

## ZXGD3101T8

### Synchronous rectifier controller for flyback converters.

#### Description

The ZXGD3101 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 propagation delay 15ns and turn-off time 20ns
- Suitable for Discontinuous Mode (DCM), Critical Conduction Mode (CrCM) and Continuous conduction mode (CCM) operation
- Compliant with Energy Star V2.0 and European Code of Conduct V3
- Low component count
- Halogen free
- 5-15V  $V_{CC}$  range

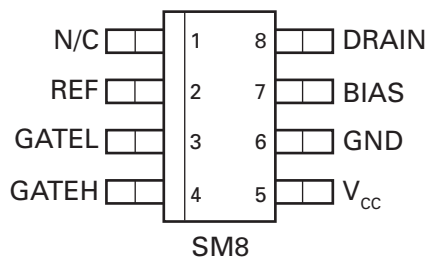
#### Applications

Flyback converters in:

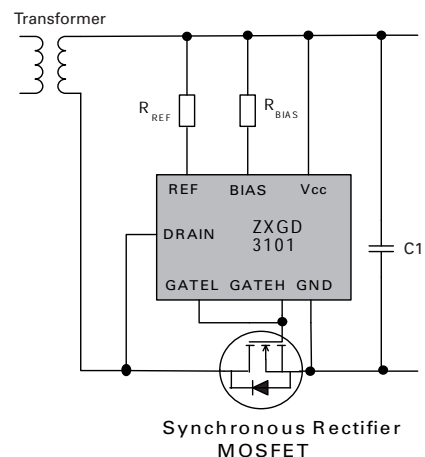
- Adaptors
- LCD monitors
- Server PSU's
- Set top boxes

Refer to documents; AN54, DN90, DN91 and DN94 available from the website

#### Pin out detail



#### Typical configuration



#### Ordering information

| Device       | Status | Package | Part Mark | Reel size (inches) | Tape width (mm) | Quantity per reel |
|--------------|--------|---------|-----------|--------------------|-----------------|-------------------|
| ZXGD3101T8TA | Active | SM8     | ZXGD3101  | 7                  | 12              | 1000              |

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## 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 lead (†)    | $R_{\theta IA}$ | 54    | $^\circ\text{C/W}$ |

### NOTES:

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

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

## ESD Rating

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

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Electrical characteristics at  $T_A = 25^\circ\text{C}$ ;

$V_{CC} = 10\text{V}$ ;  $R_{BIAS} = 1.8\text{k}\Omega$ ;  $R_{REF} = 3\text{k}\Omega$

| Parameter                                  | Symbol       | Conditions                           | Min. | Typ. | Max. | Unit |
|--|--------------|--------------------------------------|------|------|------|------|
| <b>Input and supply characteristics</b>    |              |                                      |      |      |      |      |
| Operating current                          | $I_{OP}$     | $V_{DRAIN} \leq -200\text{mV}$       | -    | 3    | -    | mA   |
|  |              | $V_{DRAIN} \geq 0\text{V}$           | -    | 8    | -    |      |
| <b>Gate Driver</b>                         |              |                                      |      |      |      |      |
| Turn-off Threshold Voltage <sup>(**)</sup> | $V_T$        | $V_G = 1\text{V}$ , (*)              | -45  | -16  | 0    | mV   |
| GATE output voltage <sup>(**)</sup>        | $V_{G(off)}$ | $V_{DRAIN} \geq 0\text{V}$ , (*)     | -    | 0.6  | 1    | V    |
|  | $V_G$        | $V_{DRAIN} = -60\text{mV}$ , (†)     | 5.0  | 7.5  | -    |      |
|  |              | $V_{DRAIN} = -80\text{mV}$ , (†)     | 7.0  | 8.5  | -    |      |
|  |              | $V_{DRAIN} = -100\text{mV}$ , (†)    | 8.4  | 9    | -    |      |
|  |              | $V_{DRAIN} \leq -140\text{mV}$ , (†) | 9.2  | 9.4  | -    |      |
|  |              | $V_{DRAIN} \leq -200\text{mV}$ , (†) | 9.3  | 9.5  | -    |      |
| GATEH peak source current                  | $I_{SOURCE}$ | $V_{GH} = 1\text{V}$                 |      | 2.5  | -    | A    |
| GATEL peak sink current                    | $I_{SINK}$   | $V_{GL} = 5\text{V}$                 |      | 2.5  | -    | A    |
| Turn on Propagation delay                  | $t_{d1}$     | $C_L = 2.2\text{nF}$ , (†) (a)       |      | 525  |      | ns   |
| Turn off Propagation delay                 | $t_{d2}$     |                                      |      | 15   |      | ns   |
| Gate rise time                             | $t_r$        |                                      |      | 305  |      | ns   |
| Gate fall time                             | $t_f$        |                                      |      | 20   |      | ns   |

**NOTES:**

(\*\*) GATEH connected to GATEL

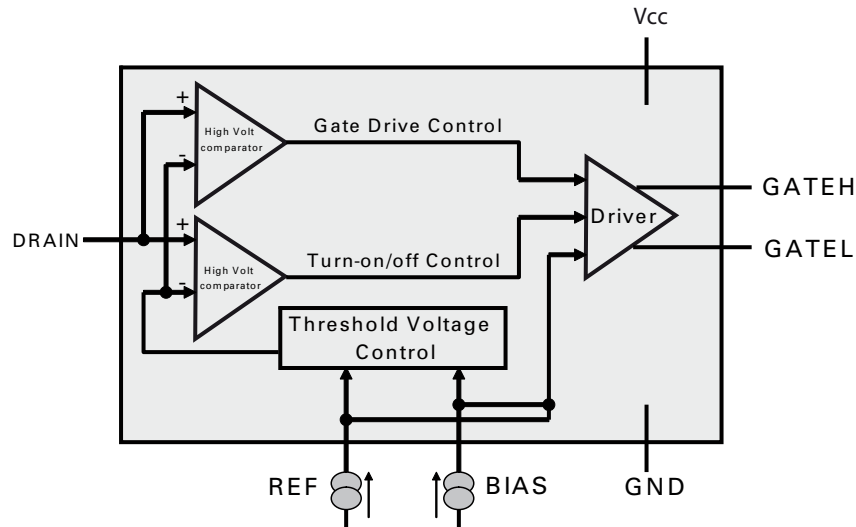
(\*)  $R_H = 100\text{k}\Omega$ ,  $R_L = 0/\text{C}$

(†)  $R_L = 100\text{k}\Omega$ ,  $R_H = 0/\text{C}$

(a) (Refer to Fig 4; Test circuit and Fig 5; Timing diagram on page 11

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## Schematic symbol and pin description



| Pin No. | Symbol   | Description and function   |
|---------|----------|--|
| 1       | NC       | <b>No connection</b><br>This pin can be connected to GND   |
| 2       | REF      | <b>Reference</b><br>This pin is connected to $V_{CC}$ via resistor, $R_{REF}$ . $R_{REF}$ should be selected to source $\sim 3\text{mA}$ into this pin. See note 1 |
| 3       | GATEL    | <b>Gate turn off</b><br>This pin sinks current, $I_{SINK}$ , from the synchronous MOSFET Gate.   |
| 4       | GATEH    | <b>Gate turn on</b><br>This pin sources current, $I_{SOURCE}$ , to the synchronous MOSFET Gate.  |
| 5       | $V_{CC}$ | <b>Power Supply</b><br>This is the supply pin. It is recommended to decouple this point to ground closely with a ceramic capacitor.                                |
| 6       | GND      | <b>Ground</b><br>This is the ground reference point. Connect to the synchronous MOSFET Source terminal.  |
| 7       | BIAS     | <b>Bias</b><br>This pin is connected to $V_{CC}$ via resistor, $R_{BIAS}$ . $R_{BIAS}$ should be selected to source 1.6 times $I_{REF}$ into this pin. See note 1  |
| 8       | DRAIN    | <b>Drain connection</b><br>This pin connects directly to the synchronous MOSFET Drain terminal.  |

### NOTES:

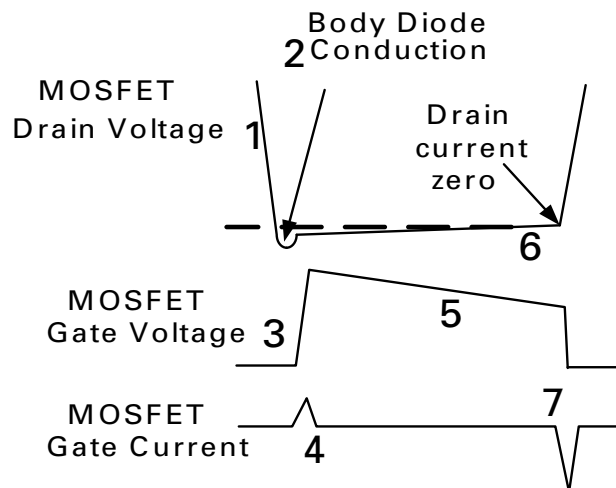
1. BIAS and REF pins should be assumed to be at  $\text{GND}+0.7\text{V}$

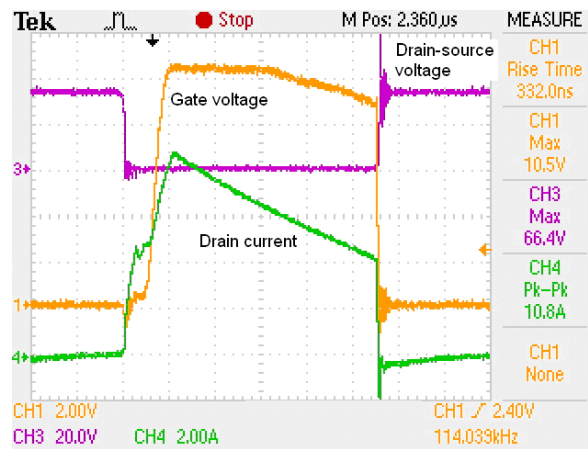
## Operation

### Normal Operation

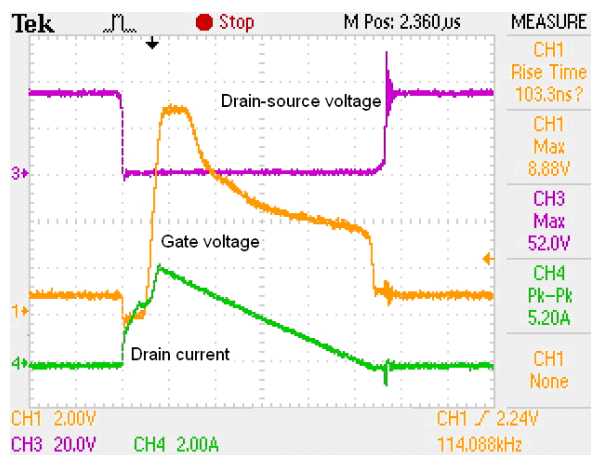
The operation of the device is described step-by-step with reference to the timing diagram below.

1. The detector monitors the MOSFET Drain-Source voltage.
2. When, due to transformer action, the MOSFET body diode is forced to conduct 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.
4. The current out of the GATEH pin is sourced into the synchronous MOSFET Gate to turn the device on.
5. The GATEH output voltage is now proportional to the Drain-Source voltage drop across the MOSFET due to the current flowing through the MOSFET.
6. MOSFET conduction continues until the drain current reaches zero.
7. At zero current the detector output voltage is zero and the synchronous MOSFET Gate voltage is pulled low by the GATEL, turning the device off.

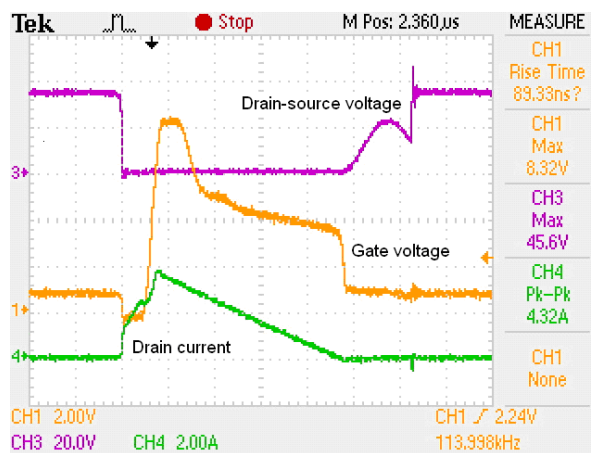




**Fig 1a: Continuous Conduction Mode (CCM)**



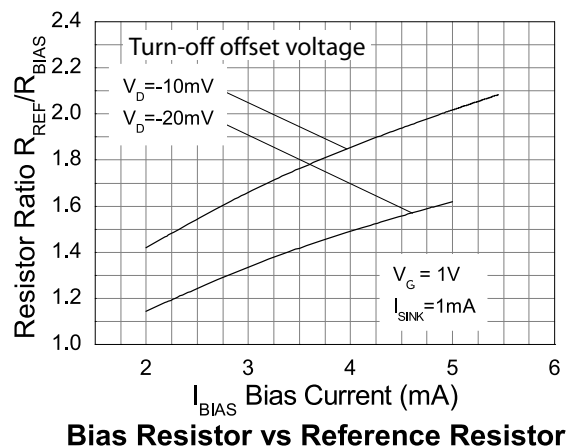
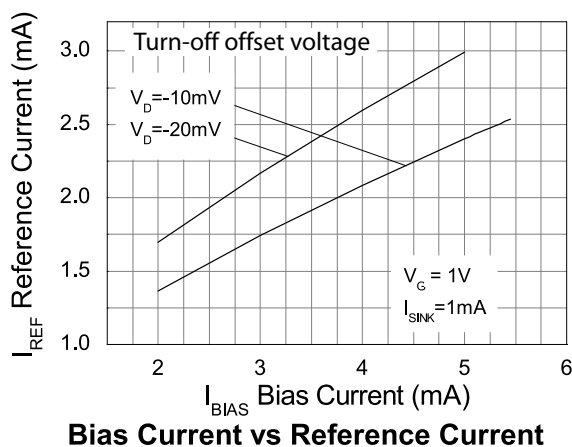
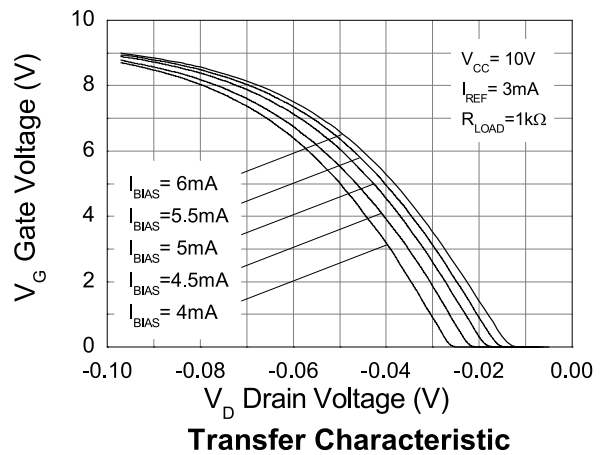
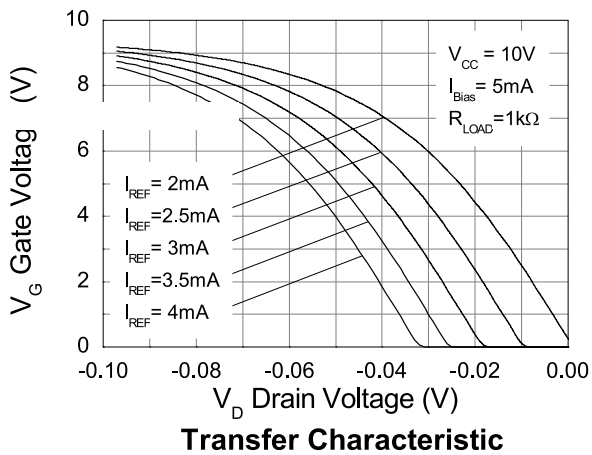
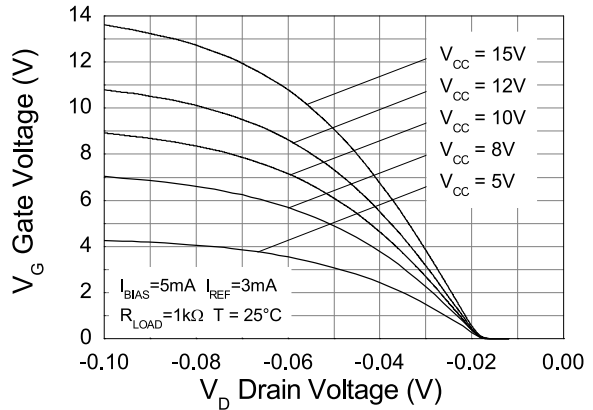
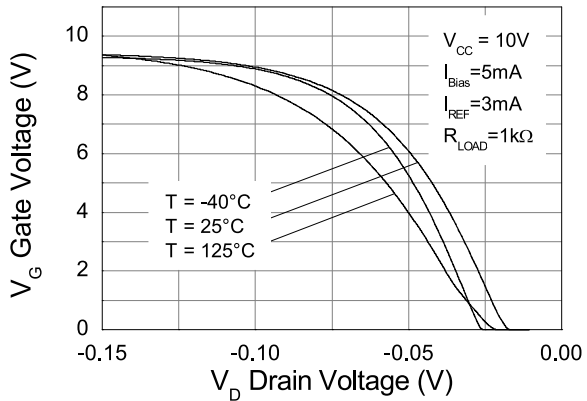
**Fig 1b: Critical Conduction Mode (CrCM)**



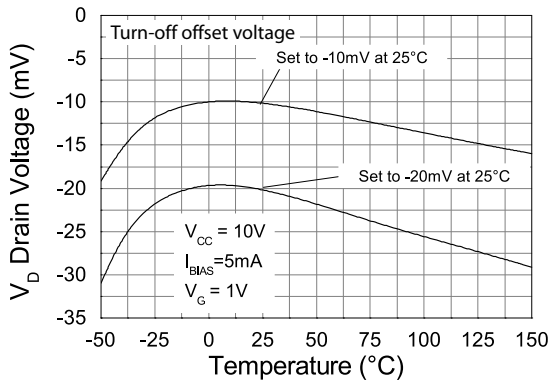
**Fig 1c: Discontinuous Conduction Mode (DCM)**

**Figure 1. Typical waveforms**

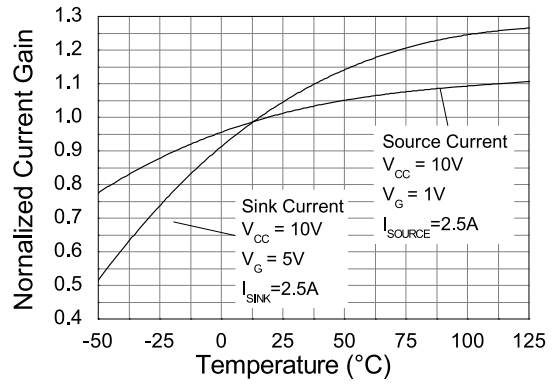
## Typical characteristics



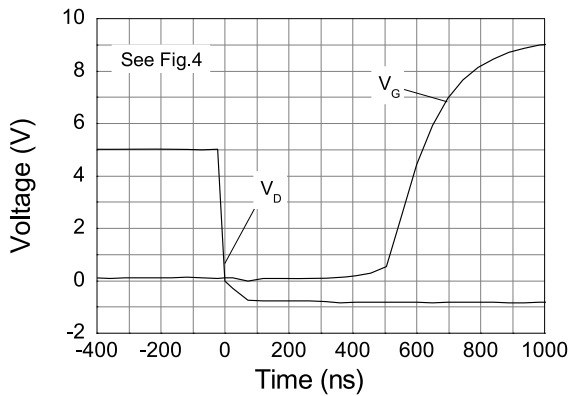
## Typical characteristics



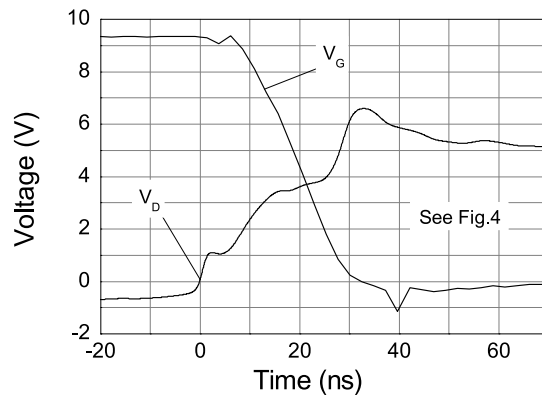
**Drain Sense Voltage vs Temperature**



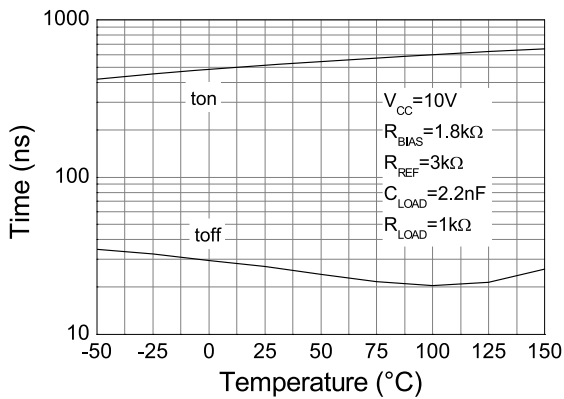
**Output Current vs Temperature**



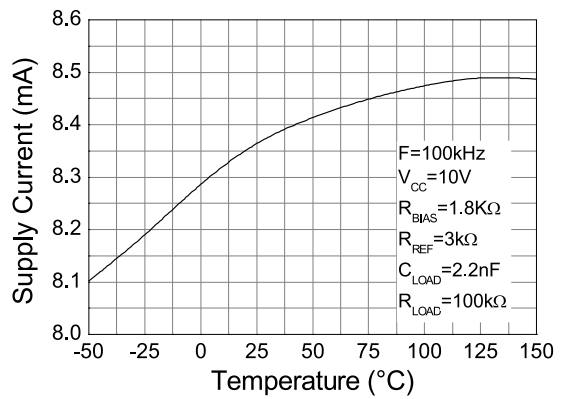
**Switch On Speed**



**Switch Off Speed**



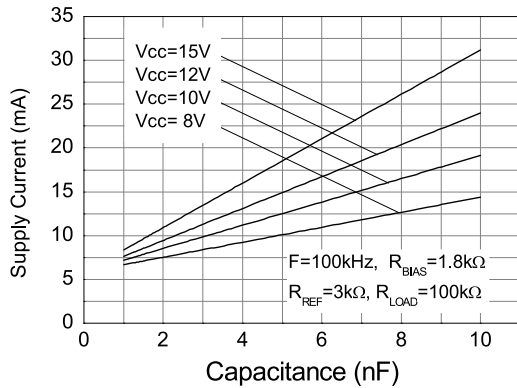
**Switching vs Temperature**



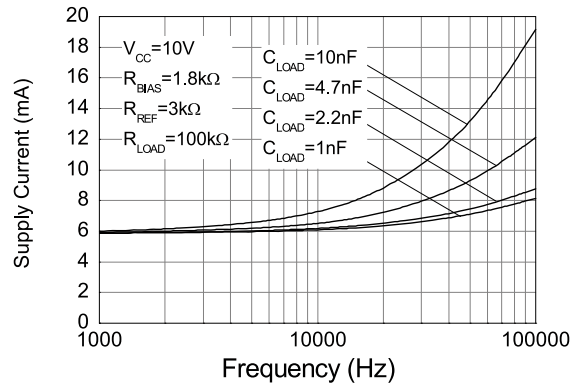
**Supply Current vs Temperature**



## Typical characteristics



Supply Current vs Capacitive Load



Supply Current vs Frequency

## Component selection

It is advisable to decouple the ZXGD3101 closely to  $V_{CC}$  and ground due to the possibility of high peak gate currents with C1 in Figure 2.

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  $\sim 3\text{mA}$ . The value of  $R_{BIAS}$  must then be 0.6 times the value of  $R_{REF}$  to give a bias current,  $I_{BIAS}$ , of 1.6 times  $I_{REF}$ . This provides a recommended typical offset voltage of  $-20\text{mV}$ .

External gate resistors are optional. They can be inserted to control the rise times which may help with EMI issues, power supply consumption issues or dissipation within the part.

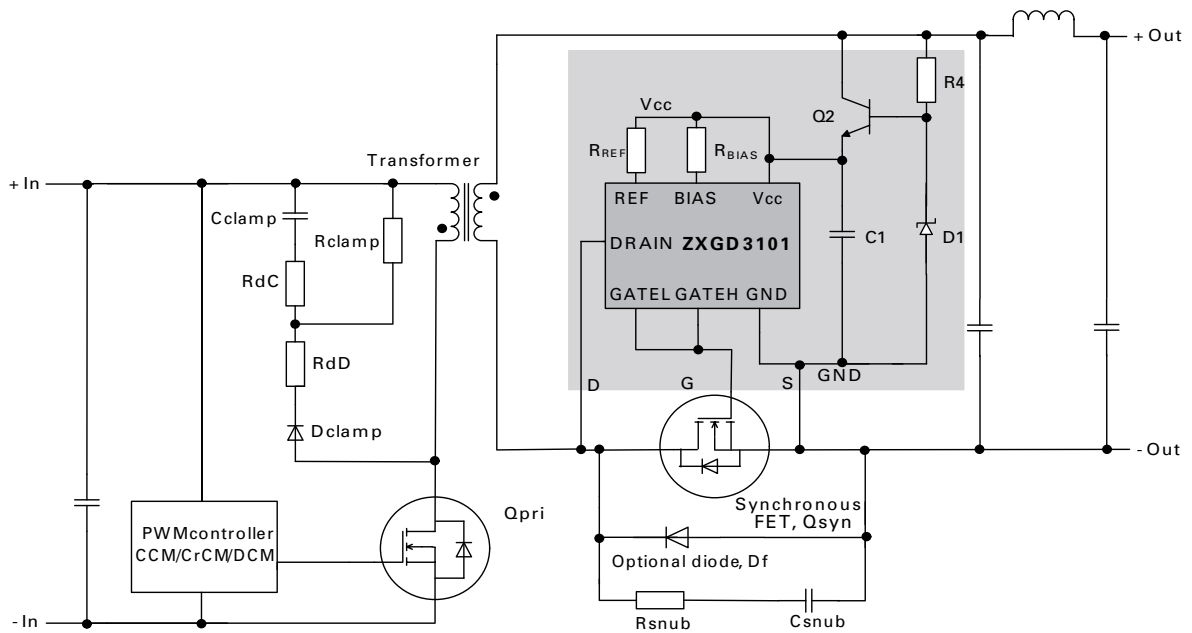
$$R_{REF} = (V_{CC} - 0.7V) / 0.003$$

$$R_{BIAS} = (V_{CC} - 0.7V) / 0.005$$

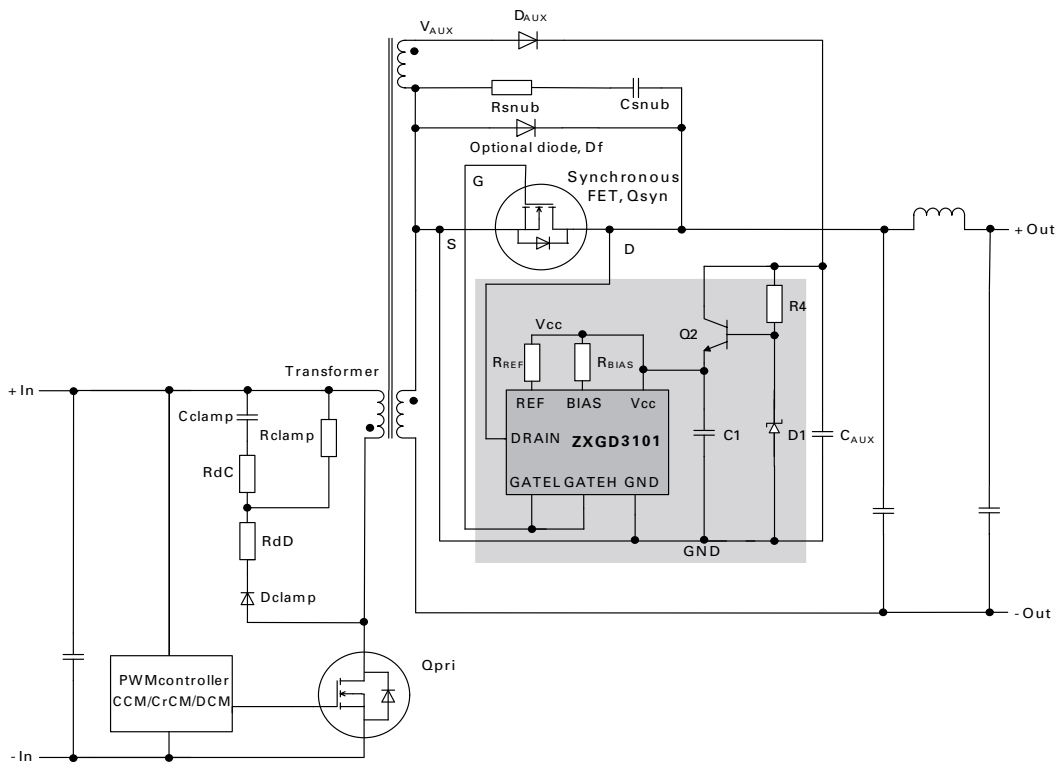
## Layout considerations

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.

For more detailed information refer to application note AN54.



**Figure 2 - Example connection for low side synchronous rectification**



**Figure 3 - Example connection for high side synchronous rectification**

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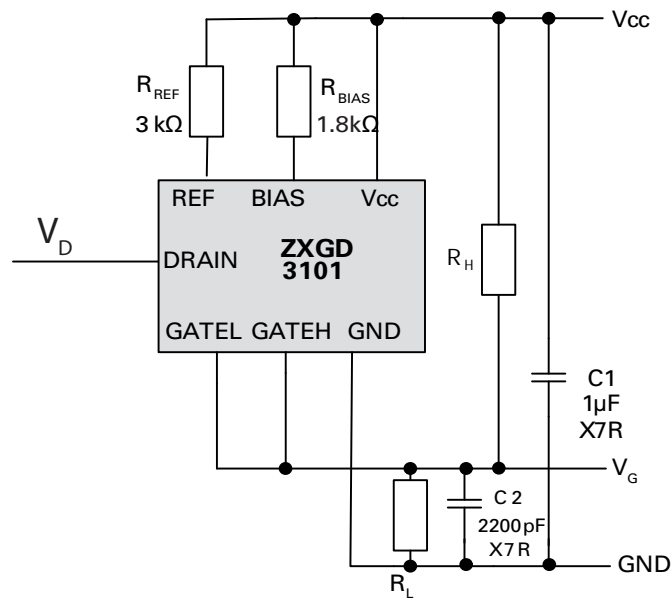
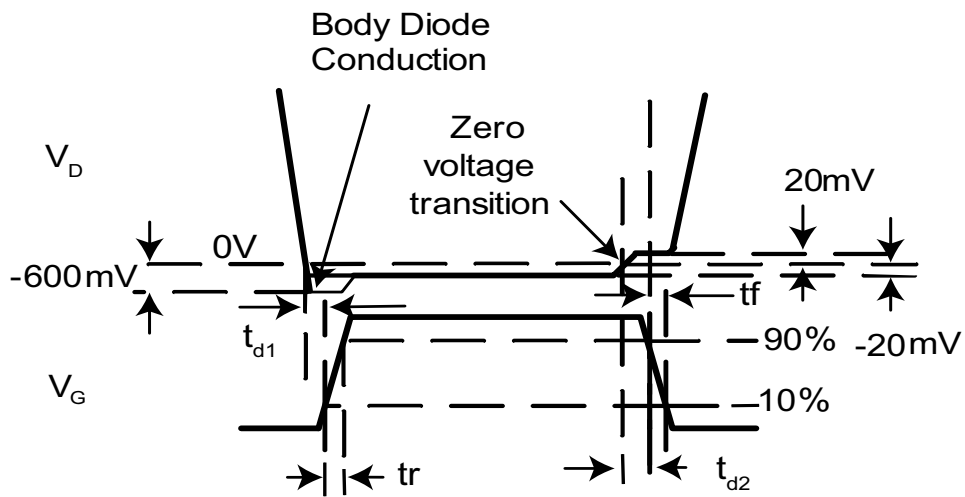


Figure 4: Test circuit

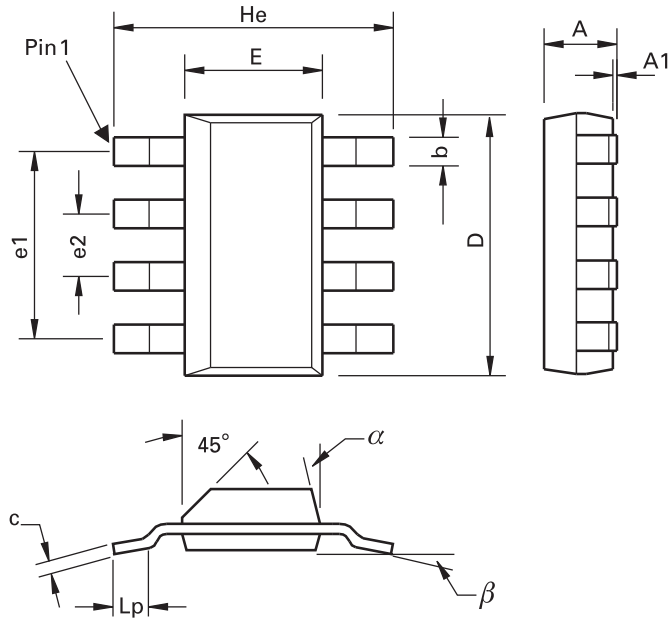


NOTE: GATE H AND GATE L ARE CONNECTED

Figure 5: Timing diagram

# ZXGD3101T8

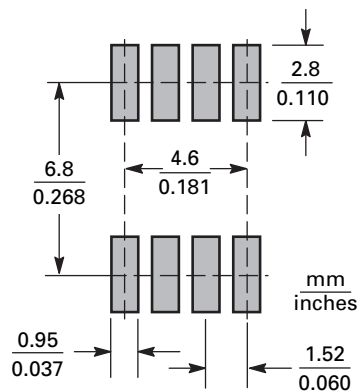
## Package information - SM8 (Surface mounted, 8 pin package)



| 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 | -      | α   | -           | 15°  | -    | -      | 15°   | -      |
| E   | 3.3         | 3.7  | -    | 0.130  | 0.145 | -      | β   | -           | -    | 10°  | -      | -     | 10°    |

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

### Soldering footprint



# ZXGD3101T8

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|                                   |  |
|-----------------------------------|--|
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| "Active"                          | Product status recommended for new designs                                     |
| "Last time buy (LTB)"             | Device will be discontinued and last time buy period and delivery is in effect |
| "Not recommended for new designs" | Device is still in production to support existing designs and production       |
| "Obsolete"                        | Production has been discontinued   |

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|                       |   |
|-----------------------|---|
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