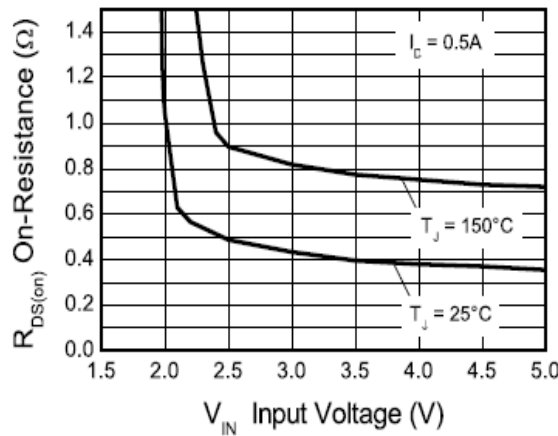
**Typical Characteristics**



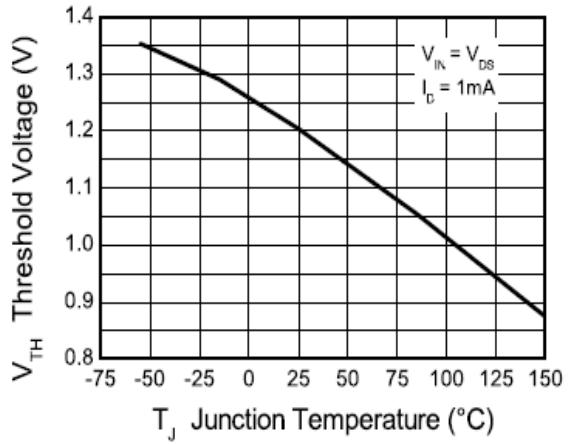
**Typical Output Characteristic**



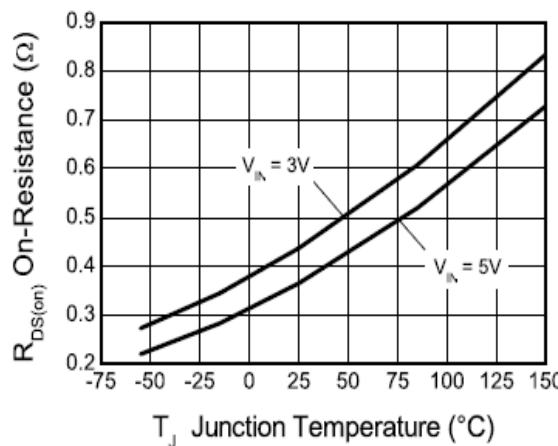
**Input Current vs Input Voltage**



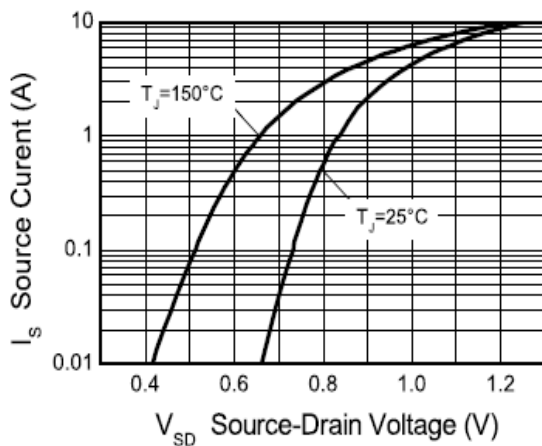
**On-Resistance vs Input Voltage**



**Threshold Voltage vs Temperature**

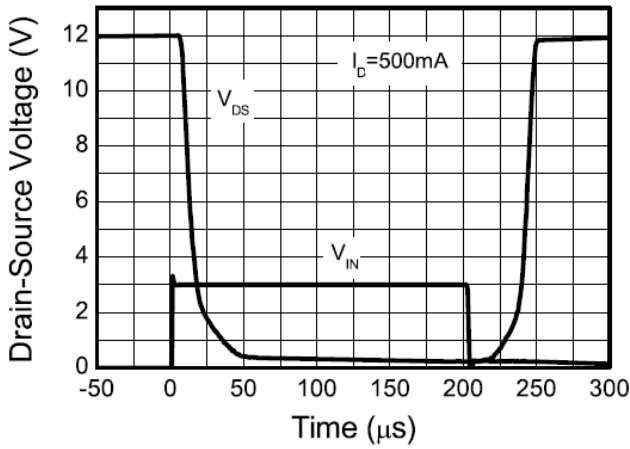


**On-Resistance vs Temperature**

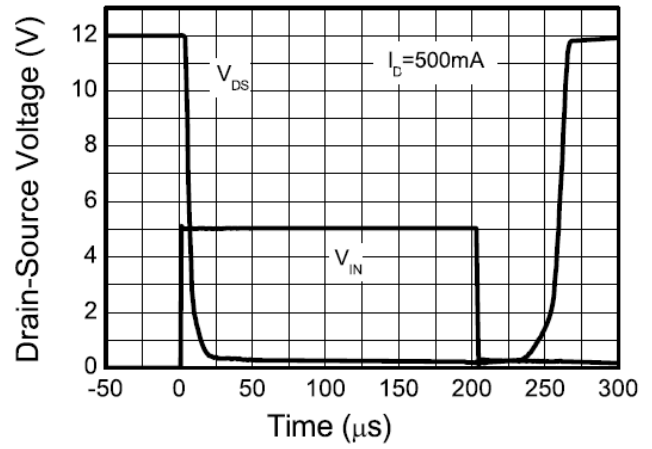


**Reverse Diode Characteristic**

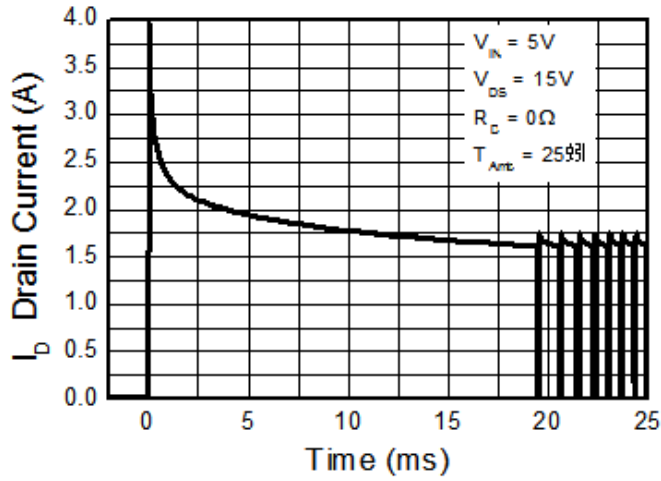
**Typical Characteristics** (continued)



**Switching Speed**



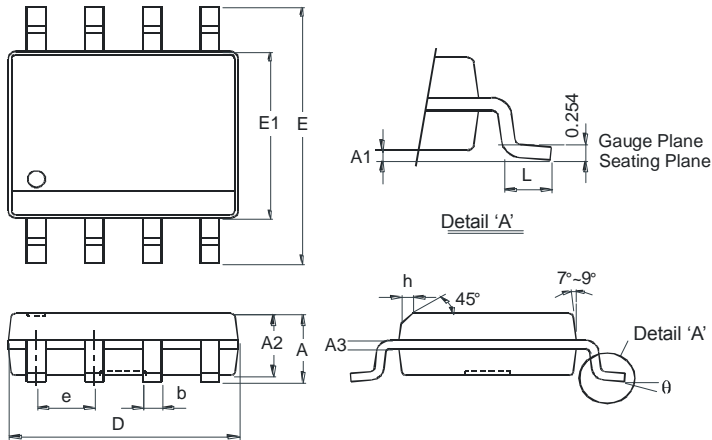
**Switching Speed**



**Typical Short Circuit Protection**

## Package Outline Dimensions

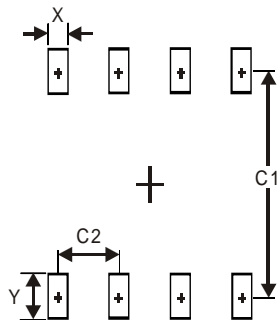
Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for the latest version.



| SO-8                 |          |      |
|----------------------|----------|------|
| Dim                  | Min      | Max  |
| A                    | -        | 1.75 |
| A1                   | 0.10     | 0.20 |
| A2                   | 1.30     | 1.50 |
| A3                   | 0.15     | 0.25 |
| b                    | 0.3      | 0.5  |
| D                    | 4.85     | 4.95 |
| E                    | 5.90     | 6.10 |
| E1                   | 3.85     | 3.95 |
| e                    | 1.27 Typ |      |
| h                    | -        | 0.35 |
| L                    | 0.62     | 0.82 |
| θ                    | 0°       | 8°   |
| 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) |
|------------|---------------|
| X          | 0.60          |
| Y          | 1.55          |
| C1         | 5.4           |
| C2         | 1.27          |

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