ZXGD3113EV1 User Guide
Synchronous MOSFET Controller in SOT26

General Description

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 Fly back converters. 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.

Key Features

- Circuit supply voltage range: 3.5V to 40V
- Low quiescent current: 6mA typical
- Switching frequency up to 250KHz
- Suitable for driving 20V to 100V synchronous MOSFETs

Ordering Information

Order Number
ZXGD3113EV1

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

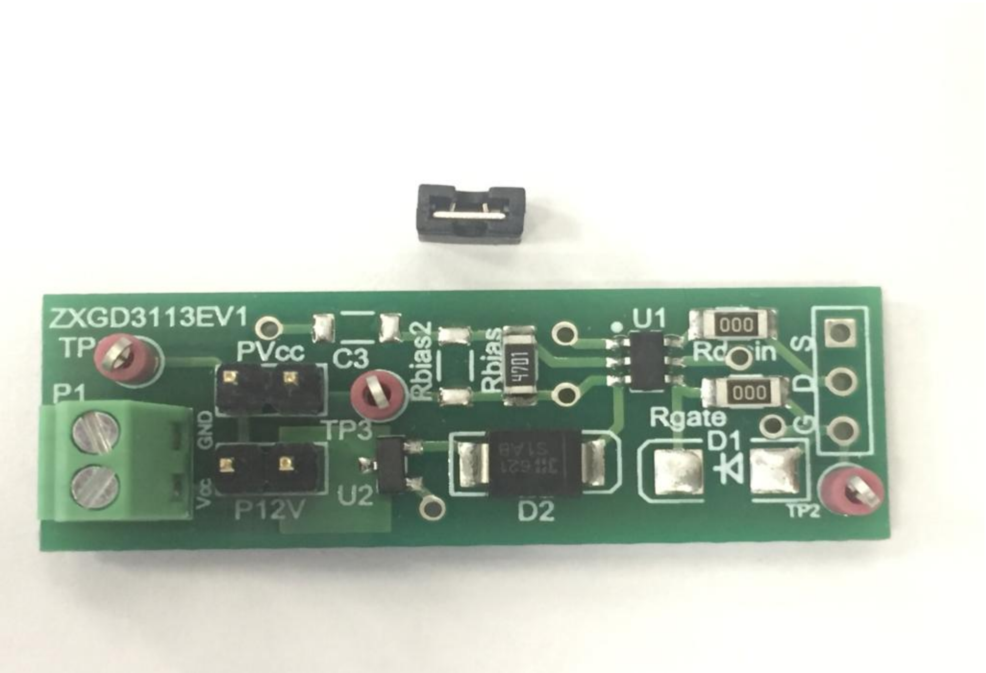


Figure 1. Evaluation board layout.

Evaluation board is provided with a jumper to select the power supply to ZXGD3113, between the direct external supply voltage from P1, through PVcc, or a regulated 12V supply through P12V.

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

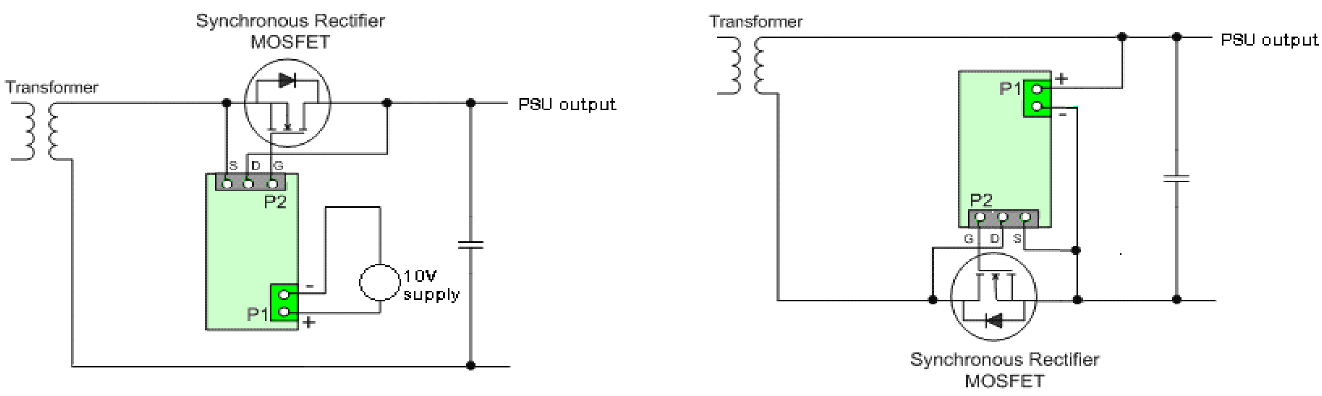
1. Remove the original Schottky from the power supply.
2. Apply a short across the Schottky's K and A terminals.
3. Cut the track connecting the negative terminal of the output filter capacitor to the output of the transformer winding.
4. Insert a low on-resistance MOSFET between the cut tracks. The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



(a) **(b)**

Figure 2: Test options for ZXGD3113EV1 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. Snubber circuit can be implemented on the secondary side as well, using the foot prints provided (Rs and Cs) on the back side of the PCB. A foot print is provided for the RGS of the synchronous MOSFET.

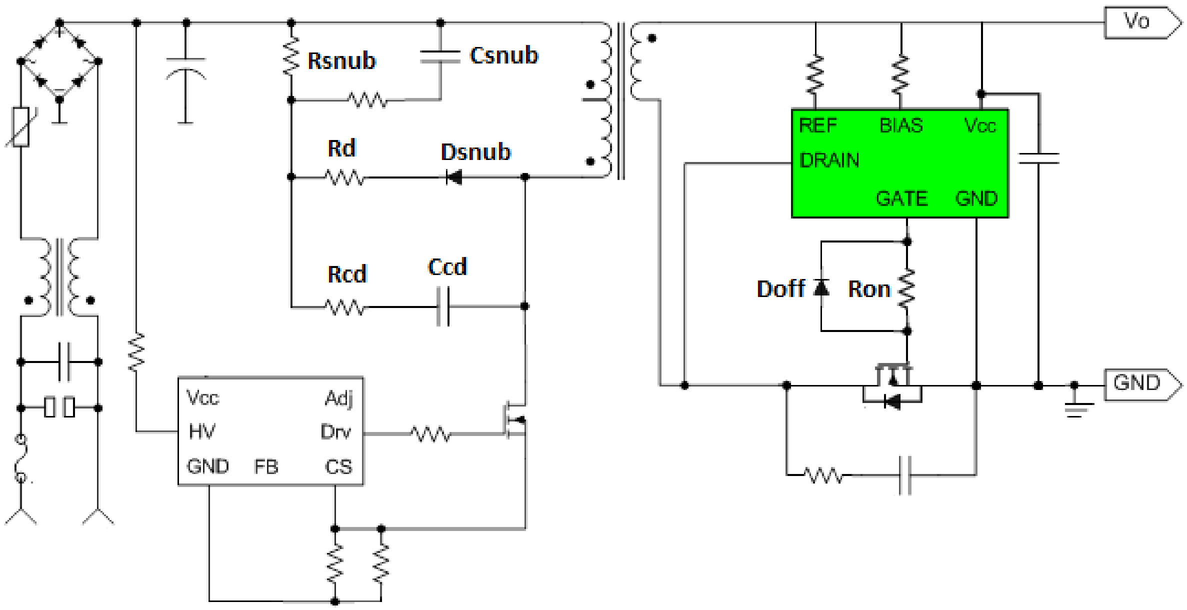


Figure 3: Techniques to prevent or reduce gate voltage oscillations

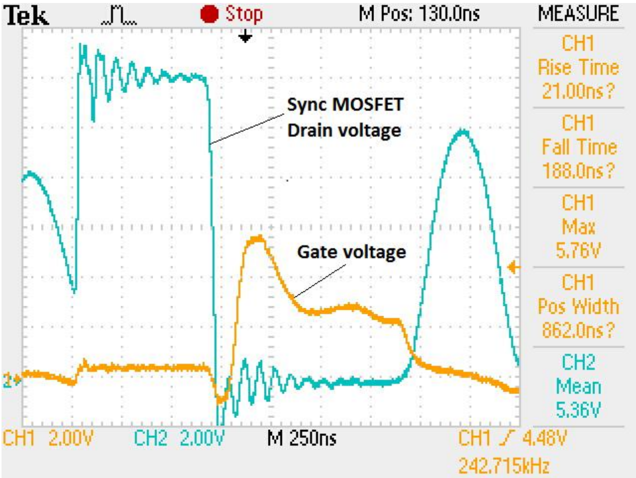
Conditioning Waveform Measurement

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.

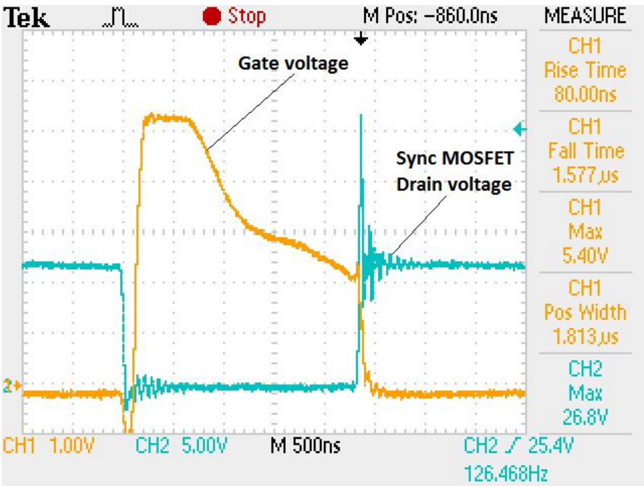
Figure 4 shows typical waveforms in the Fly back converter. The controller senses the forward voltage drop of the parasitic diode within the MOSFET, and when the diode is in conduction, applies a voltage to the MOSFET gate, turning on the MOSFET after an initial delay time. The gate output voltage of 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 and 6 shows the circuit schematic and PCB schematic of the ZXGD3113EV1 respectively. 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 voltage regulator, ZXTR2112F, provides the Vcc voltage for the controller when selected by connecting the jumper across P12V. This is useful when the supply voltage to P1 is higher than 19V. As the output gate voltage depends on the Vcc (Vgate = ~[Vcc-0.7]V), it is necessary to limit the gate voltage to a safe value while working with higher input voltages. The values of the threshold setting resistors, Rref and Rbias, are chosen for Vcc=19V. However, they can be adjusted using the additional resistor slots (Rbias2 & Rref2) provided on the evaluation board. Please refer to the ZXGD3113N8 datasheet for more information. Slots are provided for the Rdrain, Rgate, RGS and snubber circuit components Rs and Cs to be used as necessary in the application. Capacitor C3 slot can be used to minimize any noise on the gate pin.

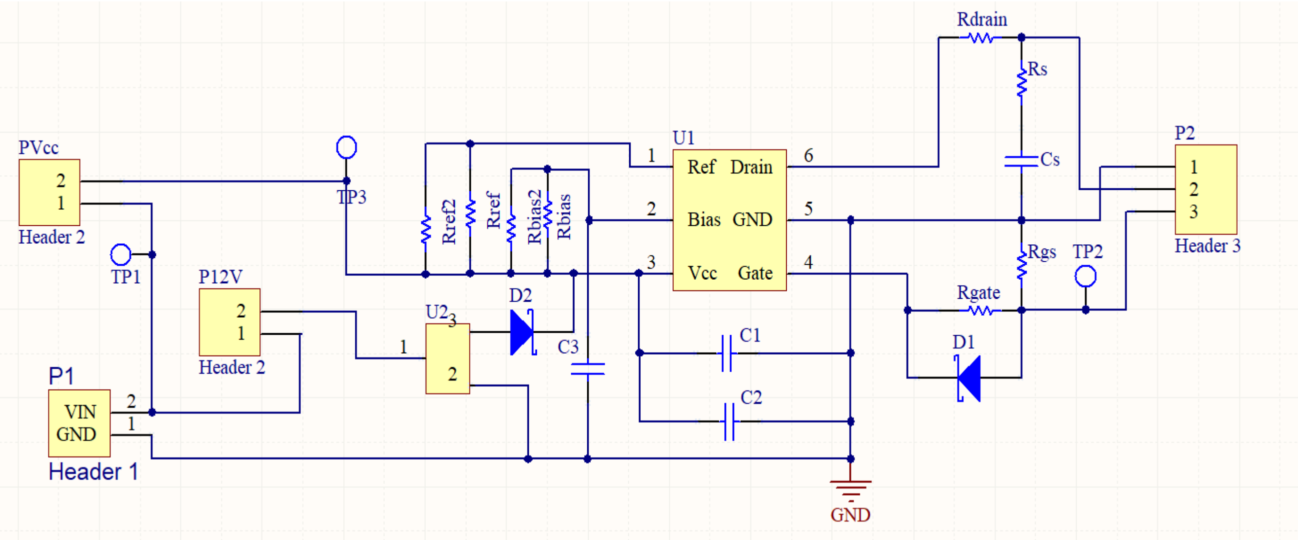


Figure 5: Circuit diagram

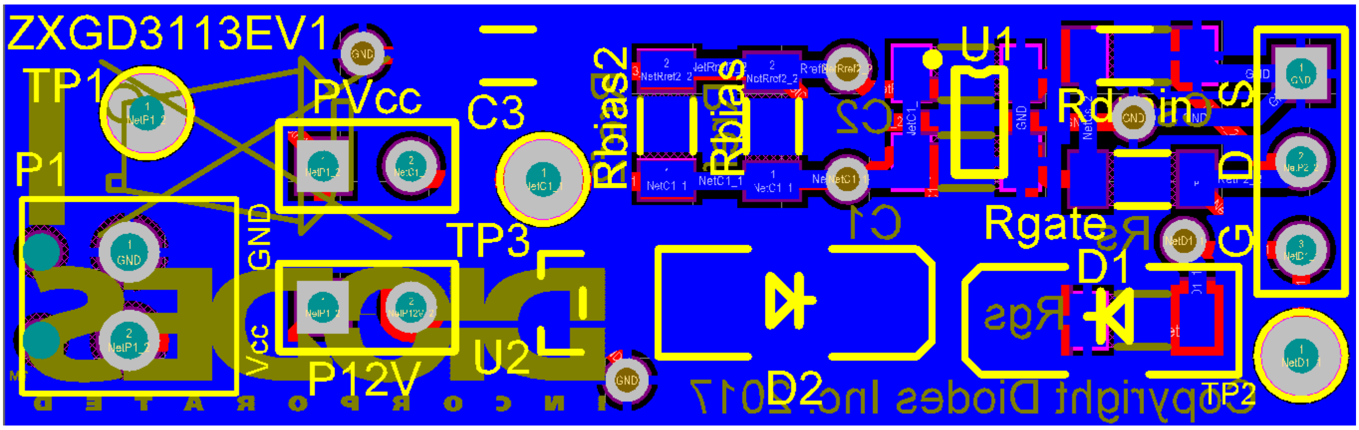


Figure 6: PCB schematic

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	Suggested source/Part number
C1,C2	10 µF, 50 V, ± 10%, X5R, GRM Series	1206	Farnell : 1845762
C3, Cs	NOT FITTED	1206	
P1	Phoenix Terminal Block, 2 way		Farnel : 3041359
Rdrain, Rgate	0Ω	1206	generic/ Farnell 2008396
Rbias2, Rref2, Rs,	NOT FITTED	1206	
Rref	8.2kΩ	1206	Farnell : 1739024
Rbias	4.7kΩ	1206	Farnell : 1739021
D2	50V , 1A rectifier	SMB	Mouser : 621-S1AB-F
D1	NOT FITTED	SMB	
P12V, PVcc	Header 2-pin	2.54mm, 2pin	Farnell : 1593411
TP1, TP2, TP3	TEST POINTS		Farnel 20-313137
U1	ZXGD3113	SOT26	ZXGD3113
U2	ZXTR2112F	SOT23	ZXTR2112F
Jumper	2.54mm Jumper		Farnell : 148029

Application Suggestions:

Stand by current is directly proportional to the synchronous MOSFET's switching times. For applications where low stand by current is a key criterion, circuit shown in figure 7 can be implemented to achieve lower stand by current while not effecting the switching performance. Figure 8 shows the dependency of the turn off threshold on Ibias and Iref, which in turn can be set by Rbias and Rref respectively.

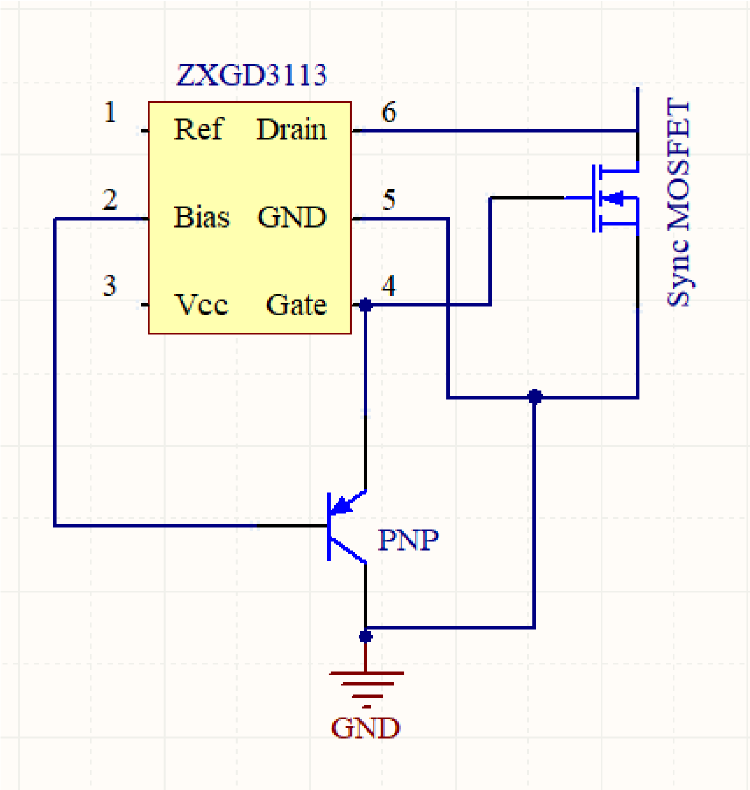


Figure 7: Circuit suggestion for lower stand by current and faster switching speed.

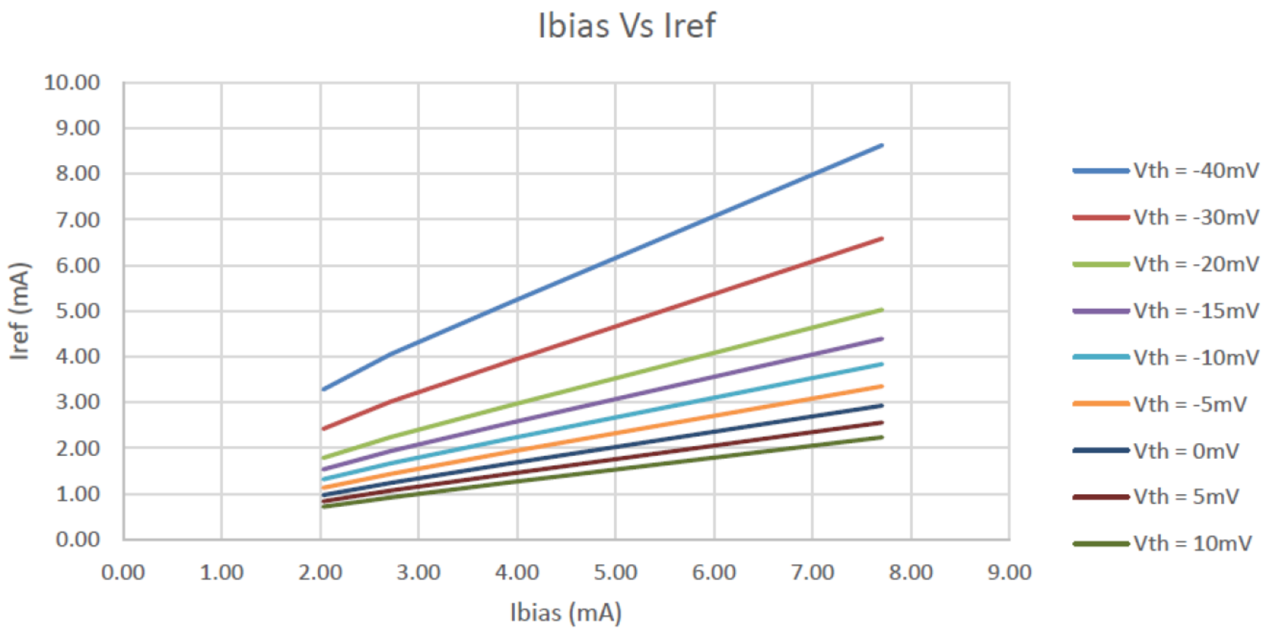


Figure 8: Turn off Threshold setting

Rbias = ~ (Vcc-0.5) / Ibias

Rref = ~ (Vcc – 0.7) / Ibias

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