ZXGD3105EV1 USER GUIDE

Introduction

The purpose of this board is to demonstrate the driving of a synchronous MOSFET as a Schottky replacement in isolated power supplies. The circuit is ideal for use in AC/DC and DC/DC Flyback converters with output voltages of less than 12V. When used to drive a low on-resistance MOSFET with a Drain breakdown voltage rating of up to 100V, the board increases power efficiency whilst still maintaining simplicity of design.

Performance

- Circuit supply voltage range: 4.5V to 33V
- Low quiescent current: 1.5mA typical
- Switching frequency up to 500KHz
- Suitable for driving 30V to 100V synchronous MOSFETs

Ordering Information

Order Number	
ZXGD3105EV1	

Caution: Do not connect the evaluation board to a supply voltage, VIN, greater than 40V!



Figure 1. Evaluation board layout.

Evaluation guide

There are two possible test setups for the evaluation board. The preferred setup is low side synchronous rectification (see Figure 2b), due to the ease of acquiring the supply voltage to the board directly from the output of the power supply. The other option is shown in Figure 2a, which shows the board driving a MOSFET for high side rectification.

Low side synchronous rectification

- 1. Remove the original Schottky from the power supply.
- 2. Apply a short across the Schottky's K and A terminals.
- 3. Cut the track connecting the negative terminal of the output filter capacitor to the output of the transformer winding.
- 4. Insert a low on-resistance MOSFET between the cut tracks. The drain terminal of the MOSFET should be connected to the output of the transformer winding whilst the source terminal is connected to the output capacitor.

Caution: The MOSFET breakdown must be higher than the maximum drain-source voltage spike, plus a 10% to 30% margin.

- 5. Connect the power supply's output to terminal block P1 (see Figure 2b).
- 6. Connect a DC or AC voltage source to the input of the power supply.
- 7. Turn on the voltage source and measure the efficiency.

High side synchronous rectification

- 8. Remove the original Schottky from the power supply
- Insert a low on-resistance MOSFET to replace the Schottky. The source terminal of the MOSFET should be connected to the output of the transformer winding whilst the drain terminal should be connected to the output capacitor.
- 10. Connect a 10V auxiliary supply to terminal block P1 (see Figure 2a).
- 11. Connect a DC or AC voltage to the power supply's input.
- 12. Turn on the voltage source and measure the efficiency.

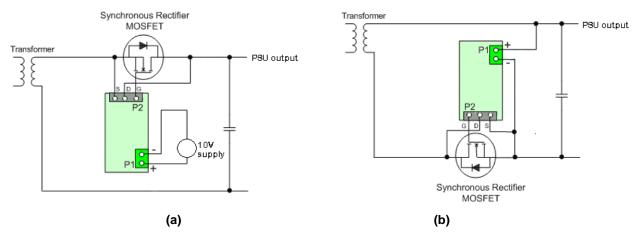


Figure 2: Test options for ZXGD3105EV1 a) high side rectification and b) low side rectification

Conditioning the power supply to maximize efficiency

Any stray inductance in the load current path may cause distortion of the drain-to-source voltage waveform, leading to premature turn-off of the synchronous MOSFET. In order to avoid this issue, drain voltage sensing should be done as physically close to the drain terminals as possible. The PCB track length between the Drain pin and the MOSFET's terminal should be kept to less than 10mm. MOSFET packages with a low internal wire-bond inductance are preferred for high switching frequency power conversion, to minimize body-diode conduction.

After the primary MOSFET turns off, its drain voltage oscillates due to reverse recovery of the snubber diode. These high frequency oscillations are reflected across the transformer to the drain terminal of the synchronous MOSFET. The synchronous IC senses the drain voltage ringing, causing its gate output voltage to oscillate. The synchronous MOSFET cannot be fully enhanced until the drain voltage stabilizes.

In order to prevent this issue, the oscillations on the primary MOSFET can be damped with either a series resistor Rd to the snubber diode or an R-C network across the diode. Both methods reduce the oscillations by softening the snubber diode's reverse recovery characteristic.

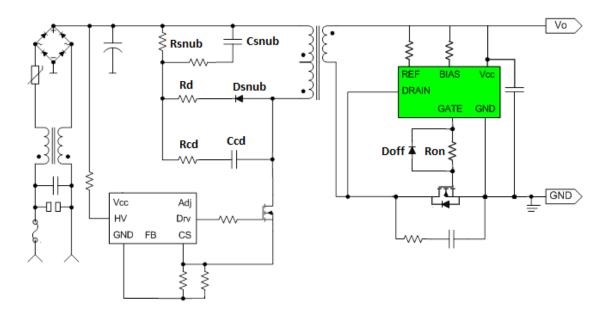


Figure 3: Techniques to prevent or reduce gate voltage oscillations

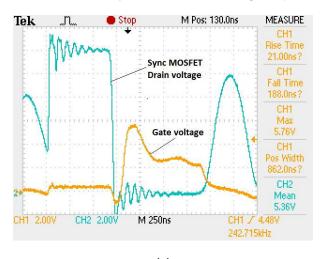
Waveform measurement

The operating waveforms of the controller can be measured using oscilloscope probes. If a current probe or transformer is used to measure the MOSFET current, the wire length should be kept short to avoid excessive loop-inductance, which could disturb the controller operation.

Figure 4 shows typical waveforms in the Flyback converter. The controller senses the forward voltage drop of the parasitic diode within the MOSFET, and when the diode is in conduction, applies a voltage to the MOSFET gate, turning on the MOSFET after an initial delay time. The gate output voltage of the controller is then proportional to the sensed voltage.

In DCM and QR mode, the gate voltage is reduced as the MOSFET's Drain current decreases. This ensures that the MOSFET is turned off at the zero current point, with little or no reverse current. Another advantage is that this technique prevents early termination of the gate voltage at low Drain currents. Early termination of the gate voltage can reduce efficiency due to body-diode conduction loss.

In CCM mode, the controller switches off the MOSFET when the primary MOSFET starts to conduct, as shown in Fig. 3b so that the reverse current is minimized. This is critical because cross-conduction of the primary side MOSFET and secondary side MOSFET can degrade power supply efficiency.



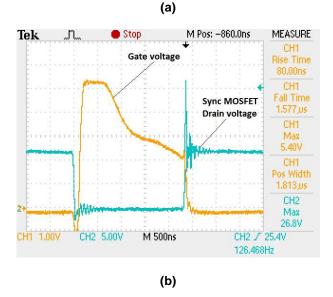


Figure 4: Operating waveforms (a) DCM mode and (b) CCM mode

Board schematic

Figure 5 shows the circuit schematic of the ZXGD3105EV1. Power for the controller is applied to the terminal block P1. A three way header, P2, is located at the other end of the board. The header allows the board to be soldered directly across a synchronous MOSFET in a TO-220 package. The board can also be used with an SMD MOSFET by connecting the pin-outs accordingly.

The on-board discrete voltage regulator, which comprises of R4, Q2, D1 and C1, provides the Vcc voltage for the controller. The values of the threshold setting resistors, Rref and Rbias, are chosen for Vcc=10V. Please refer to the ZXGD3105N8 datasheet for more information.

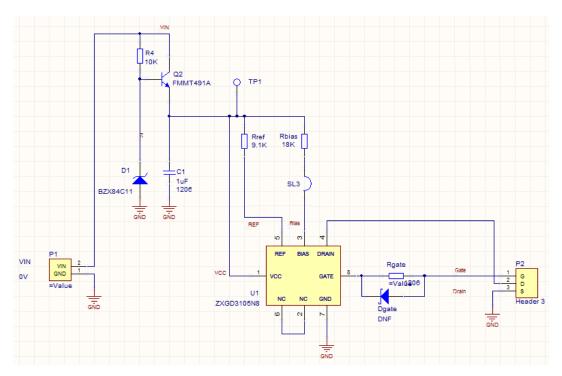


Figure 5: Circuit diagram

Please note that the component part numbers are given as a guide only. Due to continual component development, all parts quoted should be checked for suitability and availability with their respective manufacturers.

Ref. Value **Package** Part number Manufacturer **Notes** U1 Synchronous controller SO8 ZXGD3105N8 Diodes Inc. Q2 40V NPN transistor SOT23 FMMT491A Diodes Inc. 500mW D1 11V Zener SOT23 BZX84C11 Diodes Inc. 300mW C1206X105K5R X7R C1 1uF 50V capacitor 1206 Kemet P1 2-way terminal P2 3-way header R4 10kΩ resistor 0805 Generic 125mW, 1% Rbias 18kΩ resistor 1206 Generic 5%, 200ppm/°C 1206 5%, 200ppm/°C 0R resistor Generic Rgate 9.1KΩ resistor Generic Rref 1206 5%, 200ppm/°C

Table 1: Parts list

INTENTIONALLY BLANK

INTENTIONALLY BLANK

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND. EXPRESS OR IMPLIED. WITH REGARDING TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.

Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

LIFE SUPPORT

Diodes Incorporated 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 labeling can be reasonably expected to result in significant injury to the user. provided in the
- 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.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2011, Diodes Incorporated

www.diodes.com

Sales offices

The Americas 3050 E. Hillcrest Drive Westlake Village. CA 91362-3154 Tel: (+1) 805 446 4800 Fax: (+1) 805 446 4850

Europe Kustermannpark Balanstraße 59. D-81541 München Germany Tel: (+49) 894 549 490 Fax: (+49) 894 549 4949

Taiwan 7F, No. 50, Min Chuan Road Hsin-Tien Taipei, Taiwan Tel: (+886) 289 146 000 Fax: (+886) 289 146 639 Shanghai Rm. 606, No.1158 Changning Road Shanghai, China Tel: (+86) 215 241 4882 Futian CBD, Fax (+86) 215 241 4891 Shenzhen, China

Shenzhen Room A1103-04, ANLIAN Plaza, #4018 Jintian Road Fax: (+86) 755 882 849 99 Korea

6 Floor, Changhwa B/D, 1005-5 Yeongtong-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do, Korea 443-813 Tel: (+82) 312 731 884 Tel: (+86) 755 882 849 88 Fax: (+82) 312 731 885