Optical isolated probes and high CMRR applications

Floating and differential measurements are common in power systems, such as switching supplies and motor drives. Engineers used to adopt high voltage differential probes to perform these measurements. The common high voltage differential probes usually have a bandwidth around 100 MHz and have a CMRR (Common Mode Rejection Ratio) of less than 30 dB. SIGLENT offers high voltage differential probes up to 400 MHz and 80 dB CMRR.

There probes have very high price-performance ratio in most test cases. But when it comes to applications like double pulse test of the fast switching SiC/GaN wide bandgap semiconductors, the limitation of bandwidth and CMRR can lead to loss of details in the switching rise/fall edges.

Optical isolated probe uses power-over-fiber and optical signal path for complete galvanic isolation between the measurement system and DUT. It isolates the probe from the reference point of oscilloscope (typically the earth ground). Thus, there is no electrical connection between them. It results in a very high common mode rejection ratio, even at bandwidths up to 500 MHz or 1 GHz. Also the differential voltage can be measured up to thousands of volts. This technology is very useful for making accurate voltage measurements on power converters that use fast switching wide bandgap semiconductors.

	ODP6000B optical isolated probe	DPB6150A/D high voltage differential probe
Bandwidth	500 MHz/1 GHz	100/400 MHz
CMRR	DC~10 MHz: 160 dB	DC > 80 dB 100 kHz > 60 dB 1 MHz > 50 dB
Measurement range	±5000 Vpk	±1500 Vpk
Isolation voltage	±60 kV	-

Table 1. Main specs of optical isolated probe and high voltage differential probe

Measurement example

In double pulse test setup, the low side MOSFET has low voltage potential, so no floating measurement required. Measuring V_{GS} of low side MOSFET can be done with normal 10:1 passive probes.

But the high side MOSFET has high floating voltage, an optical isolated probe with high CMRR is preferable.

High side gate measurements in half-bridge circuit

The benefit of a design like half-bridge circuit can only be achieved when it can be properly measured and tested. But differential signals in the presence of high common mode voltages cannot be measured accurately.

Below picture is the typical turn-on characteristic of the high-side in a half-bridge circuit. There are mainly three regions that are of interest. First is the C_{GS} charge time. Then followed by the Miller Plateau, which is the time required to charge the capacitance between gate and source C_{GD}. After that the gate will charge up to its final value.

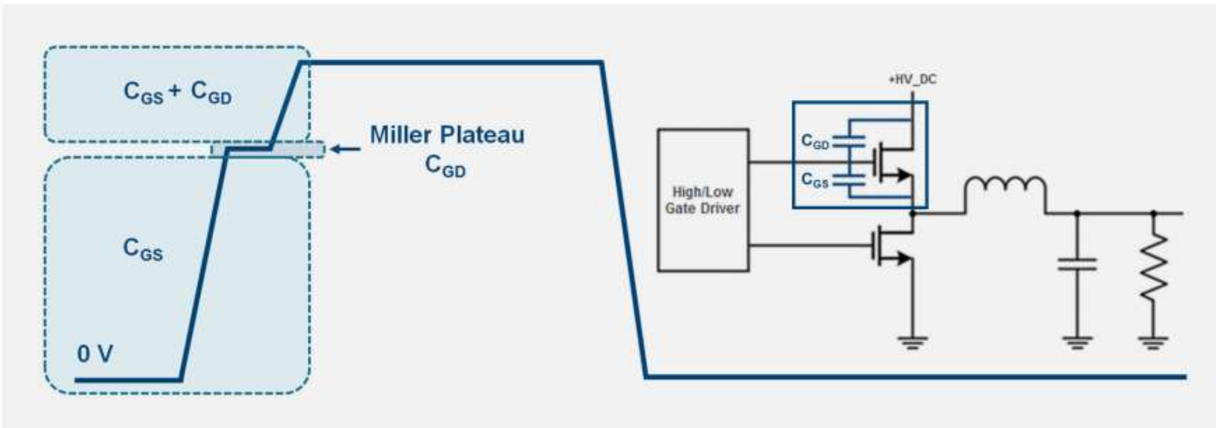

Figure 1. Turn-on characteristic of high-side

If we use the normal high voltage differential probe to measure V_{GS} and zoom in the rising and falling edge. There are lots of details missing compared to the optical isolated probe.

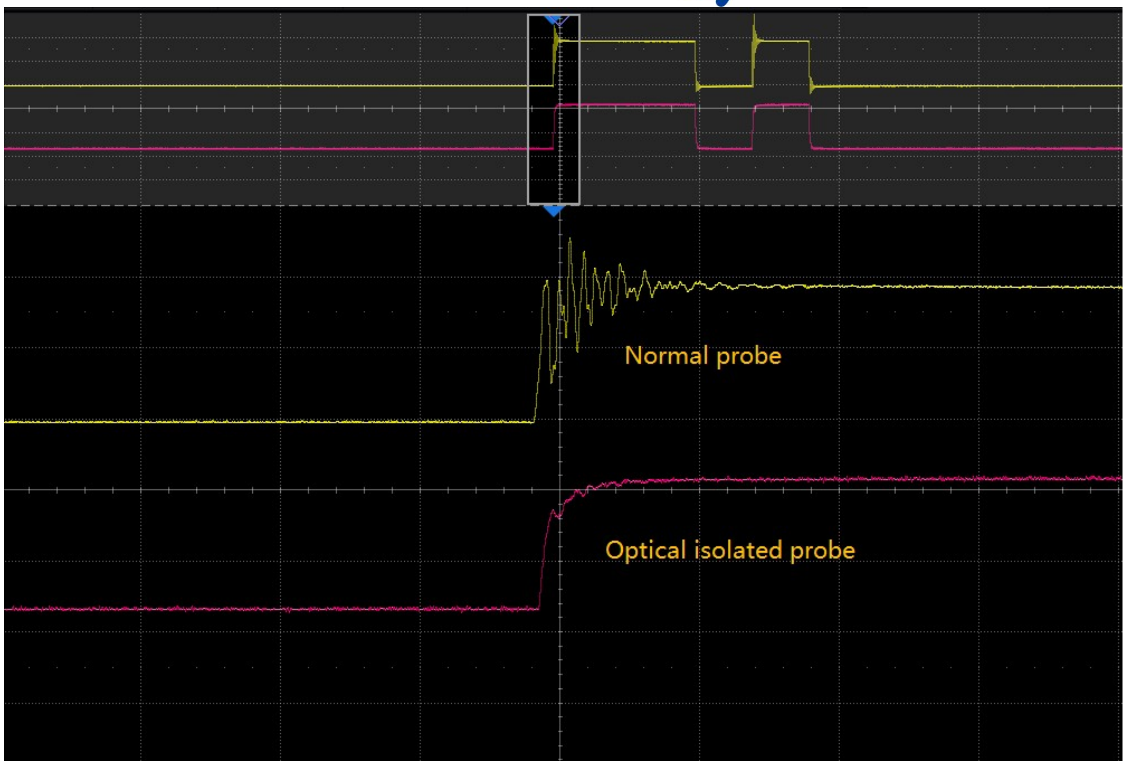

Figure 2. Rising edge of VGS, probe comparison

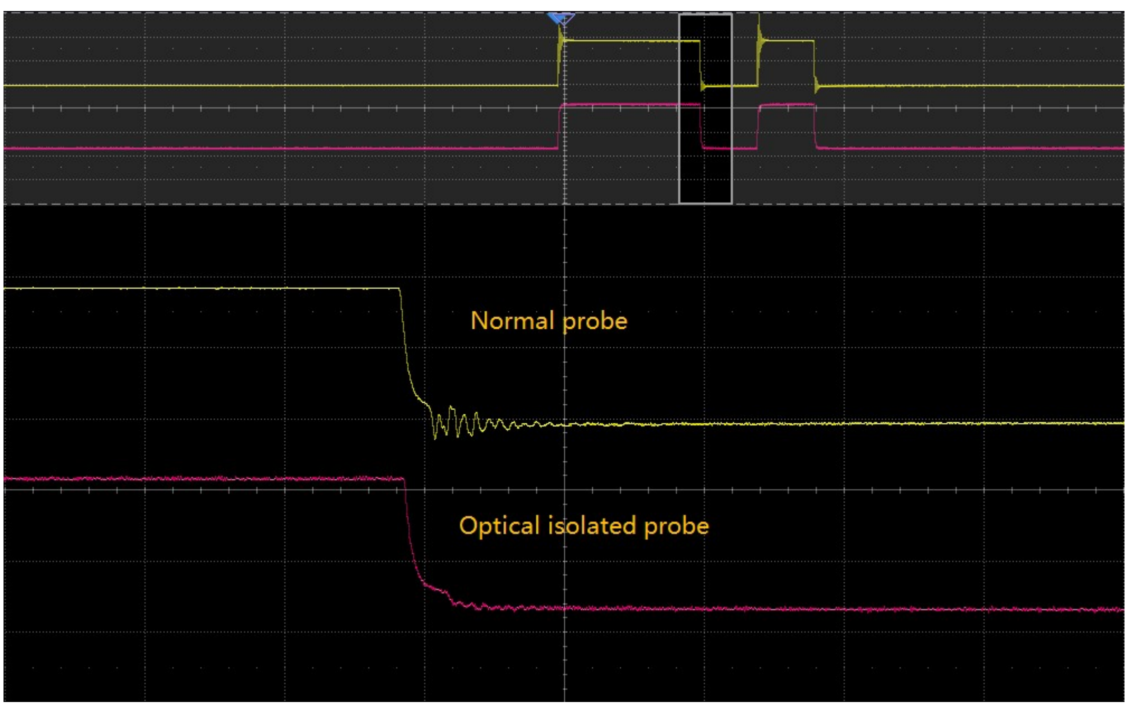

Figure 3. Falling edge of VGS, probe comparison

Common mode rejection ratio does change based on the attenuators selected for an individual application. This table shows typical CMRR values by frequency for each of the available attenuators.

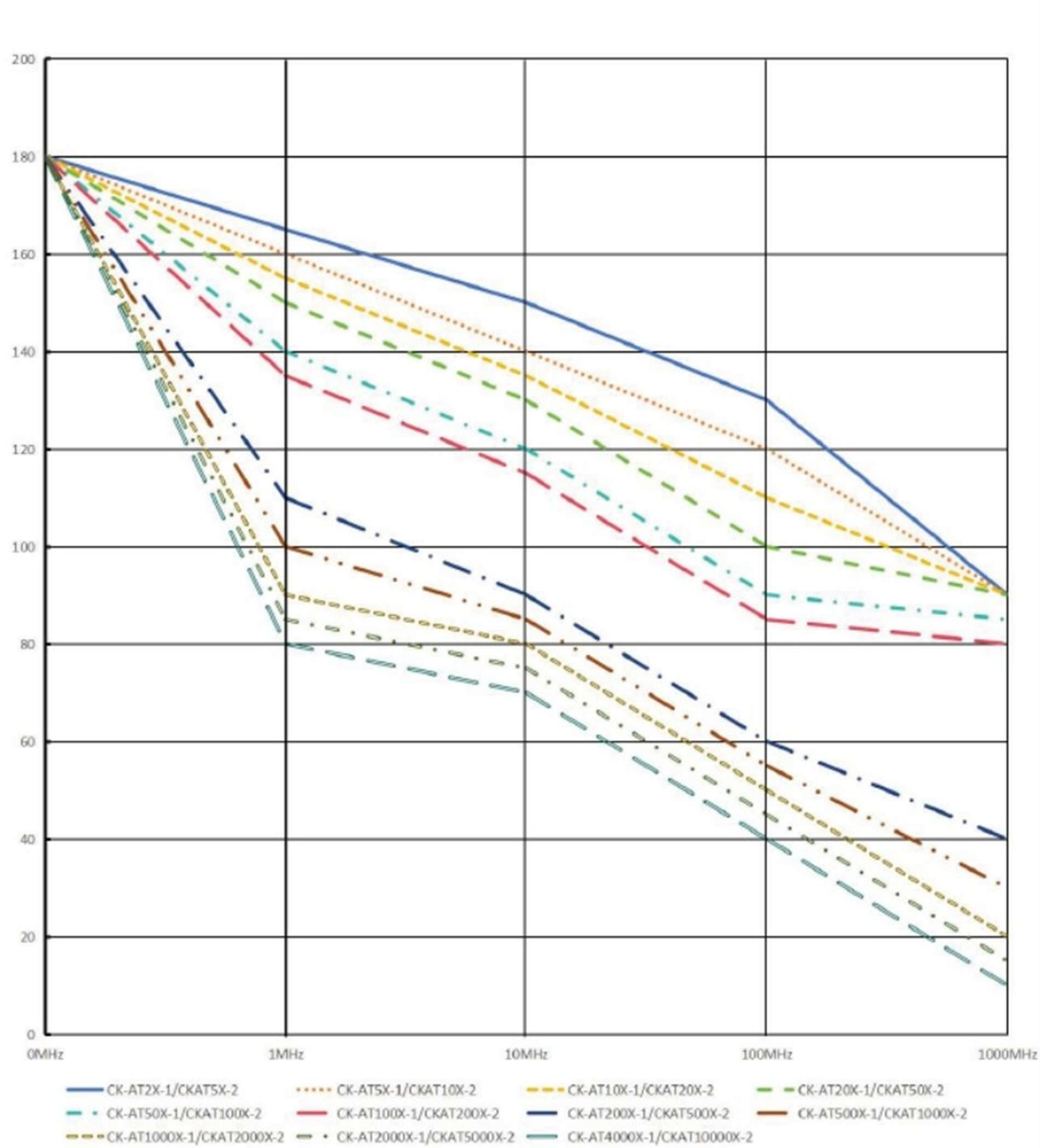

Figure 4: CMRR by frequency and attenuator

Conclusion

SIGLENT ODP6000B series optical isolated probe can measure high frequency differential voltage up to 1GHZ, while in the presence of high common mode voltage. The CMRR goes up to 160 dB, that is 100 million to 1. It is totally galvanically isolated from the DUT with ±60 kV isolation voltage. With proper use it can help engineers design and test power converter circuits efficiently.