

## Description

The ZXGD3102 is intended to drive MOSFETs configured as ideal diode replacements. The device is comprised of a differential amplifier detector stage and high current driver. The detector monitors the reverse voltage of the MOSFET such that if body diode conduction occurs a positive voltage is applied to the MOSFET's Gate pin.

Once the positive voltage is applied to the Gate the MOSFET switches on allowing reverse current flow. The detectors' output voltage is then proportional to the MOSFET Drain-Source reverse voltage drop and this is applied to the Gate via the driver. This action provides a rapid turn off as current decays.

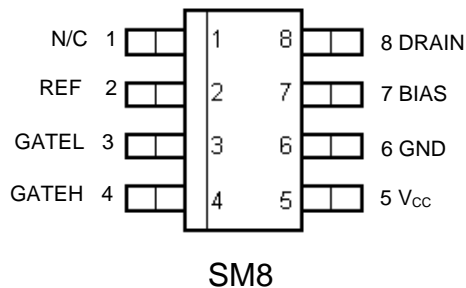
## Features

- Turn-off time typically 105ns
- 180V blocking voltage
- Proportional Gate drive
- 2A Source, 5A Sink driver
- V<sub>CC</sub> Range 5-15V
- Low component count

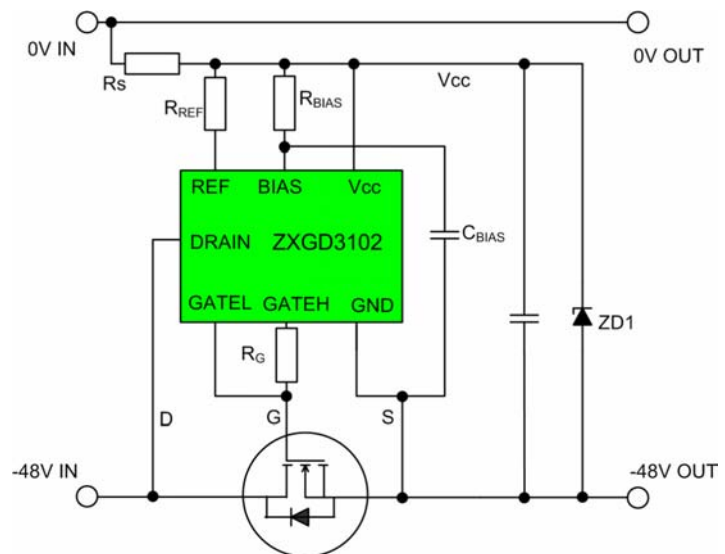
## Applications

- High Side OR'ing diode replacement for Servers, Computer
- Low Side OR'ing diode replacement for Telecoms
- Ideal diode applications

## Pin out details



## Typical Configuration



## Ordering information

Device	Status	Package	Part Mark	Reel size (inches)	Tape width (mm)	Quantity per reel
ZXGD3102T8TA	Active	SM8	ZXGD3102	7	12	1000

**Absolute maximum ratings**

Parameter	Symbol	Limit	Unit
Supply voltage <sup>1</sup>	$V_{CC}$	15	V
Continuous Drain pin voltage <sup>1</sup>	$V_D$	-3 to 180	V
GATEH and GATEL output Voltage <sup>1</sup>	$V_G$	-3 to $V_{CC} + 3$	V
Driver peak source current	$I_{SOURCE}$	4	A
Driver peak sink current	$I_{SINK}$	7	A
Reference current	$I_{REF}$	25	mA
Bias voltage	$V_{BIAS}$	$V_{CC}$	V
Bias current	$I_{BIAS}$	100	mA
Power dissipation at $T_A=25^\circ\text{C}$	$P_D$	500	mW
Operating junction temperature	$T_j$	-40 to +150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-50 to +150	$^\circ\text{C}$

Notes:

1. All voltages are relative to GND pin

**Thermal resistance**

Parameter	Symbol	Value	Unit
Junction to ambient (*)	$R_{\theta JA}$	250	$^\circ\text{C/W}$
Junction to case (†)	$R_{\theta JC}$	54	$^\circ\text{C/W}$

**Notes:**

(\*) Mounted on minimum 1oz copper on FR4 PCB in still air conditions

(†) Junction to solder point at the end of the lead 5 and 6

**ESD Rating**

Model	Rating	Unit
Human body	4,000	V
Machine	400	V

DC Electrical characteristics at  $T_A = 25^\circ\text{C}$ ;  
 $V_{CC} = 10\text{V}$ ;  $R_{BIAS} = 3.3\text{k}\Omega$ ;  $R_{REF} = 3.9\text{k}\Omega$

Parameter	Symbol	Conditions	Min.	Typ	Max.	Unit
<b>Input and supply characteristics</b>						
Operating current	$I_{OP}$	$V_D \leq -100\text{mV}$	-	2.4	-	mA
		$V_D \geq 0\text{V}$	-	5.2	-	
<b>Gate Driver</b>						
Turn-off Threshold Voltage(**)	$V_T$	$V_G = 1\text{V}, (*)$	-50	-24	0	mV
GATE output voltage (**)	$V_{G(off)}$	$V_D \geq 0\text{V}, (*)$	-	0.58	1	V
		$V_G$	$V_D = -60\text{mV}, (\dagger)$	4.1	7	
	$V_D = -80\text{mV}, (\dagger)$		6.5	8.5	-	
	$V_D = -100\text{mV}, (\dagger)$		8.0	9	-	
	$V_D = -140\text{mV}, (\dagger)$		8.5	9.4	-	
GATEH peak source current	$I_{SOURCE}$	$V_{GH} = 1\text{V}$		2	-	A
GATEL peak sink current	$I_{SINK}$	$V_{GL} = 5\text{V}$	5	-	-	A

DC Electrical Characteristics at  $T_A = 25^\circ\text{C}$ ;  
 $V_{CC} = 10\text{V}$ ;  $R_{BIAS} = 3.9\text{k}\Omega$ ;  $R_{REF} = 3.9\text{k}\Omega$

Parameter	Symbol	Conditions	Min.	Typ	Max.	Unit
<b>Input and supply characteristics</b>						
Operating current	$I_{OP}$	$V_D \leq -100\text{mV} (\dagger)$	-	2.4	-	mA
		$V_D \geq 0\text{V} (*)$	-	4.8	-	
<b>Gate Driver</b>						
Turn-off Threshold Voltage(**)	$V_T$	$V_G = 1\text{V}, (*)$	-55	-29	0	mV
GATE output voltage (**)	$V_{G(off)}$	$V_D \geq 0\text{V}, (*)$	-	0.57	1	V
		$V_G$	$V_D = -60\text{mV}, (\dagger)$	3.5	6.5	
	$V_D = -80\text{mV}, (\dagger)$		6.5	8.5	-	
	$V_D = -100\text{mV}, (\dagger)$		8.0	8.8	-	
	$V_D = -140\text{mV}, (\dagger)$		8.5	9.4	-	
GATEH peak source current	$I_{SOURCE}$	$V_{GH} = 1\text{V}$		2	-	A
GATEL peak sink current	$I_{SINK}$	$V_{GL} = 5\text{V}$	5	-	-	A

**Notes:**

(\*\*) GATEH connected to GATEL

(\*)  $R_H = 100\text{k}\Omega$ ,  $R_L = \text{O/C}$ ;  $R_H$  needed only for characterization purposes, not in the application

(†)  $R_L = 100\text{k}\Omega$ ,  $R_H = \text{O/C}$ ;  $R_L$  needed only for characterization purposes, not in the application

Transient Electrical Characteristics at  $T_A = 25^\circ\text{C}$ ;  
 $V_{CC} = 10\text{V}$ ;  $R_{BIAS} = 3.9\text{k}\Omega$ ;  $R_{REF} = 3.9\text{k}\Omega$

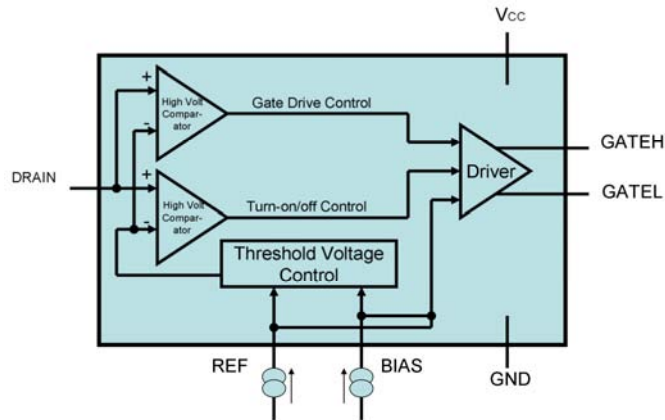
Turn on Propagation delay	$t_{d1}$	$C_L = 3.3\text{nF}$ ,	1880	ns
Turn off Propagation delay	$t_{d2}$		30	ns
Gate rise time	$t_r$	$C_{BIAS} = 1\text{nF}$ ,	9520	ns
Gate fall time	$t_f$	(†) (a)	75	ns

$V_{CC} = 10\text{V}$ ;  $R_{BIAS} = 3.9\text{k}\Omega$ ;  $R_{REF} = 3.9\text{k}\Omega$

Turn on Propagation delay	$t_{d1}$	$C_L = 10\text{nF}$ ,	1940	ns
Turn off Propagation delay	$t_{d2}$		32	ns
Gate rise time	$t_r$	$C_{BIAS} = 1\text{nF}$ ,	9840	ns
Gate fall time	$t_f$	(†) (a)	78	ns

(a) Refer to Fig 4: test circuit and Fig 5: timing diagram

### Schematic Symbol and Pin Out Details



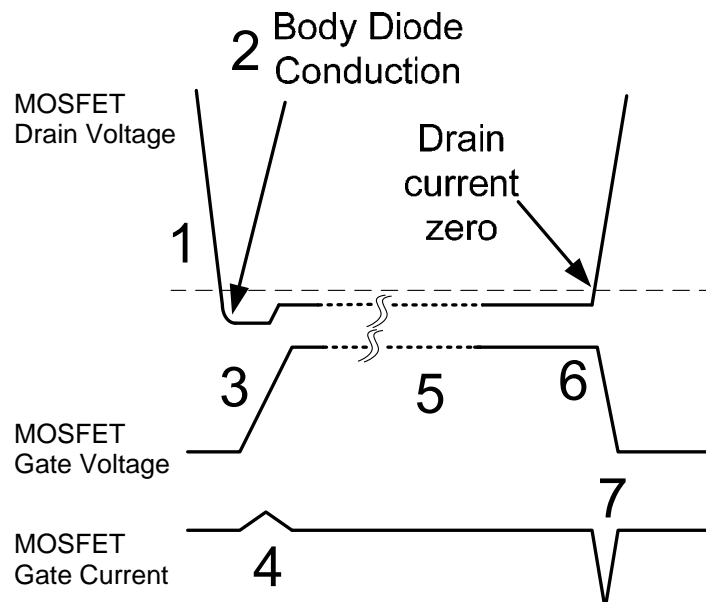
Pin No.	Symbol	Description and function
1	NC	<b>No connection</b> This pin can be connected to GND
2	REF	<b>Reference</b> This pin is connected to $V_{CC}$ via resistor, $R_{REF}$ . $R_{REF}$ should be selected to source approximately 2.4mA into this pin. See Note 1
3	GATEL	<b>Gate turn off</b> This pin sinks current, $I_{SINK}$ , from the OR'ing MOSFET Gate
4	GATEH	<b>Gate turn on</b> This pin sources current, $I_{SOURCE}$ , to the OR'ing MOSFET Gate
5	$V_{CC}$	<b>Power Supply</b> This is the supply pin. Decouple this point to ground with a ceramic capacitor
6	GND	<b>Ground</b> This is the ground reference point. Connect to the OR'ing MOSFET Source terminal
7	BIAS	<b>Bias</b> This pin is connected to $V_{CC}$ via $R_{BIAS}$ . $R_{BIAS}$ should be selected to source either 1 or 1.2 times $I_{REF}$ into this pin depending on the desired turn-off threshold voltage, $V_T$ . See Note 1
8	DRAIN	<b>Drain connection</b> This pin connects directly to the OR'ing MOSFET Drain terminal

Note 1- **BIAS** and **REF** pins should be assumed to be at **GND+0.7V**.

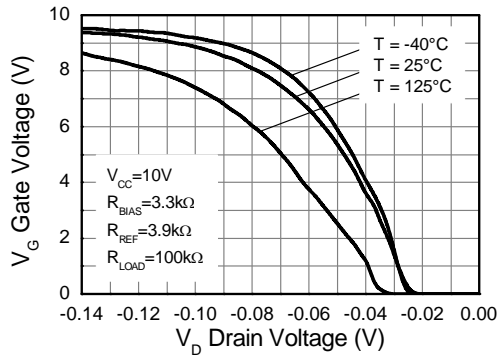
## Operation

The operation of the device is described step-by-step with reference to the timing diagram below.

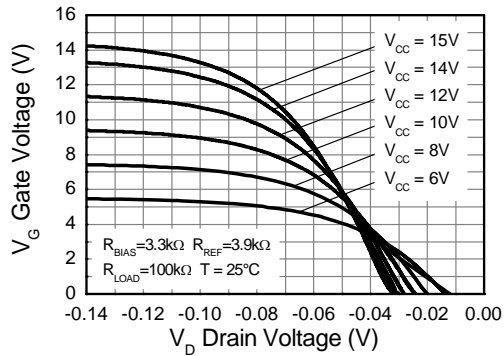
1. The detector monitors the MOSFET Drain-Source voltage.
2. At system start up, the MOSFET body diode is forced to conduct current from the input power supply to the load and there is approximately -0.6V on the Drain pin.
3. The detector outputs a positive voltage with respect to ground, this voltage is then fed to the MOSFET driver stage and current is sourced out of the GATEH pin. The turn on time of the MOSFET can be programmed through an external resistor  $R_G$ . Refer to "Speed vs. Gate resistance" graph.
4. The current out of the GATEH pin is sourced into the OR'ing MOSFET Gate to turn the device on.
5. The GATEH output voltage is proportional to the Drain-Source voltage drop across the MOSFET due to the load current flowing through the MOSFET. The controller increases its output gate voltage when the Drain current is high to ensure full MOSFET enhancement
6. If a short condition occurs on the input power supply it causes the OR'ing MOSFET Drain current to fall very quickly.
7. When the Drain-Source differential voltage drops below the turn off threshold, the MOSFET Gate voltage is pulled low by GATEL, turning the device off. This prevents high reverse current flow from the load to the input power supply which could pull down the common bus voltage causing catastrophic system failure



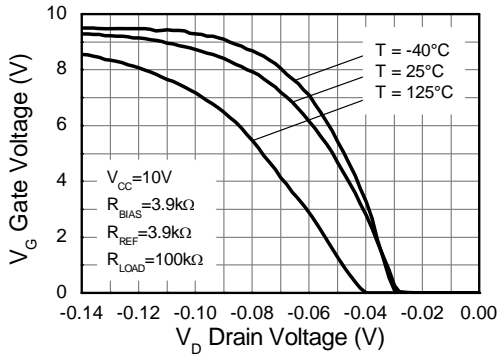
Typical characteristics



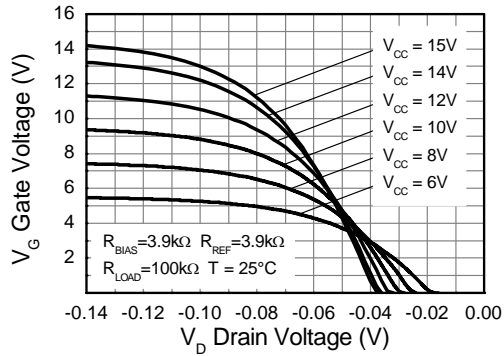
Transfer Characteristic



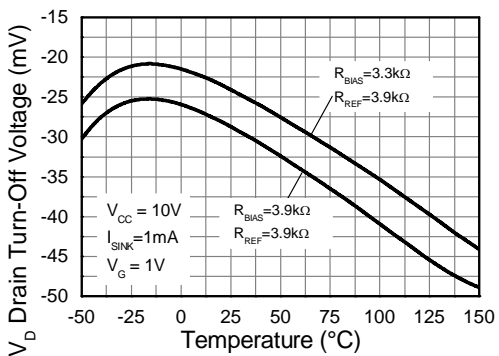
Transfer Characteristic



Transfer Characteristic

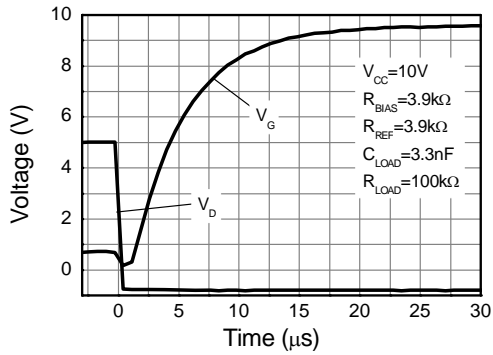


Transfer Characteristic

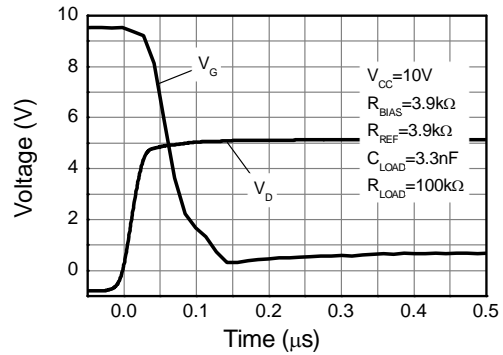


Turn-Off Voltage vs Temperature

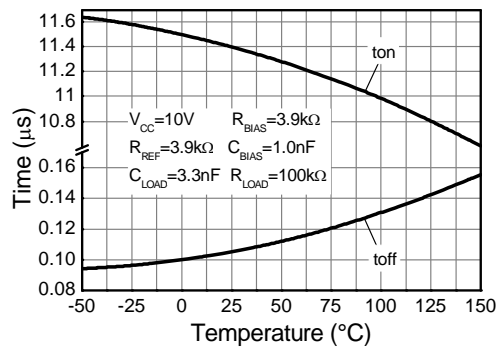
Typical characteristics



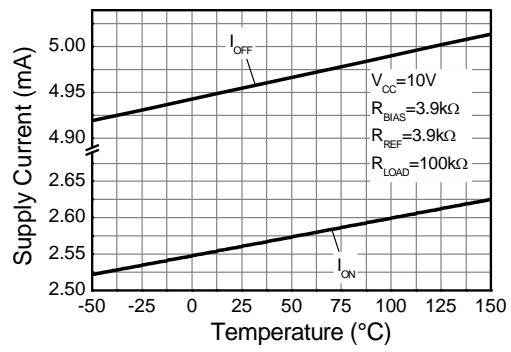
Switch-On Speed



Switch-Off Speed

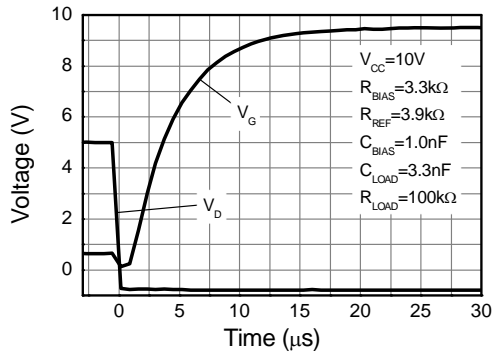


Speed vs Temperature

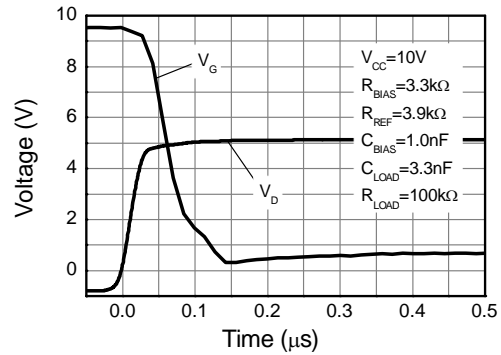


Supply Current vs Temperature

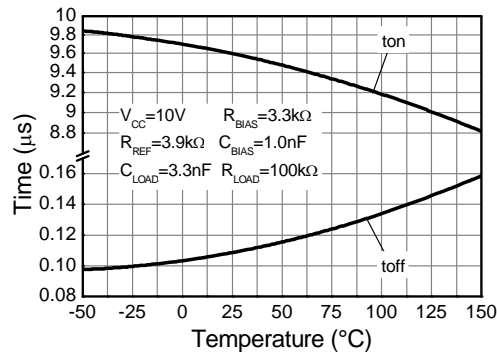
Typical characteristics



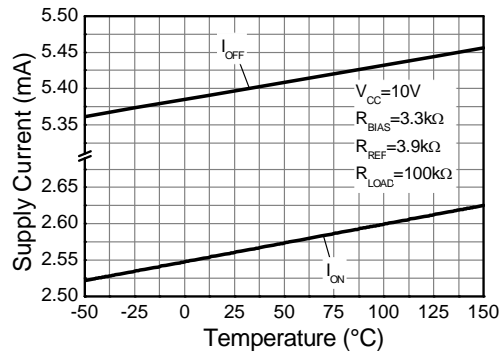
Switch-On Speed



Switch-Off Speed



Speed vs Temperature



Supply Current vs Temperature



## Component Selection

It is advisable to decouple the ZXGD3102 closely to  $V_{CC}$  and ground due to the possibility of high peak gate currents, as indicated by C1 in Figure 4. In applications where the input voltage is higher than 12V, it is recommended to use a Zener diode, ZD1 as shown in the Typical Application Circuit on page 1, and in Figure 2, in order to limit the  $V_{CC}$  supply voltage to the ZXGD3102 and also to limit the maximum voltage applied to the gate of the MOSFET. A suitable value for the Zener is 10V.

The proper selection of external resistors  $R_{REF}$  and  $R_{BIAS}$  is important to the optimum device operation. Select a value for resistor  $R_{REF}$  to give a reference current,  $I_{REF}$ , of ~2.4mA. The value of  $R_{BIAS}$  must then be selected to give a bias current,  $I_{BIAS}$ , of approximately 1.2 times  $I_{REF}$ . This sets the turn-off threshold voltage  $V_T$  of the controller to '-24mV' at  $V_{CC} = 10V$ .

$$R_{REF} = (V_{CC} - 0.7V) / 0.0024$$

$$R_{BIAS} = (V_{CC} - 0.7V) / 0.0028$$

Alternatively,  $R_{REF}$  and  $R_{BIAS}$  can be chosen to be equal to set the turn-off threshold voltage  $V_T$  to '-29mV' at  $V_{CC} = 10V$ . This also reduces the IC current consumption when the gate voltage is off.

External gate resistor to GATEH pin is optional. It can be inserted to control the turn-on gate rise time which may help with in-rush current protection, EMI issues or power dissipation within the part. The addition of  $C_{BIAS}$  controls the switch-on delay of the MOSFET, and ensures stability. A suitable value is 1nF.

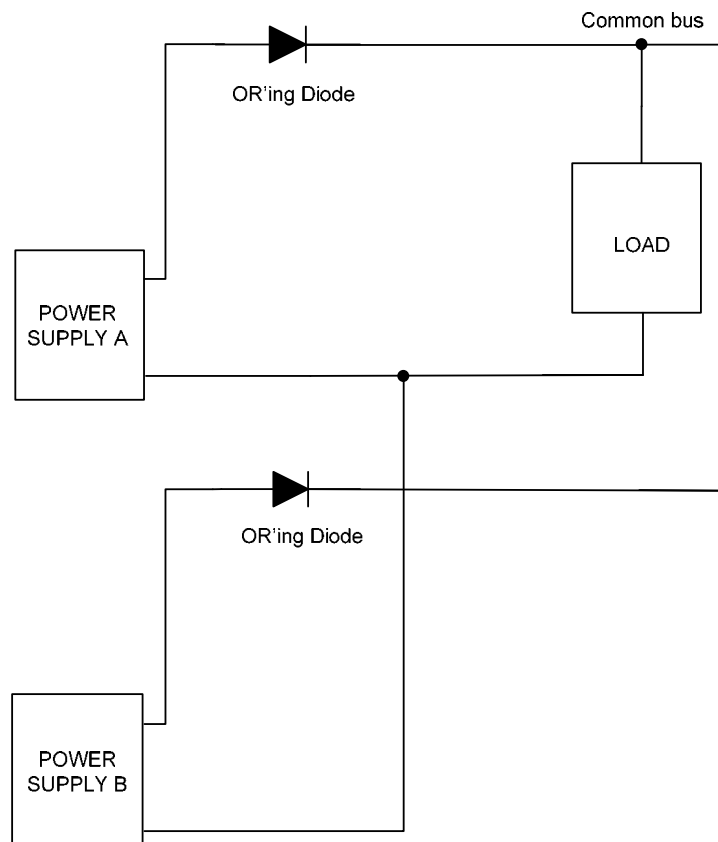
## Layout considerations

The Gate pins should be as close to the MOSFET gate as possible. Also the ground return loop should be as short as possible. The decoupling capacitor should be close to the  $V_{CC}$  and Ground pin, and should be a X7R type. Trace widths should be maximized in the high current path through the MOSFET and ground return in order to minimize the effects of circuit inductance and resistance.

For best thermal performance, the PCB heat path from pins 5 and 6 needs attention. The area of copper connected to pins 5 and 6 should be maximised.

## Active OR'ing or N+1 redundancy

- In normal operation, power supply A and B share the load for maximum reliability.
- Power supply A supports the load if power supply B fails and vice versa.
- Blocking diodes protect the load from a faulty power supply affecting the load voltage.
- The load can be tens of amps.
- Dissipation in the diodes can be high!
- The ZXGD3102 is designed to switch the low on-resistance MOSFETs used to replace the blocking diodes.



**Figure 1: OR'ING with Schottky Diodes**

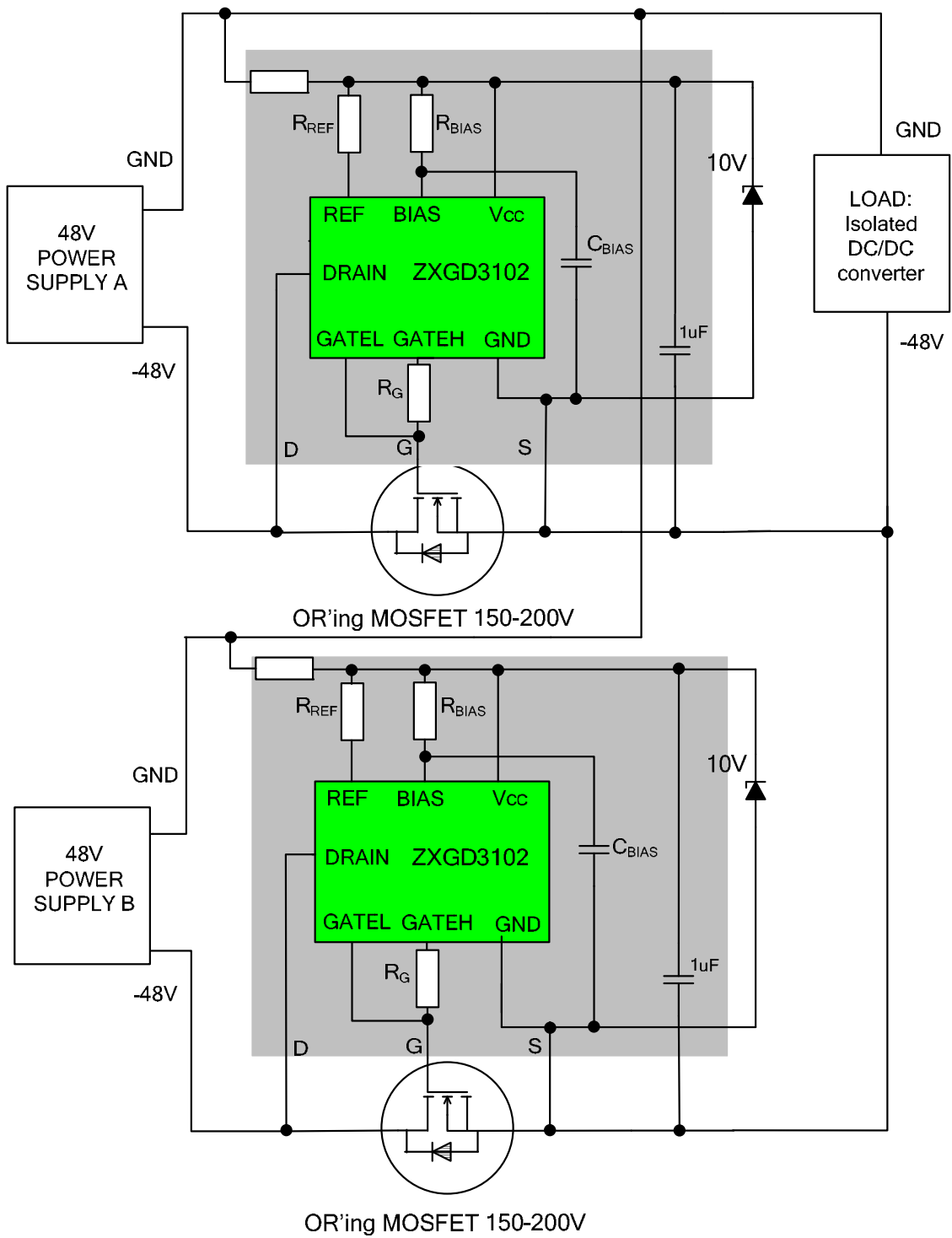


Figure 2: Negative telecom active OR'ing evaluation

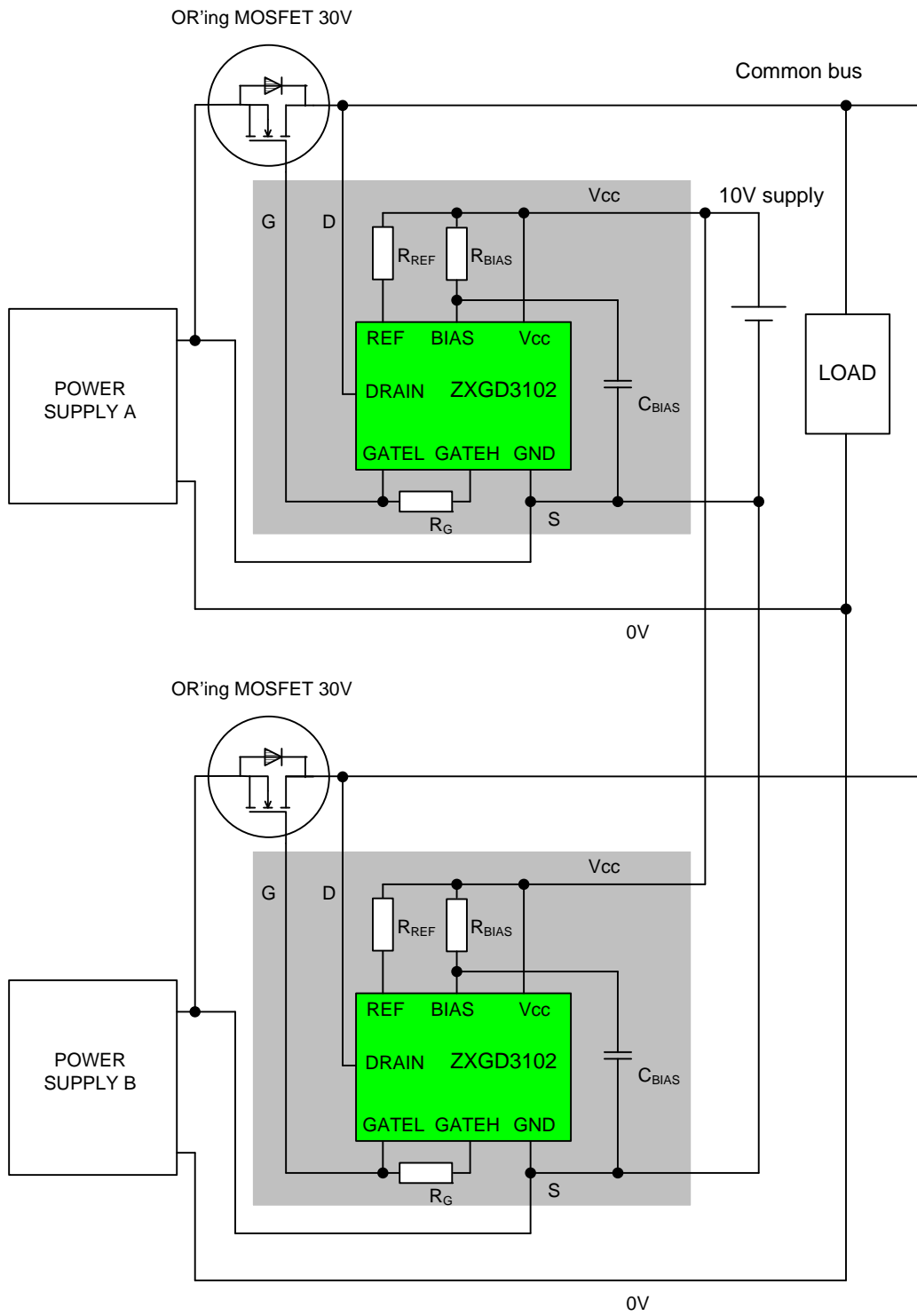


Figure 3: Positive rail power supply active OR'ing evaluation

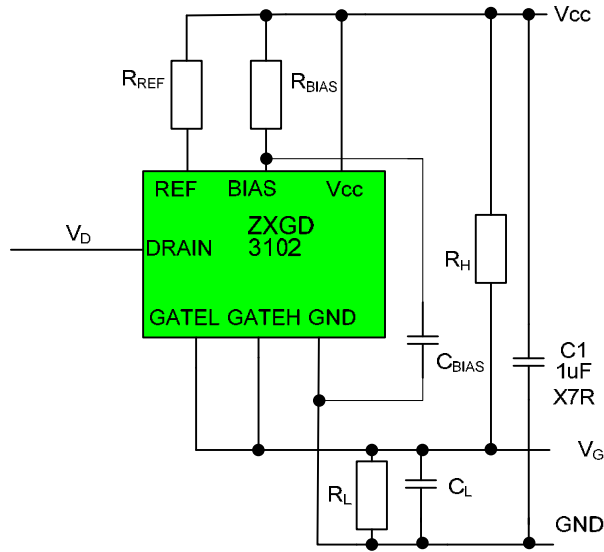


Figure 4: Test Circuit

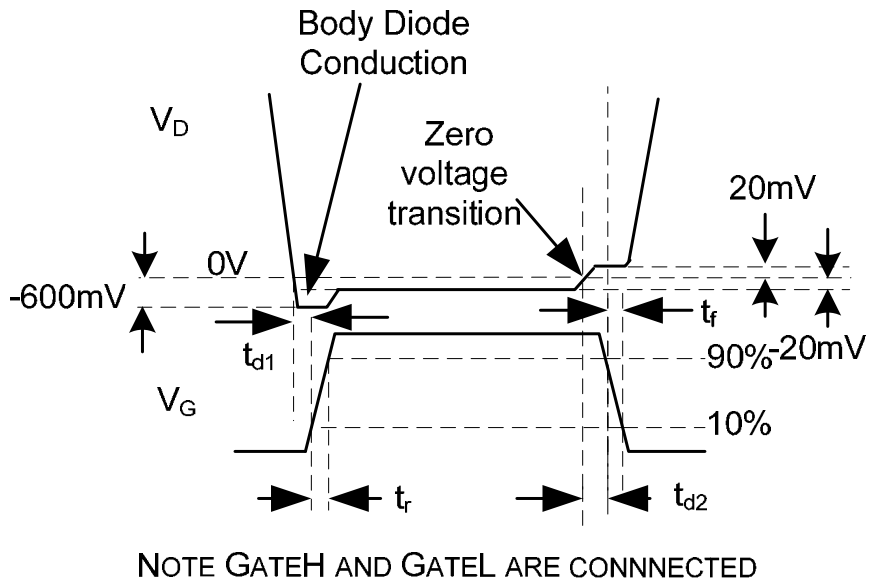
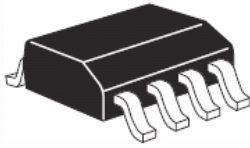


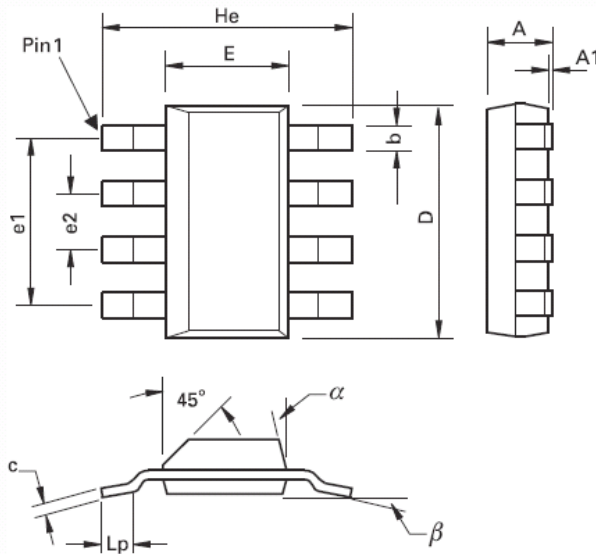
Figure 5: Timing Diagram



## Package information - SM8

Surface mounted, 8 pin package

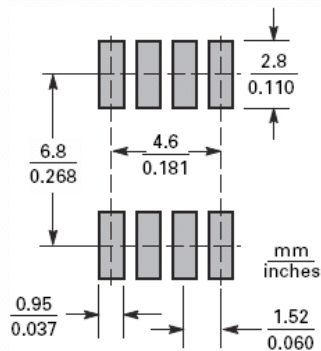
### Package outline



DIM	Millimeters			Inches			DIM	Millimeters			Inches		
	Min.	Max.	Typ.	Min.	Max.	Typ.		Min.	Max.	Typ.	Min.	Max.	Typ.
A	-	1.7	-	-	0.067	-	e1	-	-	4.59	-	-	0.1807
A1	0.02	0.1	-	0.0008	0.004	-	e2	-	-	1.53	-	-	0.0602
b	-	-	0.7	-	-	0.0275	He	6.7	7.3	-	0.264	0.287	-
c	0.24	0.32	-	0.009	0.013	-	Lp	0.9	-	-	0.035	-	-
D	6.3	6.7	-	0.248	0.264	-	$\alpha$	-	15°	-	-	15°	-
E	3.3	3.7	-	0.130	0.145	-	$\beta$	-	-	10°	-	-	10°

Note: Controlling dimensions are in millimeters. Approximate dimensions are provided in inches

### Soldering footprint



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