Practical Tips for Applying AOZ7200 Optimally

By Richard Liu

Introduction

The AOZ7200 is a 600 V AlphaZBL™ product that controls the N-channel MOSFET to replace a diode when used in AC/DC diode-bridge application. The AOZ7200 can help to reduce power consumption and heat dissipation.

In diode-bridge application, the AOZ7200 senses the voltage drop and reduces the forward conduction loss to the minimum value. When the forward current is reversed, the AOZ7200 will turn-off the external switch and suffer the reverse voltage. In AC/DC application, the AOZ7200 is a self-powered system without extra voltage supply.

Basic Circuit Configuration

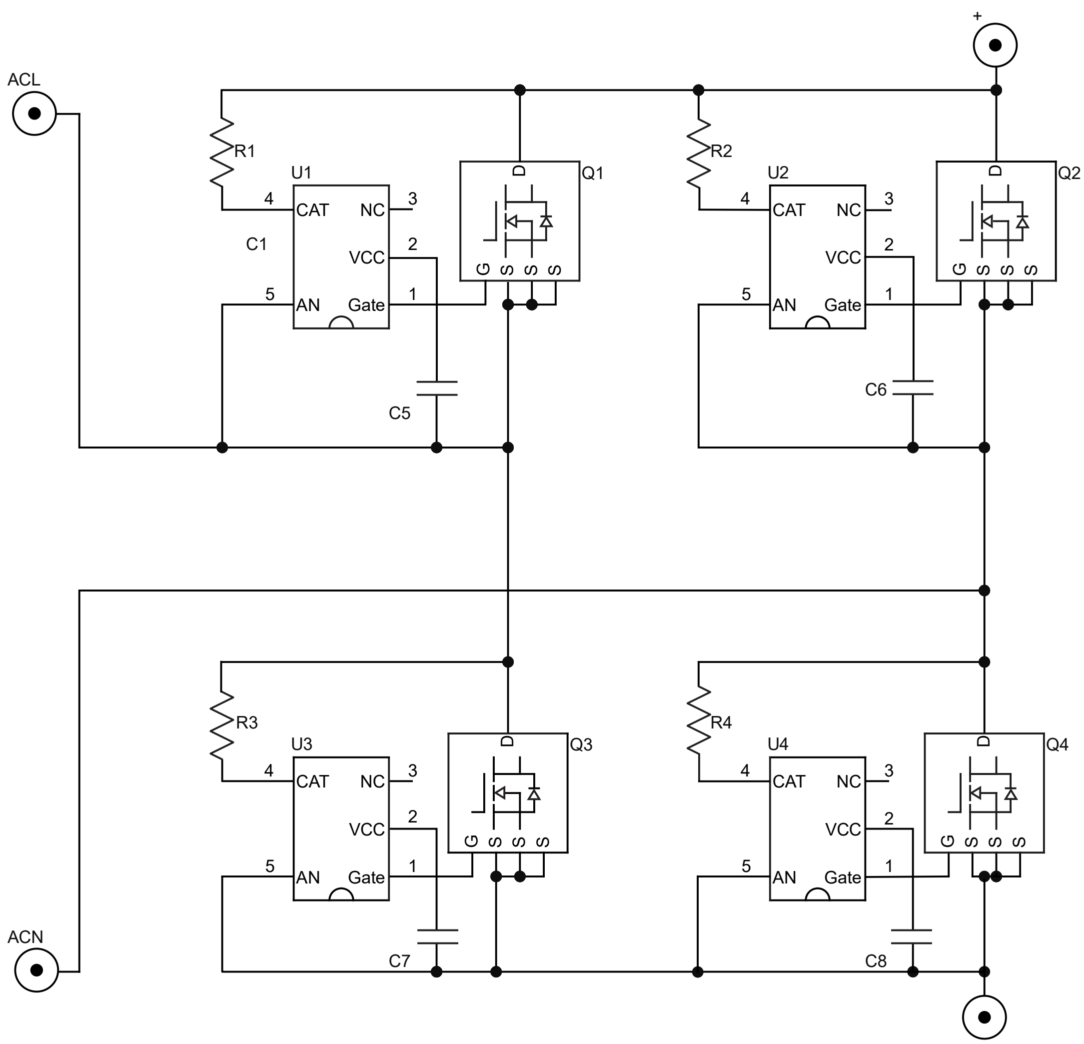

Figure 1. Typical Circuit

High Voltage (HV) Start-up

The AOZ7200 with a low-voltage capacitor can drive N-MOSFET to replace each diode in high-voltage bridge rectifier application. In normal operation, after V_{CC} UVLO AOZ7200 will sense the voltage between Cathode and Anode, if this voltage is less than -105 mV, the Gate will turn on the MOSFET and the conduction loss is reduced. In the switch-on cycle, the controller keeps monitoring this voltage. When this voltage is larger than 1 mV, the controller will turn off the switch.

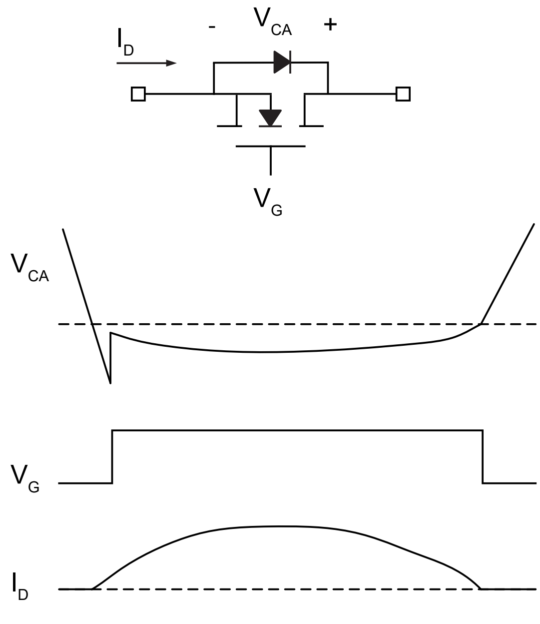

Figure 2. V_{CA} vs Switch Gate

There is a high voltage depletion MOS that could charge the V_{CC} capacitor. In normal operation, the charging procedure happens at lower voltage drop and it helps to reduce the quiescent power.

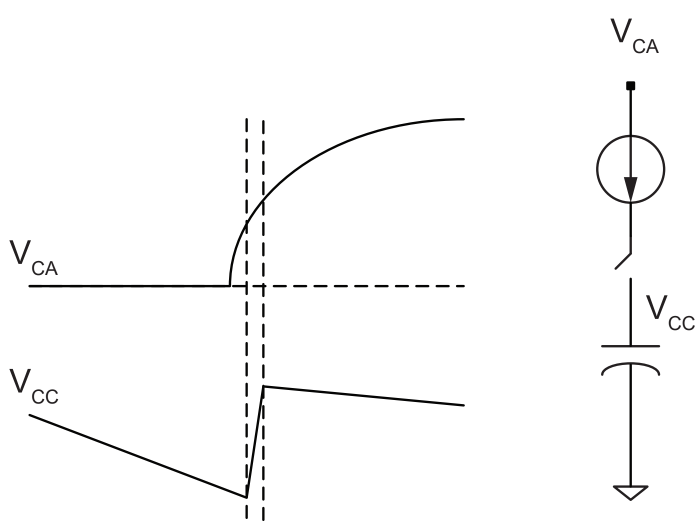

Figure 3. Charging V_{CC}

Layout Guidelines

1. The peripheral components are placed as close as possible to the IC. The track from IC Anode pin to MOSFET source should be as short as possible.
2. Large copper-clad and multi-layer PCB are recommended for cooling.
3. Adding vias on the exposed pad can let heat pass through to other layers easily. For MOSFET TC characteristic, the AlphaZBL™ must be as cool as possible.
4. If using diodes and AlphaZBL™ together, e.g. AlphaZBL™ on the low side and diodes on the high side, split cooling areas of diodes and AlphaZBL™. AlphaZBL™ needs a large cooling copper-clad area, and should not be placed too close to the diodes which generate much more heat.

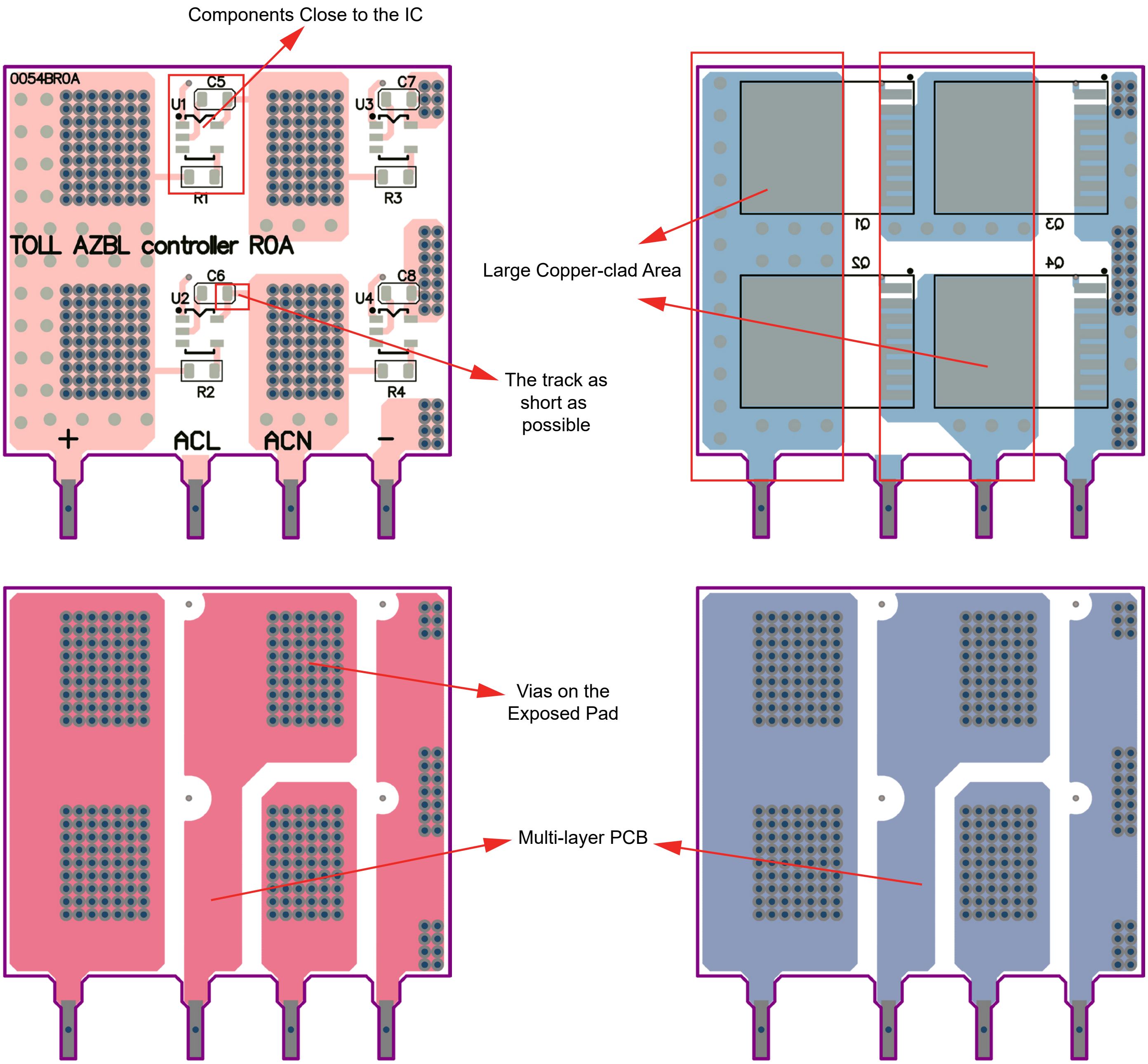

Figure 4. Layout Example

HV Detection For X-Cap Discharge Function or Brown In/Out Function

The AOZ7200 detects the N-MOSFET current and determines the gate duty. At no/light load, output gate duty may be very small or zero. Some PFC ICs with X-Cap discharge function or brown in/out function need to detect AC waveform. Those PFC ICs may see the wrong waveform due to the small or zero gate duty, and then trigger protection or hiccup.

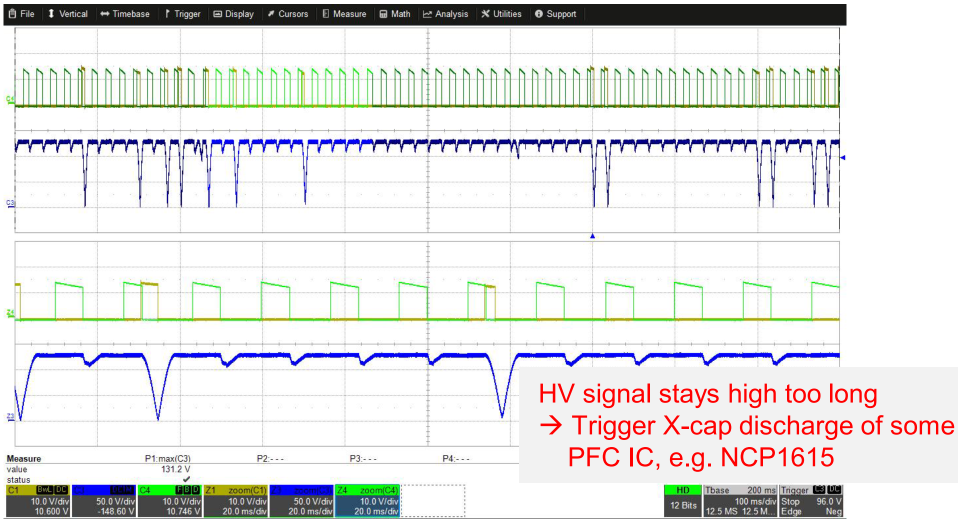

Figure 5a. Example Waveform of Triggering X-cap Discharge Wrongly at No Load Condition

Graph Information: CH1 Low-side Gate; CH3 X-Cap Discharge Function IC HV Pin; CH4 Hi-side Gate

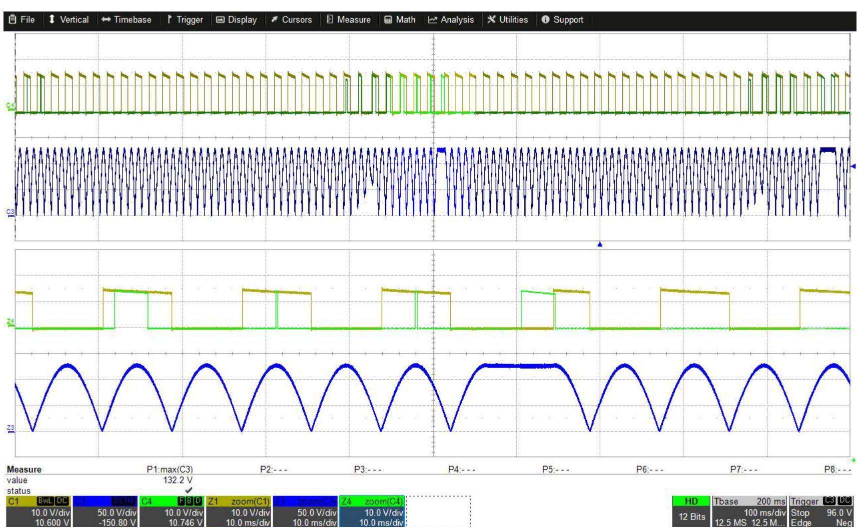

Figure 5b. Adding 10 kΩ for R1 and R2 (Refer to the BOM Below) can Generate Appropriate HV Signals

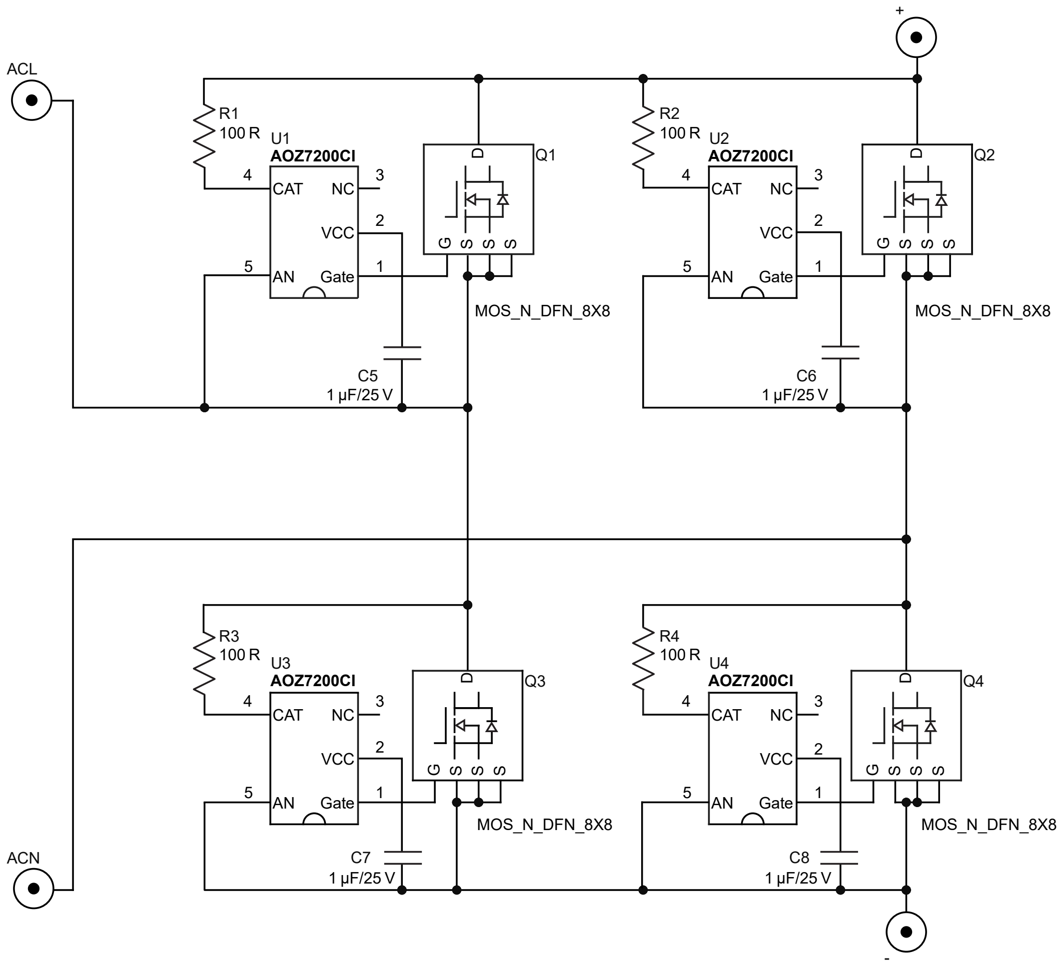

Figure 6. Schematic and Component Selection Guidelines

BOM for Application

General Application		To Avoid Triggering Protection by Some PFC ICs with HV Detection	
Component	**Description**	**Component**	**Description**
R1, R2, R3, R4	100 Ω, 0603	R1, R2, R3, R4	R1/R2 = 1.5 kΩ ~ 5.1 kΩ R3/R4 = 100 Ω ~ 510 Ω
C5, C6, C7, C8	1 µF, 0603, 25 V	C5, C6, C7, C8	1 µF, 0603, 25 V
Q1, Q2, Q3, Q4	Optional by Wattage	Q1, Q2, Q3, Q4	Optional by Wattage
U1, U2, U3, U4	AOZ7200CI	U1, U2, U3, U4	AOZ7200CI

- To avoid triggering protection or hiccup by some PFC ICs with HV detection, need adding resistors for R1~R4, as the above table suggests. Note that the value of R1/R2 should be at least 1 kΩ larger than the value of R3/R4.
- Please check ZBL signal at 25% load. If on duty is too small, need to adjust R1~R4 resistance to a lower value. (And double-check at no/light load that the protection is not triggered.)
- For PFC ICs without this kind of HV detection, using BOM for general application (refer to the table above) has no problem.
- Place small components as close as possible to the chip.

Lightning Surge Path

Refer to Figure 7, C2 >> C1 is satisfied in most applications.

If there is no bypass diode “D”, surge energy charges C1 (red current path), and then Vc1 rises to high voltage. So V_X2 and V_X3 suffer extremely high voltage.

If there is bypass diode “D”, surge energy charges both C1 and C2 (orange current path). Because the value of C2 is usually large, Vc1 and Vc2 will be limited to much lower voltage.

Adding bypass diode “D” is strongly recommended.

To increase lightning surge capability further, placing a varistor 471 or 511 in front of the ZBL bridge is also strongly recommended.

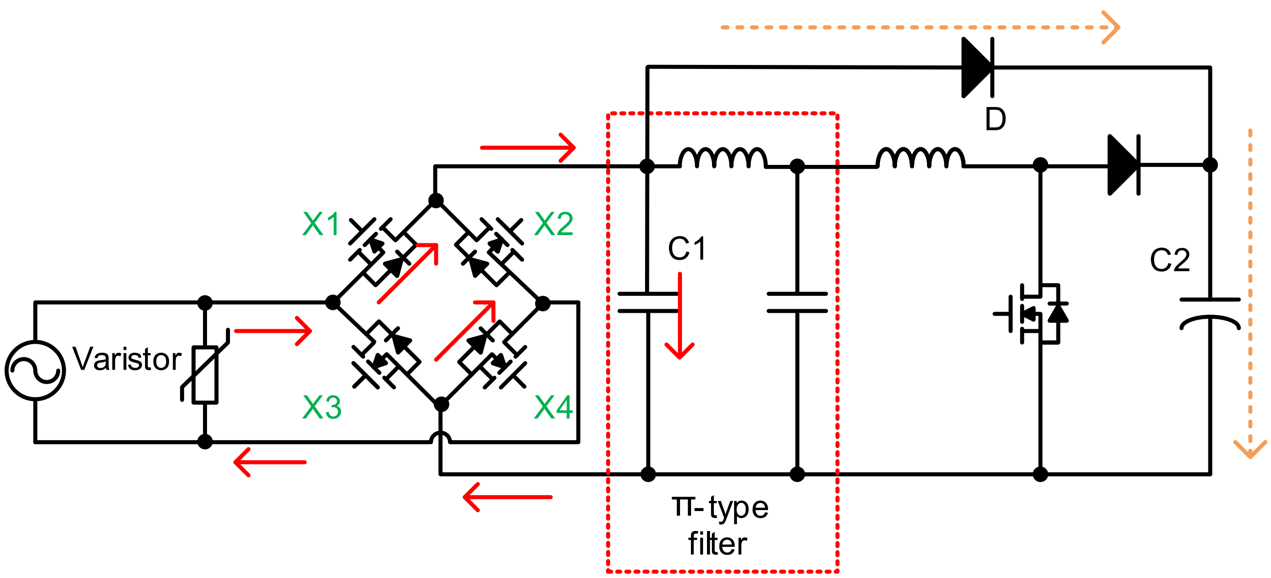

Figure 7. Lightning Surge Path, with and without Bypass Diode

Gate Measurement with Probe on AlphaZBL™ Circuit

When the gate signal (especially high side) is measured directly with a probe, a leakage path due to the probe is added from gate to source. This may make V_{CC} voltage drop to UVLO much faster and turn off gate prematurely. If this happens, we can probe Vds (between cathode and anode) for checking the turn-on duty of MOSFETs instead.

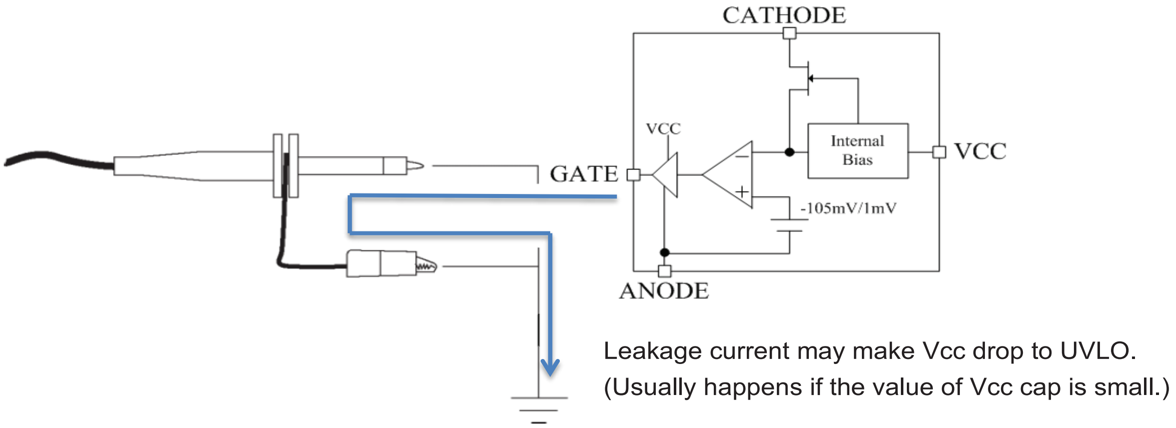

Figure 8. Leakage Current Induced by the Probe

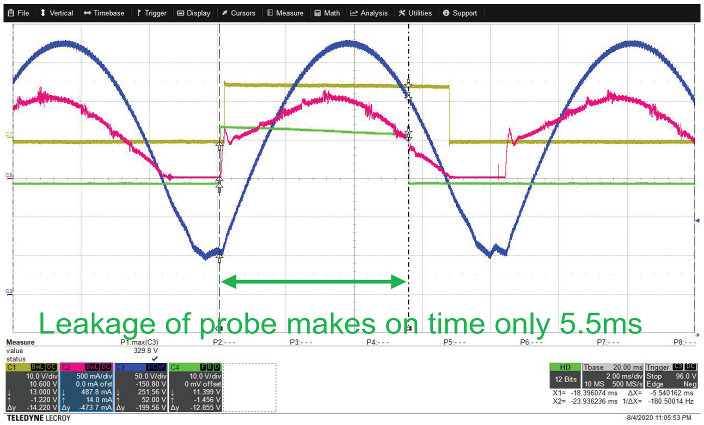

Figure 9a. Wrong Output Gate Duty

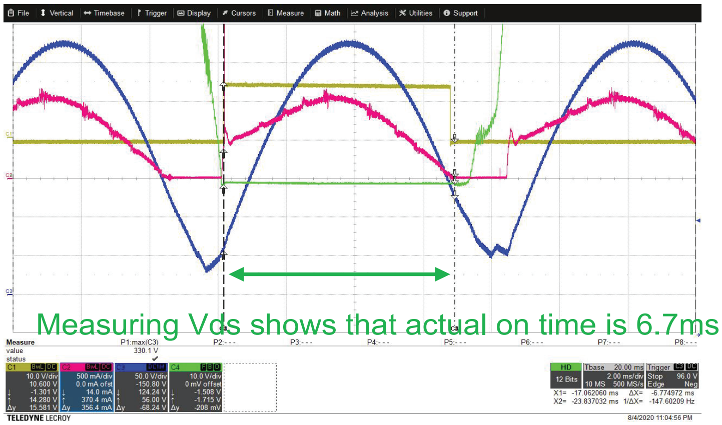

Figure 9b. Real Output Gate Duty

Graph Information: CH1 Low-side Gate Duty; CH2 MOSFET Current; CH3 V_{OUT}; CH4 Hi-side Gate Signal / Hi-side Vds

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