

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, V_{IN} , greater than 40V!

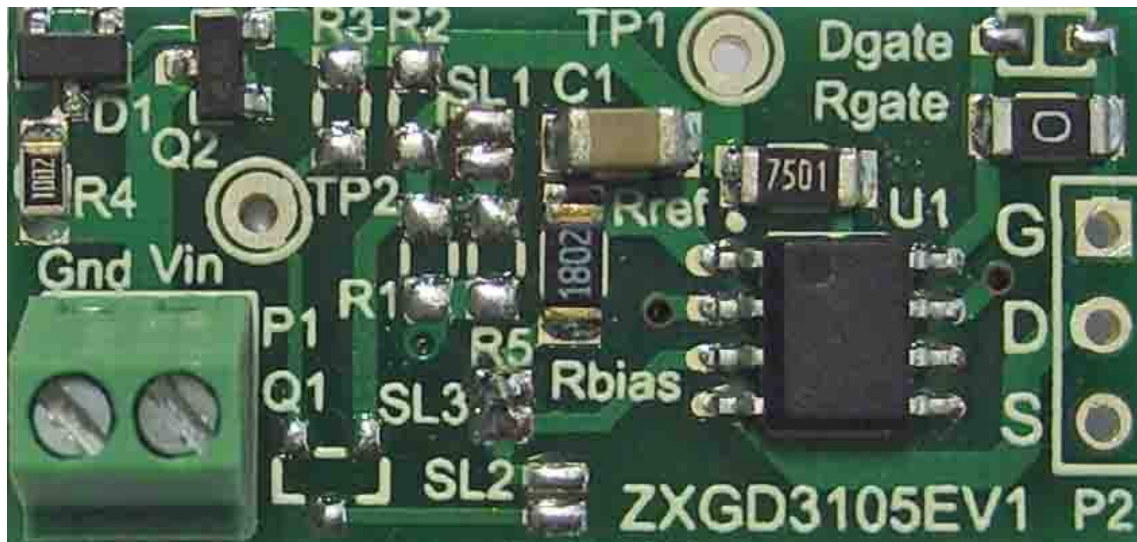


Figure 1. Evaluation board layout.

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
9. 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.

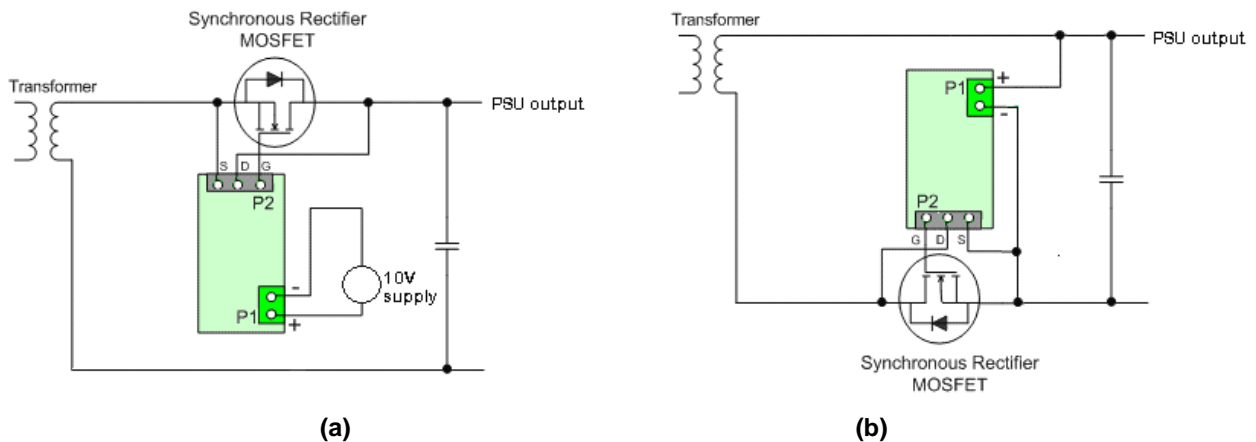


Figure 2: Test options for ZXGD3105EV1 a) high side rectification and b) low side rectification

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 R_d 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.

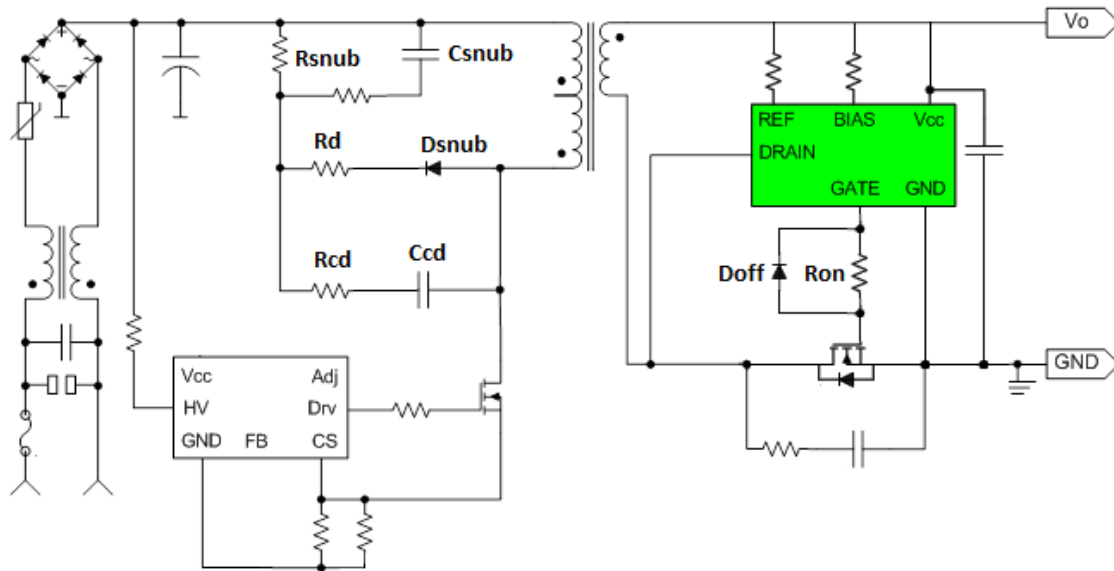


Figure 3: Techniques to prevent or reduce gate voltage oscillations

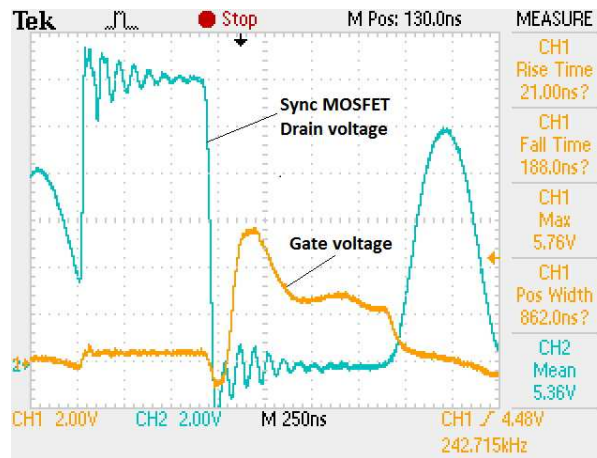
Waveform measurement

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.

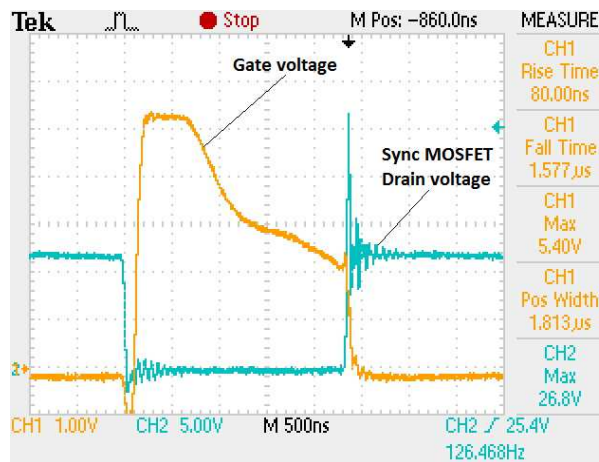
Figure 4 shows typical waveforms in the Flyback converter. The controller senses the forward voltage drop of the parasitic diode within the MOSFET, and when the diode is in conduction, applies a voltage to the MOSFET gate, turning on the MOSFET after an initial delay time. The gate output voltage of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



(a)



(b)

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.

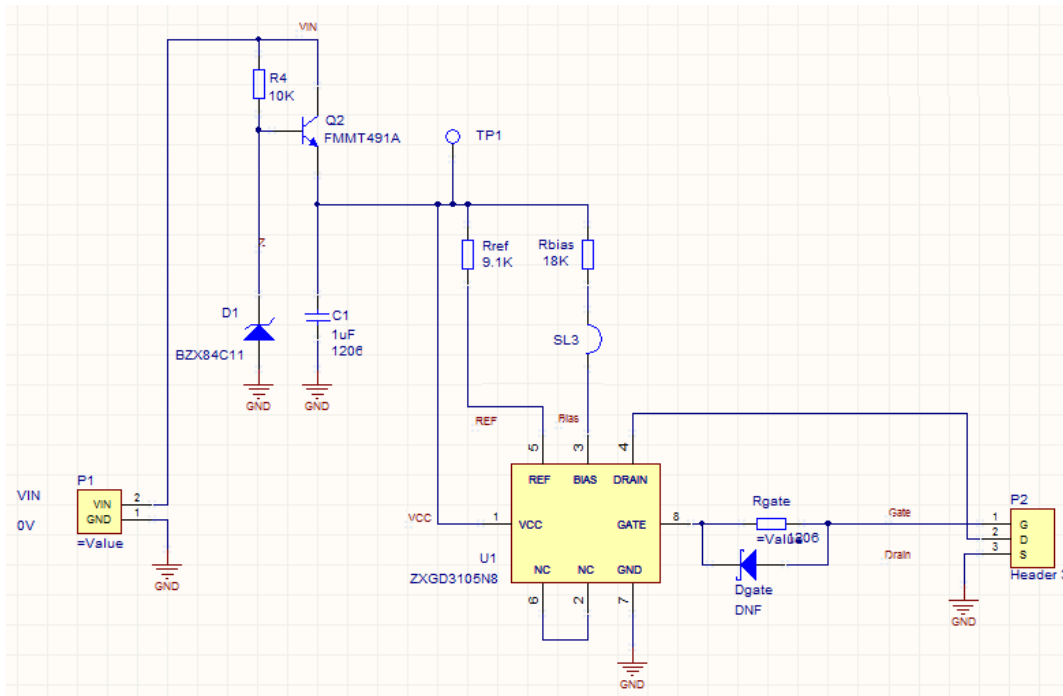


Figure 5: Circuit diagram

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.

Table 1: Parts list

Ref.	Value	Package	Part number	Manufacturer	Notes
U1	Synchronous controller	SO8	ZXGD3105N8	Diodes Inc.	
Q2	40V NPN transistor	SOT23	FM491A	Diodes Inc.	500mW
D1	11V Zener	SOT23	BZX84C11	Diodes Inc.	300mW
C1	1uF 50V capacitor	1206	C1206X105K5R	Kemet	X7R
P1	2-way terminal				
P2	3-way header				
R4	10kΩ resistor	0805	Generic		125mW, 1%
Rbias	18kΩ resistor	1206	Generic		5%, 200ppm/°C
Rgate	0R resistor	1206	Generic		5%, 200ppm/°C
Rref	9.1kΩ resistor	1206	Generic		5%, 200ppm/°C

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