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.

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 VCC 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

Ordering information

<table>
<thead>
<tr>
<th>Device</th>
<th>Status</th>
<th>Package</th>
<th>Part Mark</th>
<th>Reel size (inches)</th>
<th>Tape width (mm)</th>
<th>Quantity per reel</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZXGD3101T8TA</td>
<td>Active</td>
<td>SM8</td>
<td>ZXGD3101</td>
<td>7</td>
<td>12</td>
<td>1000</td>
</tr>
</tbody>
</table>

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.
### Absolute maximum ratings

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

**NOTES:**
1. All voltages are relative to GND pin

### Thermal resistance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction to ambient&lt;sup&gt;(*&lt;sup&gt;)&lt;/sup&gt;</td>
<td>$R_{BJA}$</td>
<td>250</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction to lead&lt;sup&gt;(†)&lt;/sup&gt;</td>
<td>$R_{BIA}$</td>
<td>54</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**NOTES:**

<sup>(*<sup>)</sup></sup> Mounted on minimum 1oz copper on FR4 PCB in still air conditions
<sup>(†)</sup> Output Drivers - Junction to solder point at end of the lead 5 and 6

### ESD Rating

<table>
<thead>
<tr>
<th>Model</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human body</td>
<td>4,000</td>
<td>V</td>
</tr>
<tr>
<td>Machine</td>
<td>400</td>
<td>V</td>
</tr>
</tbody>
</table>
### Electrical characteristics at $T_A = 25^\circ$C;

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

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

**NOTES:**

- (***) GATEH connected to GATEL
- (*) $R_H = 100K\Omega$, $R_L = 0/C$
- (†) $R_L = 100K\Omega$, $R_H = 0/C$
- (a) (Refer to Fig 4; Test circuit and Fig 5; Timing diagram on page 11)
Schematic symbol and pin description

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description and function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>No connection&lt;br&gt;This pin can be connected to GND</td>
</tr>
<tr>
<td>2</td>
<td>REF</td>
<td>Reference&lt;br&gt;This pin is connected to VCC via resistor, RREF. RREF should be selected to source ~3mA into this pin. See note 1</td>
</tr>
<tr>
<td>3</td>
<td>GATEL</td>
<td>Gate turn off&lt;br&gt;This pin sinks current, ISINK, from the synchronous MOSFET Gate.</td>
</tr>
<tr>
<td>4</td>
<td>GATEH</td>
<td>Gate turn on&lt;br&gt;This pin sources current, ISOURCE, to the synchronous MOSFET Gate.</td>
</tr>
<tr>
<td>5</td>
<td>Vcc</td>
<td>Power Supply&lt;br&gt;This is the supply pin. It is recommended to decouple this point to ground closely with a ceramic capacitor.</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>Ground&lt;br&gt;This is the ground reference point. Connect to the synchronous MOSFET Source terminal.</td>
</tr>
<tr>
<td>7</td>
<td>BIAS</td>
<td>Bias&lt;br&gt;This pin is connected to VCC via resistor, RBIAS. RBIAS should be selected to source 1.6 times IREF into this pin. See note 1</td>
</tr>
<tr>
<td>8</td>
<td>DRAIN</td>
<td>Drain connection&lt;br&gt;This pin connects directly to the synchronous MOSFET Drain terminal.</td>
</tr>
</tbody>
</table>

NOTES:

1. BIAS and REF pins should be assumed to be at GND+0.7V
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.
Figure 1. Typical waveforms

Fig 1a: Continuous Conduction Mode (CCM)

Fig 1b: Critical Conduction Mode (CrCM)

Fig 1c: Discontinuous Conduction Mode (DCM)
Typical characteristics

- **Turn-off offset voltage**
  - $V_{CC} = 10V$
  - $I_{REF} = 5mA$
  - $R_{LOAD} = 1k\Omega$

- **Transfer Characteristic**
  - $V_{CC} = 10V$
  - $I_{REF} = 2mA$
  - $I_{REF} = 2.5mA$
  - $I_{REF} = 3mA$
  - $I_{REF} = 3.5mA$
  - $I_{REF} = 4mA$

- **Bias Current vs Reference Current**
  - $V_{cc} = 10mV$
  - $V_{cc} = 20mV$

- **Bias Resistor vs Reference Resistor**
  - $V_{cc} = 10mV$
  - $V_{cc} = 20mV$
Typical characteristics

- **Turn-off offset voltage**
  - $V_{DS} = 10V$
  - $I_{DSS} = 5mA$
  - $V_{G} = 1V$
  - Set to ~10mV at 25°C
  - Set to ~20mV at 25°C

- **Normalized Current Gain**
  - Source Current
    - $V_{CC} = 10V$
    - $V_{D} = 1V$
    - $I_{DSS} = 2.5A$
  - Sink Current
    - $V_{CC} = 10V$
    - $V_{D} = 5V$
    - $I_{DSS} = 2.5A$

- **Switch On Speed**
  - $V_{D}$
  - See Fig.4
  - Voltage (V)
  - Time (ns)

- **Switch Off Speed**
  - $V_{D}$
  - See Fig.4
  - Voltage (V)
  - Time (ns)

- **Switching vs Temperature**
  - $V_{CC} = 10V$
  - $R_{DS} = 1.8kΩ$
  - $R_{DS} = 3kΩ$
  - $C_{DSS} = 2.2nF$
  - $R_{DSS} = 1kΩ$

- **Supply Current vs Temperature**
  - $F = 100kHz$
  - $V_{CC} = 10V$
  - $R_{DS} = 1.8kΩ$
  - $R_{DS} = 3kΩ$
  - $C_{DSS} = 2.2nF$
  - $R_{DSS} = 100kΩ$
Typical characteristics

Component selection

It is advisable to decouple the ZXGD3101 closely to VCC and ground due to the possibility of high peak gate currents with C1 in Figure 2.

The proper selection of external resistors RREF and RBIAS is important to the optimum device operation. Select a value for resistor RREF to give a reference current, IREF, of ~3mA. The value of RBIAS must then be 0.6 times the value of RREF to give a bias current, IBIAS, of 1.6 times IREF. This provides a recommended typical offset voltage of -20mV.

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.

\[
R_{\text{REF}} = \frac{(V_{\text{CC}} - 0.7V)}{0.003} \\
R_{\text{BIAS}} = \frac{(V_{\text{CC}} - 0.7V)}{0.005}
\]

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 VCC 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
Figure 4: Test circuit

Figure 5: Timing diagram

NOTE: GATE H AND GATE L ARE CONNECTED
### Package information - SM8 (Surface mounted, 8 pin package)

<table>
<thead>
<tr>
<th>DIM</th>
<th>Millimeters</th>
<th>Inches</th>
<th>DIM</th>
<th>Millimeters</th>
<th>Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.7</td>
<td>0.067</td>
<td>e1</td>
<td>-</td>
<td>4.59</td>
</tr>
<tr>
<td>A1</td>
<td>0.02 - 0.1</td>
<td>0.0008 - 0.004</td>
<td>e2</td>
<td>-</td>
<td>1.53</td>
</tr>
<tr>
<td>b</td>
<td>- - 0.7</td>
<td>- - 0.0275</td>
<td>He</td>
<td>6.7 - 7.3</td>
<td>- 0.264 - 0.287</td>
</tr>
<tr>
<td>c</td>
<td>0.24 - 0.32</td>
<td>0.009 - 0.013</td>
<td>Lp</td>
<td>0.9</td>
<td>- 0.035</td>
</tr>
<tr>
<td>D</td>
<td>6.3 - 6.7</td>
<td>0.248 - 0.264</td>
<td>α</td>
<td>- 15°</td>
<td>- 15°</td>
</tr>
<tr>
<td>E</td>
<td>3.3 - 3.7</td>
<td>0.130 - 0.145</td>
<td>β</td>
<td>- 10°</td>
<td>- 10°</td>
</tr>
</tbody>
</table>

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

### Soldering footprint

```
6.8
0.268

4.6
0.181

0.95
0.037

1.52
0.060
```

---

**Issue 4 - January 2009**

© Diodes Incorporated 2009

www.zetex.com

www.diodes.com
Definitions

Product change
Diodes Incorporated reserves the right to alter, without notice, specifications, design, price or conditions of supply of any product or service. Customers are solely responsible for obtaining the latest relevant information before placing orders.

Applications disclaimer
The circuits in this design/application note are offered as design ideas. It is the responsibility of the user to ensure that the circuit is fit for the user's application and meets with the user's requirements. No representation or warranty is given and no liability whatsoever is assumed by Diodes Inc. with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Diodes Inc. does not assume any legal responsibility or will not be held legally liable (whether in contract, tort (including negligence), breach of statutory duty, restriction or otherwise) for any damages, loss of profit, business, contract, opportunity or consequential loss in the use of these circuit applications, under any circumstances.

Life support
Diodes Zetex products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:
A. Life support devices or systems are devices or systems which:
   1. are intended to implant into the body
   or
   2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labelling can be reasonably expected to result in significant injury to the user.
B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Reproduction
The product specifications contained in this publication are issued to provide outline information only which (unless agreed by the company in writing) may not be used, applied or reproduced for any purpose or form part of any order or contract or be regarded as a representation relating to the products or services concerned.

Terms and Conditions
All products are sold subjects to Diodes Inc. terms and conditions of sale, and this disclaimer (save in the event of a conflict between the two when the terms of the contract shall prevail) according to region, supplied at the time of order acknowledgement.

Quality of product
Diodes Zetex Semiconductors Limited is an ISO 9001 and TS16949 certified semiconductor manufacturer.

ESD (Electrostatic discharge)
Semiconductor devices are susceptible to damage by ESD. Suitable precautions should be taken when handling and transporting devices. The possible damage to devices depends on the circumstances of the handling and transporting, and the nature of the device. The extent of damage can vary from immediate functional or parametric malfunction to degradation of function or performance in use over time. Devices suspected of being affected should be replaced.

Green compliance
Diodes Inc. is committed to environmental excellence in all aspects of its operations which includes meeting or exceeding regulatory requirements with respect to the use of hazardous substances. Numerous successful programs have been implemented to reduce the use of hazardous substances and/or emissions.

Product status key:
- "Preview" Future device intended for production at some point. Samples may be available
- "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

Datasheet status key:
- "Draft version" This term denotes a very early datasheet version and contains highly provisional information, which may change in any manner without notice.
- "Provisional version" This term denotes a pre-release datasheet. It provides a clear indication of anticipated performance. However, changes to the test conditions and specifications may occur, at any time and without notice.
- "Issue" This term denotes an issued datasheet containing finalized specifications. However, changes to specifications may occur, at any time and without notice.

Sales offices

The Americas

Europe

Taiwan

Shanghai

Shenzhen

Korea

3050 E. Hillcrest Drive
Westlake Village, CA 91362-3154
Tel: (+1) 805 446 4800
Fax: (+1) 805 446 4850
Kustermann-Park
Balanastraße 59, D-81541 München
Germany
Tel: (+49) 894 549 490
Fax: (+49) 894 549 4949

7F, No. 90, Min Chuan Road
Hsin-Tien
Taipei, Taiwan
Tel: (+886) 289 146 000
Fax: (+886) 289 146 639

Rm. 606, No.1158
Changning Road
Shanghai, China
Tel: (+86) 215 241 4882
Fax: (+86) 215 241 4891

ANLIAN Plaza, #4018
Jintian Road
Shenzhen, China
Tel: (+86) 755 882 849 88
Fax: (+86) 755 882 849 99

6 Floor, Changhwa B/D,
1005-5 Yeongtong-dong,
Yeongdong-gu, Suwon-si,
Gyeonggi-do, Korea 443-813

© Diodes Incorporated 2009
www.zetex.com
www.diodes.com