



**THE DATASHEET OF
ZXMS6004N8Q-13**



60V N-CHANNEL SELF PROTECTED ENHANCEMENT MODE LOW-SIDE INTELLIFET
Product Summary

V_{DS}	$R_{DS(ON)}$	EAS	I_D $T_A = +25^\circ C$
60V	500m Ω	120mJ	1.3A

Description

The ZXMS6004N8Q is a self-protected low side IntelliFET[®] with logic level input. It integrates over-temperature, overcurrent, overvoltage (active clamp) and ESD protected logic level functionality. The ZXMS6004N8Q 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

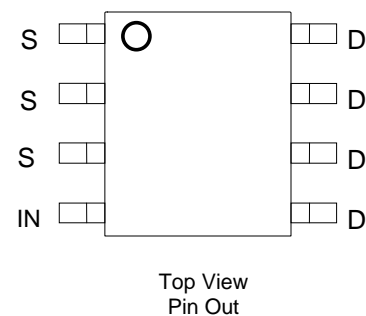
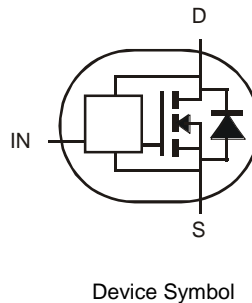
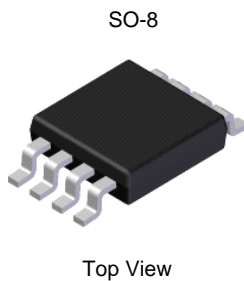
- Especially Suited for Loads with a High In-rush Current Such As Lamps and Motors
- All types of resistive, inductive and capacitive loads in switching applications
- μC Compatible Power Switch for 12V and 24V DC Applications
- Replaces electromechanical relays and discrete circuits
- Linear Mode capability - 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)**
- **Characterized to AEC-Q101-006 Grade E for Short-circuit Reliability**
- **PPAP Capable (Note 4)**

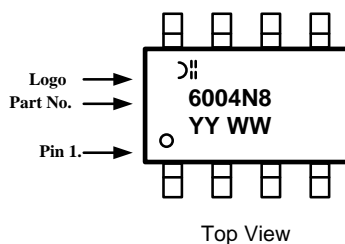
Mechanical Data

- 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 ^(e3)
- Weight: 80.2mg (Approximate)

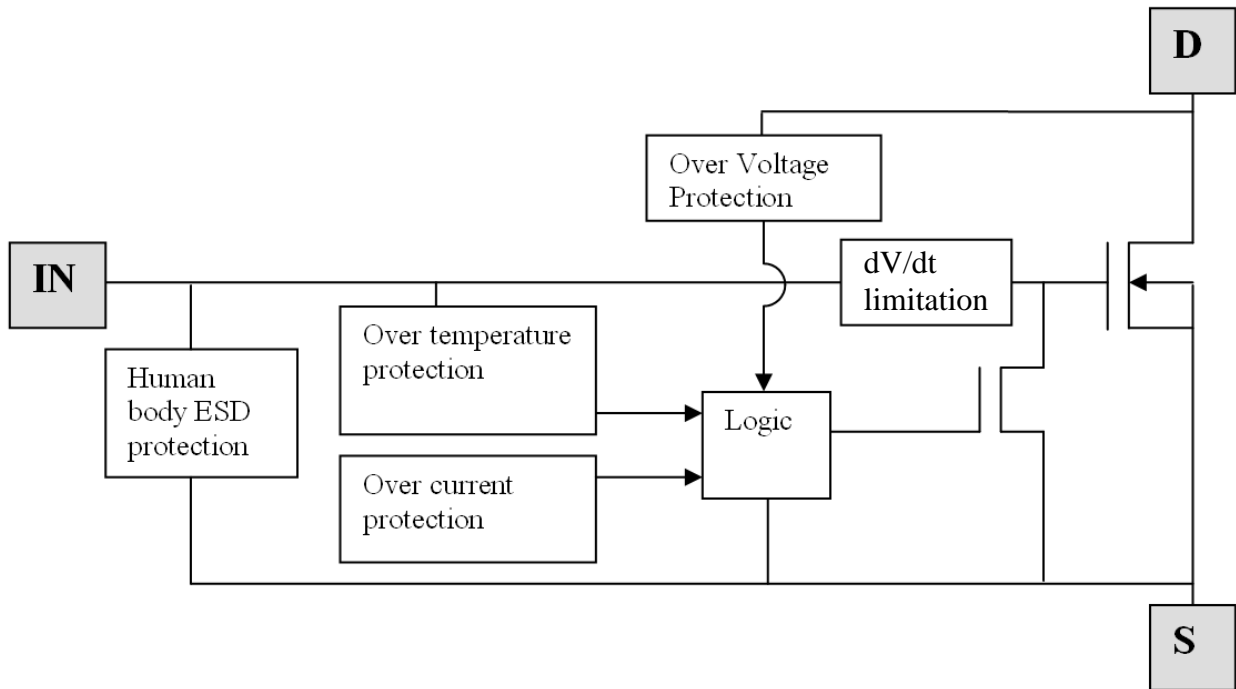

Ordering Information (Note 5)

Part number	Marking	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXMS6004N8Q-13	6004N8	13	12	2,500 units

- 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 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-Q101 qualified and are PPAP capable. Refer to http://www.diodes.com/product_compliance_definitions.html.
 5. 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 (@ $T_A = +25^\circ\text{C}$, unless otherwise stated.)

Characteristic	Symbol	Value	Units
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 @ $-0.2\text{V} \leq V_{IN} \leq 6\text{V}$	I_{IN}	No limit	mA
Continuous Input Current @ $V_{IN} < -0.2\text{V}$ or $V_{IN} > 6\text{V}$	I_{IN}	$ I_{IN} \leq 2$	mA
Pulsed Drain Current @ $V_{IN} = 3.3\text{V}$	I_{DM}	2	A
Pulsed Drain Current @ $V_{IN} = 5\text{V}$	I_{DM}	2.5	A
Continuous Source Current (Body Diode) (Note 5)	I_S	1	A
Pulsed Source Current (Body Diode)	I_{SM}	5	A
Unclamped Single Pulse Inductive Energy, $T_J = +25^\circ\text{C}$, $I_D = 0.5\text{A}$, $V_{DD} = 24\text{V}$	E_{AS}	120	mJ
Electrostatic Discharge (Human Body Model)	V_{HBM}	4,000	V
Charged Device Model	V_{CDM}	1,000	V

Thermal Resistance (@ $T_A = +25^\circ\text{C}$, unless otherwise specified.)

Characteristic	Symbol	Value	Units
Power Dissipation at $T_A = +25^\circ\text{C}$ (Note 5)	P_D	1.28	W
Linear Derating Factor		10	mW/ $^\circ\text{C}$
Power Dissipation at $T_A = +25^\circ\text{C}$ (Note 6)	P_D	1.65	W
Linear Derating Factor		12.4	mW/ $^\circ\text{C}$
Thermal Resistance, Junction to Ambient (Note 5)	$R_{\theta JA}$	98	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Ambient (Note 6)	$R_{\theta JA}$	76	$^\circ\text{C}/\text{W}$
Thermal Resistance, Junction to Case (Note 7)	$R_{\theta JC}$	12	$^\circ\text{C}/\text{W}$
Operating Temperature Range	T_J	-40 to +150	$^\circ\text{C}$
Storage Temperature Range	T_{STG}	-55 to +150	$^\circ\text{C}$

- 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 ZXMS6004N8Q is optimized for use with μC operating from 3.3V and 5V supplies.

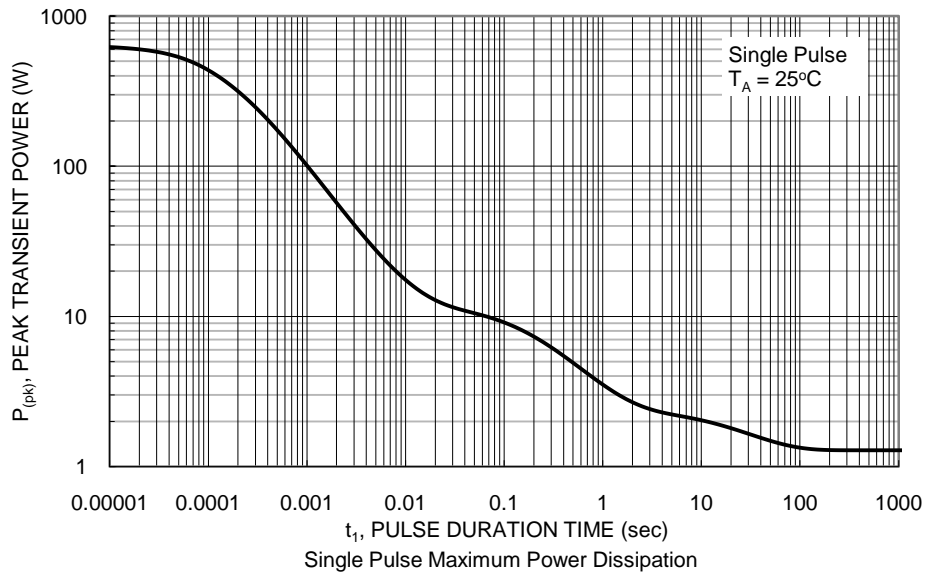
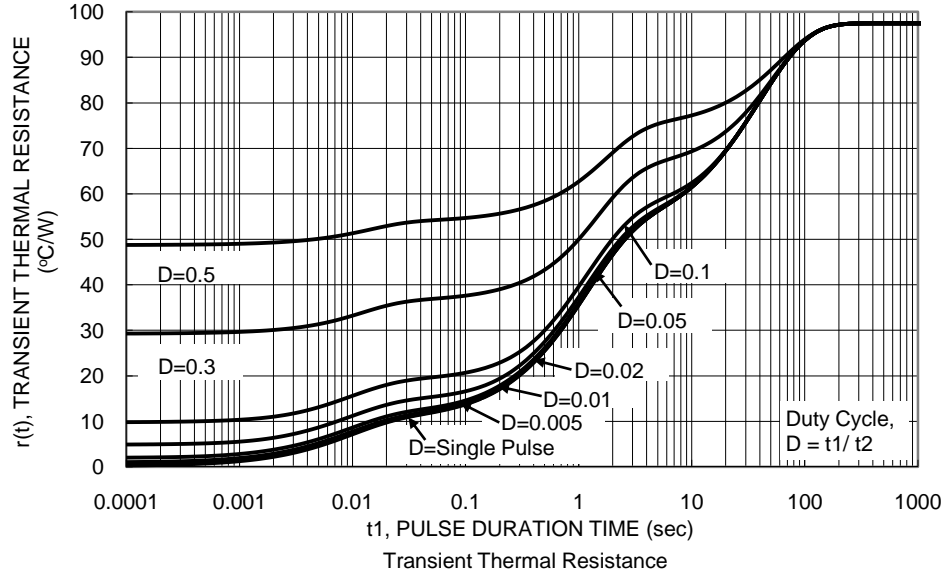
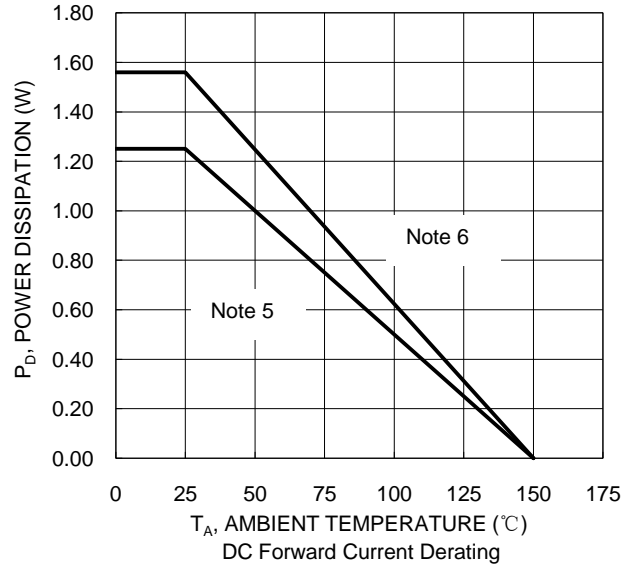
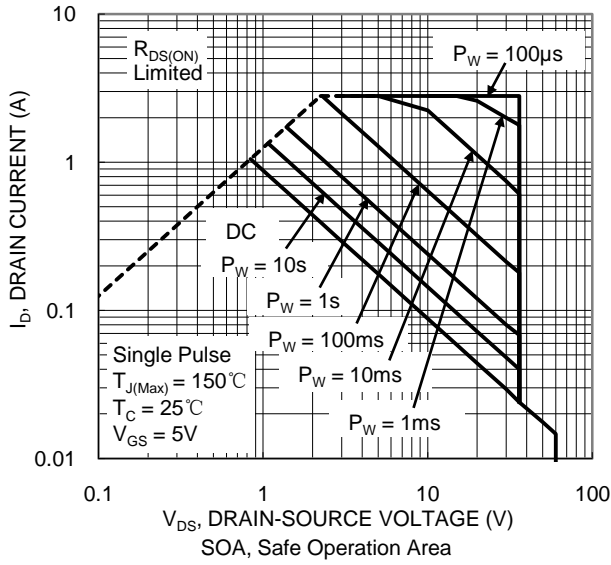
Characteristic	Symbol	Min	Max	Unit
Input Voltage Range	V_{IN}	0	5.5	V
Ambient Temperature Range	T_A	-40	+125	$^{\circ}\text{C}$
High Level Input Voltage for MOSFET to be on	V_{IH}	3	5.5	V
Low Level Input Voltage for MOSFET to be off	V_{IL}	0	0.7	V
Peripheral Supply Voltage (voltage to which load is referred)	V_P	0	36	V

Electrical Characteristics (@ $T_A = +25^{\circ}\text{C}$, unless otherwise stated.)

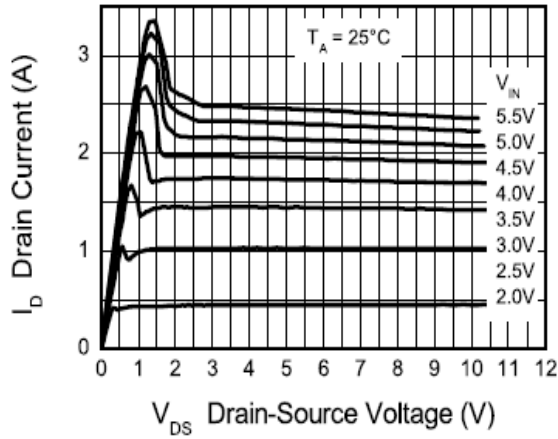
Characteristic	Symbol	Min	Typ	Max	Unit	Test Condition
Static Characteristics						
Drain-Source Clamp Voltage	$V_{DS(AZ)}$	60	65	70	V	$I_D = 10\text{mA}$
Off State Drain Current	I_{DSS}	–	–	0.5	μA	$V_{DS} = 12\text{V}, V_{IN} = 0\text{V}$
		–	–	1		$V_{DS} = 36\text{V}, V_{IN} = 0\text{V}$
Input Threshold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

- 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.
 - 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.

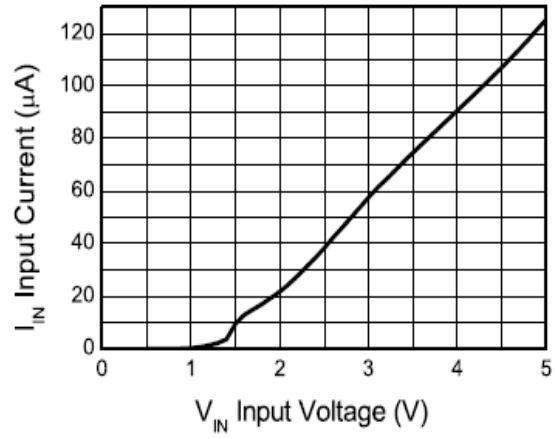
Thermal Characteristics



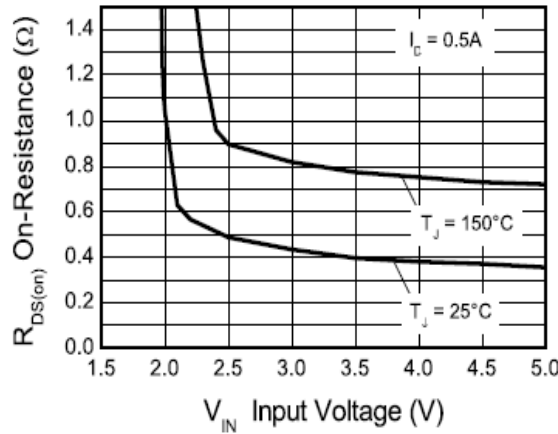
Typical Characteristics



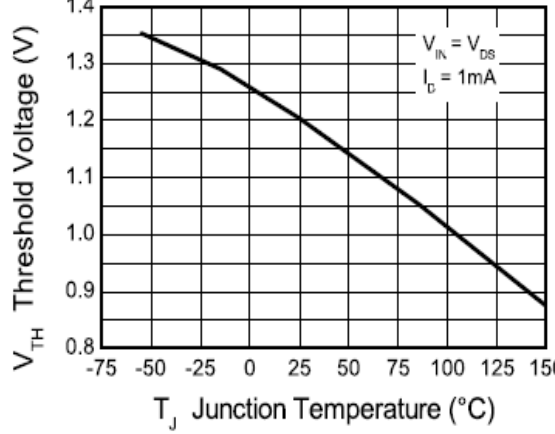
Typical Output Characteristic



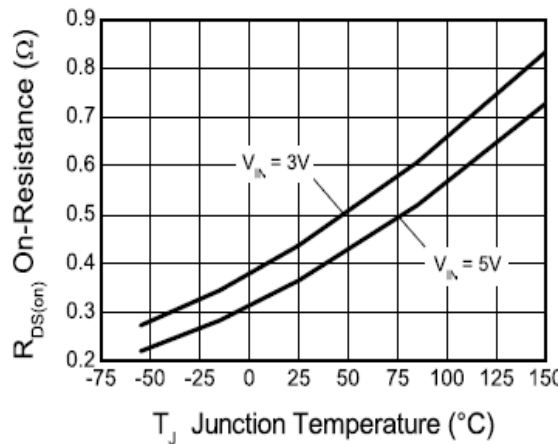
Input Current vs Input Voltage



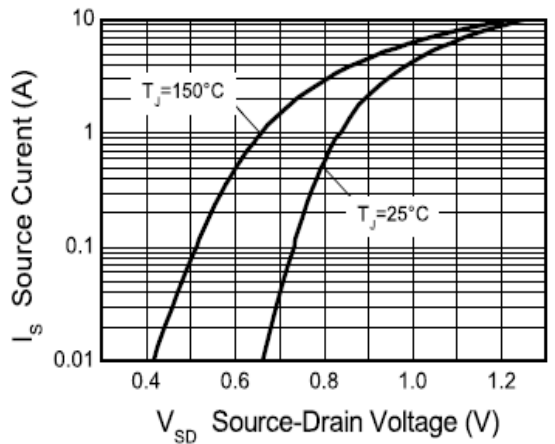
On-Resistance vs Input Voltage



Threshold Voltage vs Temperature

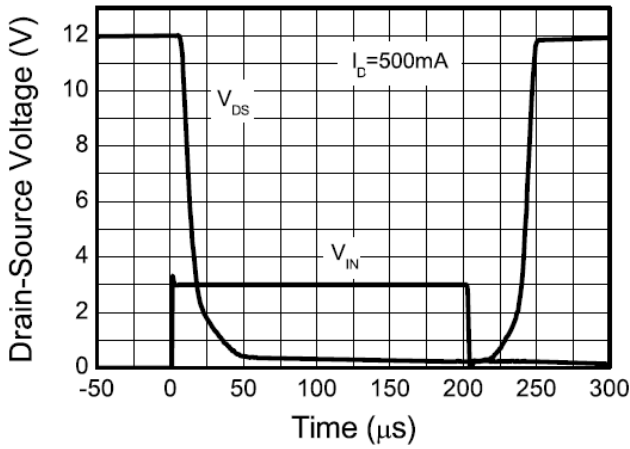


On-Resistance vs Temperature

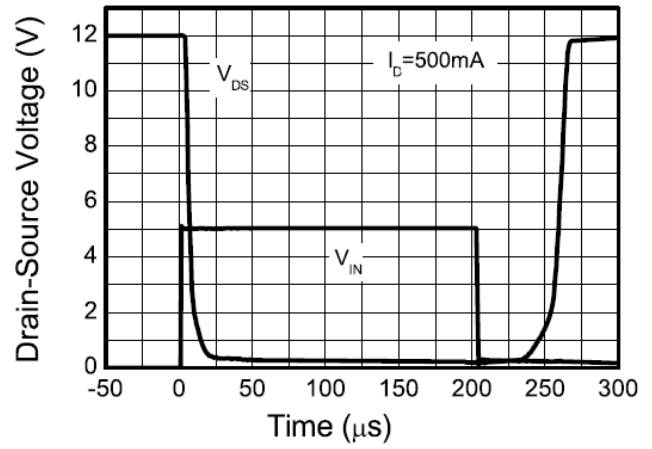


Reverse Diode Characteristic

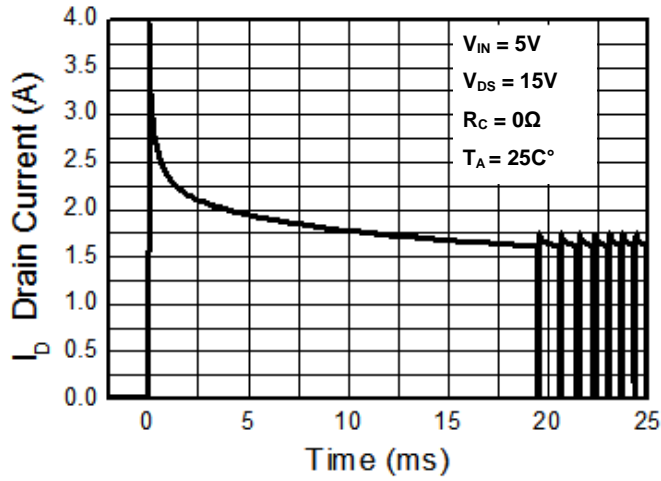
Typical Characteristics (Cont.)



Switching Speed



Switching Speed

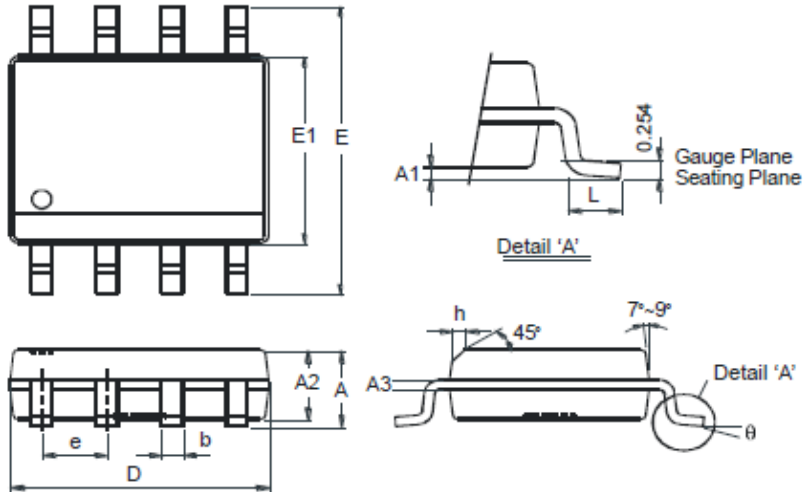


Typical Short Circuit Protection

Package Outline Dimensions

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

SO-8

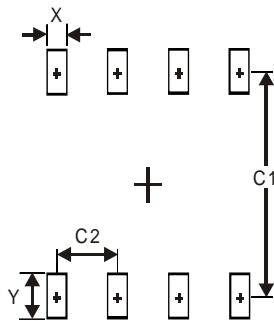


SO-8		
Dim	Min	Max
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

Suggested Pad Layout

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

SO-8



Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

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