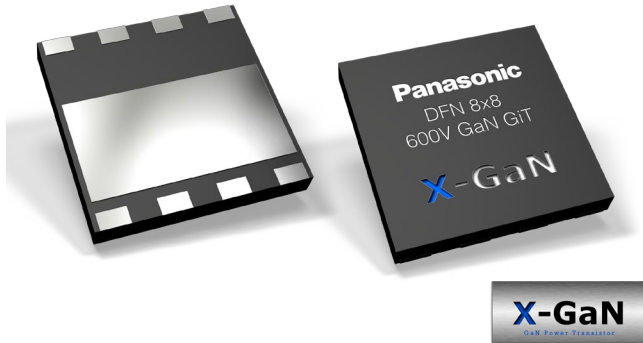


Tektronix IsoVu Measurement Systems Helps Panasonic Semiconductor Solutions Significantly Shorten Development Time for New GaN Device



Customer Solution Summary

CHALLENGE

Panasonic Semiconductor Solutions faced challenges when attempting to perform differential measurements in a new high-speed gallium nitride (GaN) power device using an oscilloscope. In particular, switching waveforms were distorted due to parasitic capacitance in standard oscilloscope probes while attempting to evaluate the high-side of a half-bridge circuit design.

SOLUTION

The high-performance Tektronix IsoVu measurement system uses optical technology to provide complete galvanic isolation between the oscilloscope and the device under test and does not derate over frequency.

BENEFITS

Using IsoVu, Panasonic was able to accurately observe the high-side gate voltage waveform to evaluate and optimize switching performance and reliability without degrading dV/dt . This significantly reduced the time required for analysis of the half-bridge circuit and the signal

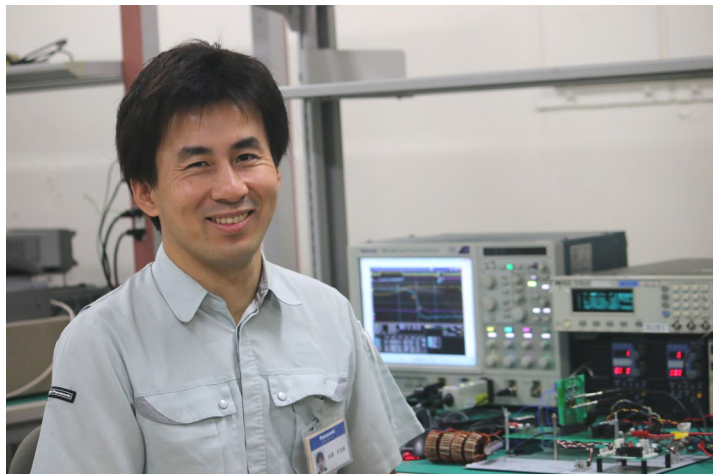
Pioneering new power device applications

High-efficiency low-loss power devices are indispensable for such applications as motor control circuit and switching mode power supplies and for handling high power and high voltage/high current levels. Until recently, power MOSFET and IGBT (insulated gate bipolar transistor) devices have largely been based on silicon.

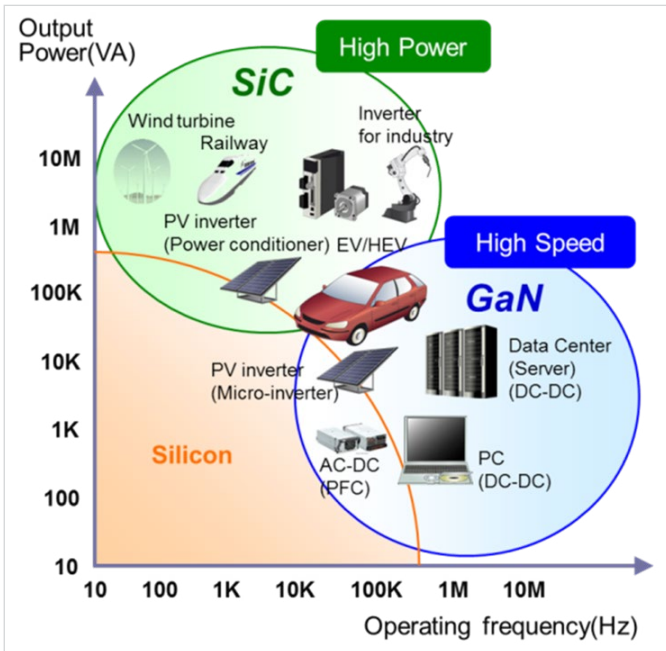
Compound semiconductors, however have rapidly started gaining attention as a power device material, in particular gallium nitride (GaN) and silicon carbide (SiC). Compared to silicon, GaN and SiC offer a number of advantages, including:

- / Wide band gap, high dielectric breakdown voltage, high operating temperature
- / High-voltage capability and low on-state resistance
- / Smaller chip size
- / Ability to operate at high speeds and high frequency

SiC is good for high power (more than 10 kW), high voltage (more than 1 kV) and high speed (less than 1 MHz) applications. GaN is appropriate for mid-power (less than 10 kW), mid-voltage (less than 1 kV) and ultra-high speed, ultra-high frequency (more than 1 MHz) applications. Since it has been difficult to develop power devices with these characteristics using existing silicon semiconductor materials, GaN and SiC semiconductors are enabling completely new applications, not simply replacing silicon.



Mr. Daijiro Arisawa, System Development Group Staff Engineer, Panasonic Semiconductor Solutions



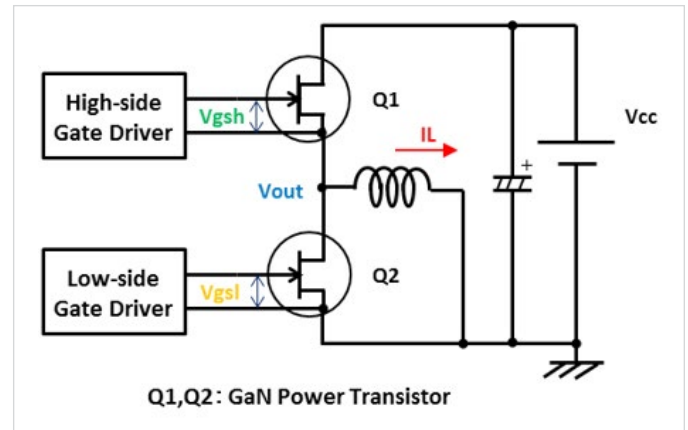
GaN technologies operate at both high voltage and much higher frequencies, requiring measurement system with greater performance and much higher common mode rejection.

Challenges developing ultra-high speed GaN power devices

Panasonic is developing ultra-fast, ultra-high-frequency GaN devices including a 600 V class of device that will offer advantages over SiC and silicon-based devices. Potential GaN applications include server power supplies, solar inverters, electric vehicles, and AC power supply adapters. In addition to high conversion efficiency, GaN devices will also allow the external size of the power supply to be reduced while operating at a higher frequency.

While the advantages are highly desirable, the team was facing a big problem in the development stage. Their existing measurement equipment was well-suited for silicon power devices but GaN technologies which operate at both high voltage and much higher frequencies require a measurement system with greater performance and much higher common mode rejection. Specifically, Panasonic’s development team ran into problems when attempting to measure the half-bridge circuit’s high side gate-source voltage using an oscilloscope.

Half-bridge circuits are very well known in the field of power electrical and electronic circuits and are a basic circuit used in standard switching power supplies. The half-bridge circuit consists of an upper and lower switch connected in a cascade arrangement. This 5-terminal circuit includes a DC bus voltage input, a switch node between the two switches, a ground return, a low-side gate drive input and a high-side gate drive input.



Half-bridge circuit

The benefits of such a design can only be achieved when the half-bridge circuit, the gate drive circuit, and layout, are all properly designed and optimized. It’s impossible to tune and optimize this circuit if you cannot measure it. The circuit can even short out if the high-side and low-side circuits turn on at the same time under certain conditions.

The IsoVu Solution

In a half-bridge circuit, the high-side VGS is riding on top of the switch node voltage which is switching between “ground” and the input supply voltage. Because of the large common mode voltage and fast edge rates, the gate-source voltage is impossible to measure without adequate common mode rejection. Traditional probes offer relatively good common mode rejection ratios at low frequencies up to a few MHz, but derate significantly as frequencies increase.

“This is truly revolutionary.”

Mr. Daijiro Arisawa
 Staff Engineer, System Development Group
 Panasonic Semiconductor Solutions



Because initial measurements using traditional differential probes did not agree with the expected results, Panasonic’s team was unable to extract meaningful details regarding their device under test. Making things worse, the waveforms changed dramatically based upon the position of the probe’s input leads, making repeatable measurements impossible.

Given the measurement challenges, Panasonic had been using a time-consuming and tedious manual method based on estimating high-side circuit failure. “There was a clear need for a new probe technology that would allow us to take



direct measurements on the high-side voltages,” said Mr. Daijiro Arisawa, Staff Engineer of System Development Group, Panasonic Semiconductor Solutions. “We needed a way to isolate the common mode voltages from the differential signals we were interested in.”

“I can say that for any future development in compound semiconductors we will be using Tektronix oscilloscopes and IsoVu probes to deliver the measurement insights we need to be successful.”

Mr. Daijiro Arisawa
Staff Engineer, System Development Group
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With its innovative optical technology, IsoVu offers complete galvanic isolation between the device under test and the oscilloscope. IsoVu has a 1 million to 1 common mode rejection ratio up to 100 MHz and 10,000 to 1 common mode rejection up to 1 GHz with no derating as frequency increases. It has 1 GHz bandwidth and 2,000 V common mode rating. This combination makes half bridge measurements possible.

Panasonic’s team was able to acquire an early IsoVu unit on a trial basis and came away impressed. “We could now directly observe the gate voltage waveforms on the high side and there were no adverse effects on the circuit. This is truly revolutionary,” said Mr. Arisawa.

Unlike all other commercially available probes, IsoVu uses an electro-optic sensor to convert the input signal to optical modulation, which electrically isolates the device-under-test from the oscilloscope. IsoVu incorporates four separate lasers, an optical sensor, five optical fibers, and sophisticated feedback and control techniques. The IsoVu architecture with galvanic isolation provides common mode withstand voltages of >2000 V peak across its frequency range. The electrical limitation for an optically isolated solution such as IsoVu is many thousands of volts.



Using a Tektronix oscilloscope and IsoVu probe, Panasonic was able to significantly reduce the time required for analysis of the halfbridge circuit and the signal.

“We were struggling to get the high-speed switching performance of GaN devices and to remove the influence of parasitic capacitance,” said Panasonic’s Mr. Arisawa. “With conventional silicon devices, switching speeds are not very fast and ordinary differential probes can observe the signal. Compound semiconductors such as GaN and SiC are too fast for traditional probes. I can say that for any future development in compound semiconductors we will be using Tektronix oscilloscopes and IsoVu probes to deliver the measurement insights we need to be successful.”



With the IsoVu probe, the high-side gate voltage waveform can be accurately captured to evaluate and optimize switching performance and reliability without degrading dV/dt.

For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tektronix.com

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