ZXGD3104EV2 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 suitable for use in AC/DC Flyback converters. End applications include external power adaptors for laptops greater than 90W, and LED monitors. When used to drive a low on-resistance MOSFET, the board increases power efficiency whilst still maintaining simplicity of design.

Performance

- Recommended supply voltage VIN: 19V
- Gate voltage clamped to 12V maximum
- Ideal for Quasi Resonant operation
- Switching frequency up to 250KHz

Ordering Information

Order Number
ZXGD3104EV2

Caution: Do not connect the evaluation board to a supply voltage, VIN, greater than 25V!

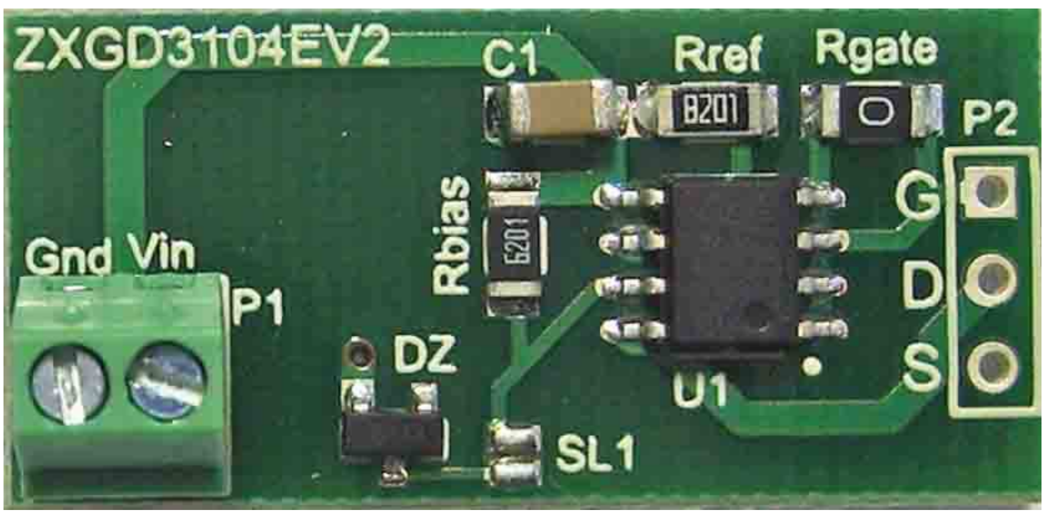


Figure 1. Evaluation board layout

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 3a. Figure 3a shows the board driving a MOSFET for high side rectification.

Low side synchronous rectification

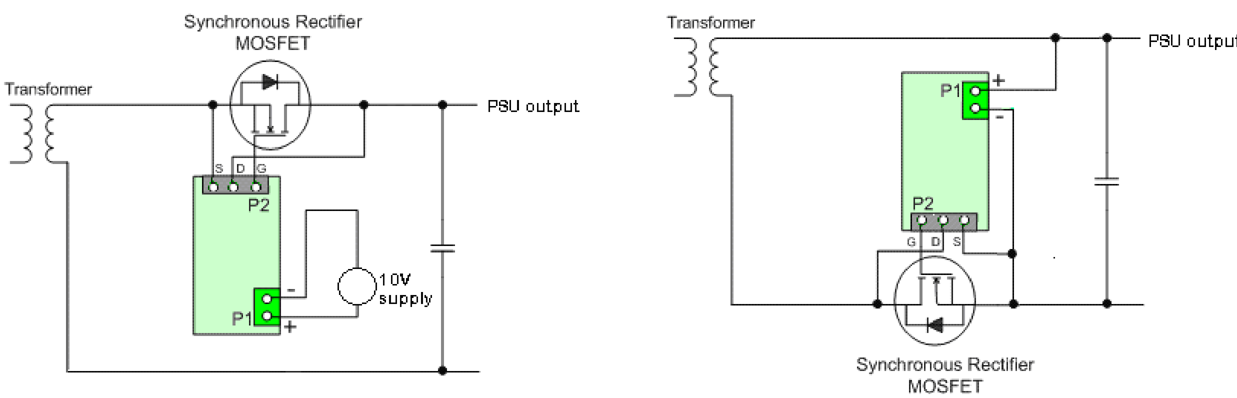
1. Remove the original Schottky from the power supply
2. Apply a short across the Schottky's K and A terminals
3. Cut the track that connects the negative terminal of the output filter capacitor to the output of the transformer winding.
4. Insert a low on-resistance MOSFET between the cut tracks. The 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 voltage, 19V, to the terminal block P1 (see Figure 2b).
6. Connect an AC voltage source to the power supply's input.
7. Turn on the AC 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 an AC voltage source voltage to the power supply's input.
12. Turn on the power supply and measure the efficiency.



(a) **(b)**

Figure 2: Test options for evaluation board 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 the reverse recovery of the snubber diode. These high frequency oscillations are reflected into the transformer secondary winding and 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 Dsnub, or an R-C network across Dsnub as shown in Figure 3. Both methods reduce the oscillations by softening the snubber diode's reverse recovery characteristic.

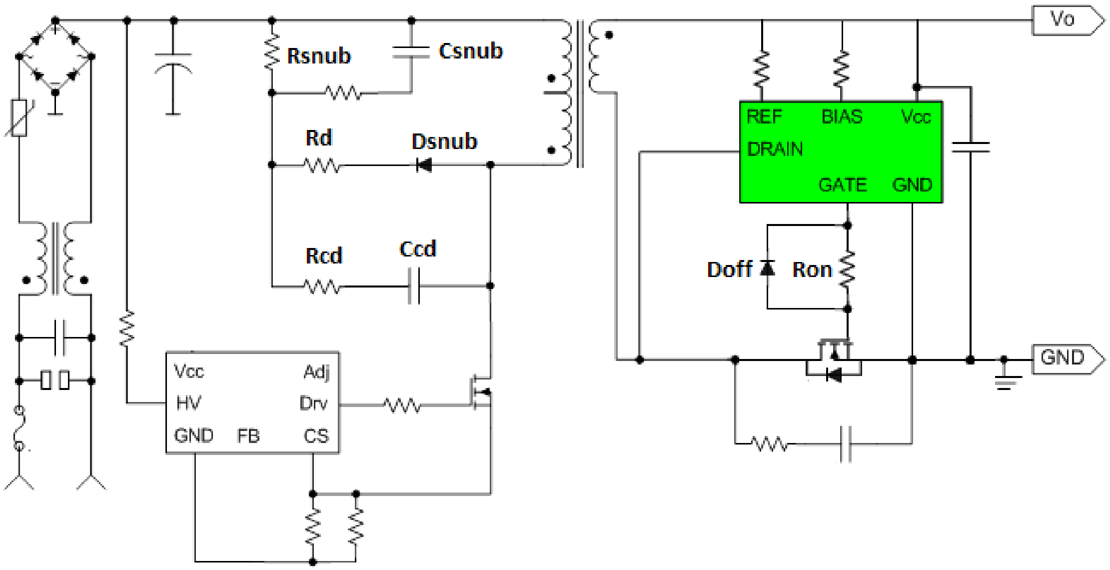


Figure 3: Techniques to prevent/reduce gate voltage oscillations

Waveform and efficiency measurements

The operating waveforms of the controller can be measured using oscilloscope probes. If a current probe or transformer is also 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 the operating waveforms in the Flyback converter inside a 19V 90W output power adaptor. The power adaptor also incorporates a boost power factor correction stage to comply with IEC61000-3-2.

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 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 current. Early termination of gate voltage can reduce the efficiency due to body-diode conduction loss.

Figure 5 shows that 90% efficiency can be achieved in the 90W adaptor when using the evaluation board to drive a 10mΩ 100V synchronous MOSFET.

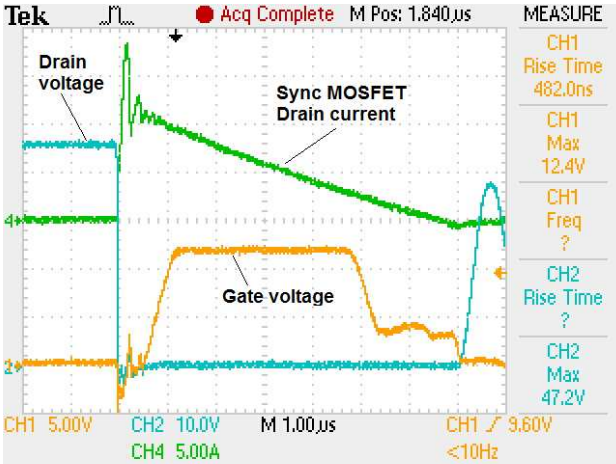


Figure 4: Operating waveforms in QR mode with a 10mΩ 100V synchronous MOSFET

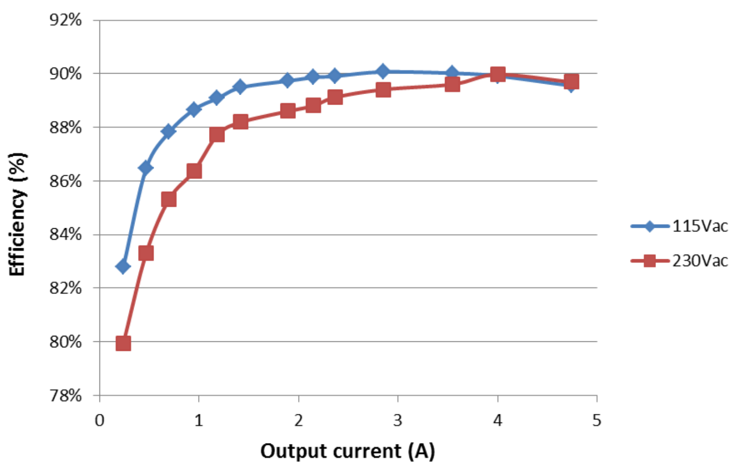


Figure 5: Efficiency measurement in a 19V 90W power adaptor

Board schematic

Figure 6 shows the circuit schematic of ZXGD3104EV2. 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 TO220 package. The board can also be used with an SMD MOSFET by connecting the pin-outs accordingly.

The evaluation board is designed to accept a supply voltage of 19V, which is the typical output voltage of a laptop power adaptor. If the power supply's output voltage is required to be greater than 25V, a voltage regulator should be used to step down the high voltage to 19V before connecting to the evaluation board. The values of the threshold setting resistors, Rref and Rbias, are chosen for Vcc=19V. Please refer to the ZXGD3105N8 datasheet for more information.

DZ is an optional Zener diode connected to the BIAS pin of the controller to limit the maximum gate voltage to 12V. DZ is recommended when the controller is used to drive a high-gate-charge synchronous MOSFET or/and at high switching frequency. This configuration reduces the gate-charge switching loss.

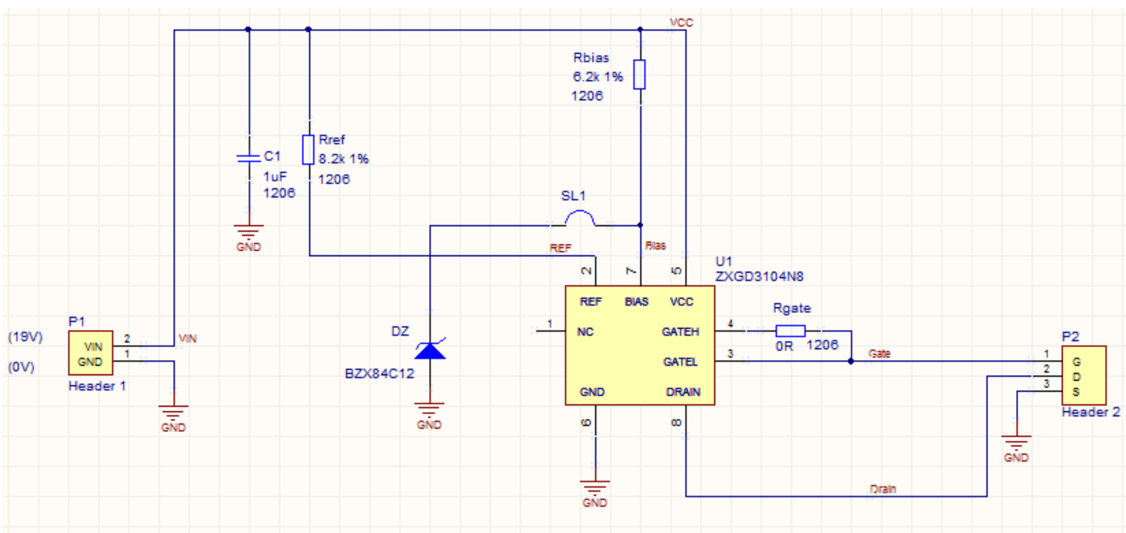


Figure 6: Circuit diagram

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: Part list

Ref.	Value	Package	Part number	Manufacturer	Notes
U1	25V VCC max synchronous controller	SO8	ZXGD3104N8	Diodes Inc.	
DZ	12V Zener	SOT23	BZX84C12	Diodes Inc.	
C1	1uF 50V capacitor	1206	C1206X105K5R	Kemet	X7R
P1	2-way terminal				generic
P2	3-way header				generic
Rbias	6k2 resistor	1206	Generic		1%, 200ppm/ºC
Rgate	0R resistor	1206	Generic		5%, 200ppm/ºC
Rref	8k2 resistor	1206	Generic		1%, 200ppm/ºC

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