Water-Cooled Probe Achieves Tiny Size Needed To Measure Power Supply Noise Rejection

Picotest's P2124A high-speed line modulator is being introduced as the first water-cooled probe for electronics testing. Its use of liquid cooling in combination with its GaN transistors enables the probe to achieve the small form factor required for measuring power supply noise rejection (PSNR) in 400G/800G pluggable optical transceivers.

This new probe is one of several power rail modulators made by Picotest to measure power supply rejection ratio (PSRR), power supply modulation ratio (PSMR) and PSNR, which are all measures of how power rail noise appears at the output of voltage regulators, RF amplifiers, and digital channel jitter. These "injectors" allow designers to easily impose a modulation signal on a power rail voltage, which is then injected into the device under test (DUT). The input and output noise are then measured and compared to reveal the level of impact and rejection (Fig. 1).

According to Picotest, the P2124A release marks a revolutionary change in how test instruments are packaged and implemented. The probe currently addresses high-power, high-injection-level noise immunity testing such as those required for 400G/800G pluggable optical transceivers. Other water-cooled GaN probes are planned by Picotest to address additional test needs.

The rapid growth of the Internet of Things (IoT) and the explosion of cloud computing and 5G, have forced a rising demand on data centers and cloud service providers to increase both network capacity and new solutions to achieve increased data volume required for faster processing, more bandwidth, and increased density without sacrificing reliability. New, higher-speed devices, such as optical transceivers, which support these higher data rates, require testing to much higher bandwidths than previously available. This is especially true in the case of testing the signal and power integrity of gigabit communication interfaces.

Enter the QSFP-DD/QSFP-DD800/QSFP112 Hardware Specification; the test specification for QSFP Double Density 8x and 4x pluggable transceivers. The specification required PSNR testing that was not physically realizable as envisioned. After several discussions with the specification writers, it became evident that a new type of line injector was required. To meet the interconnection inductance required for the bandwidth, the interconnect impedance needed to be reduced to nanohenries, which meant limiting the interconnect length to fractions of an inch. So the interconnecting modulated power cable usually employed in such measurements needed to disappear.

Steve Sandler of Picotest addressed this challenge by downsizing the line injector instrument into a probe form. Many technical challenges, such as the use of GaN and extraction of the heat from such a small device, had to be solved. Achieving the bandwidth was made possible by using very small eGaN semiconductor devices in place of Si. These eGaN devices are extremely fast due to very low junction capacitance combined with very low internal resistance. The very small GaN devices and the water cooling allowed the circuit to be miniaturized to a very small form factor probe (Fig. 2).

Solving the thermal issue was the most challenging task. Placing the device in a small, water-cooled probe allowed the line injector to get very close to the device under test, achieving the fraction-of-an-inch interconnect required to achieve the measurement bandwidth. This downsizing of the probe would have been impossible with passive cooling solutions, which would simply be too large. In this case, water cooling was implemented using a very small, precision, micromachined liquid-cooling plenum. Together these innovations enabled QSFP-DD/QSFP-DD800/QSFP112 noise testing today, and will permit higher-bandwidth/higher-power testing in the future.

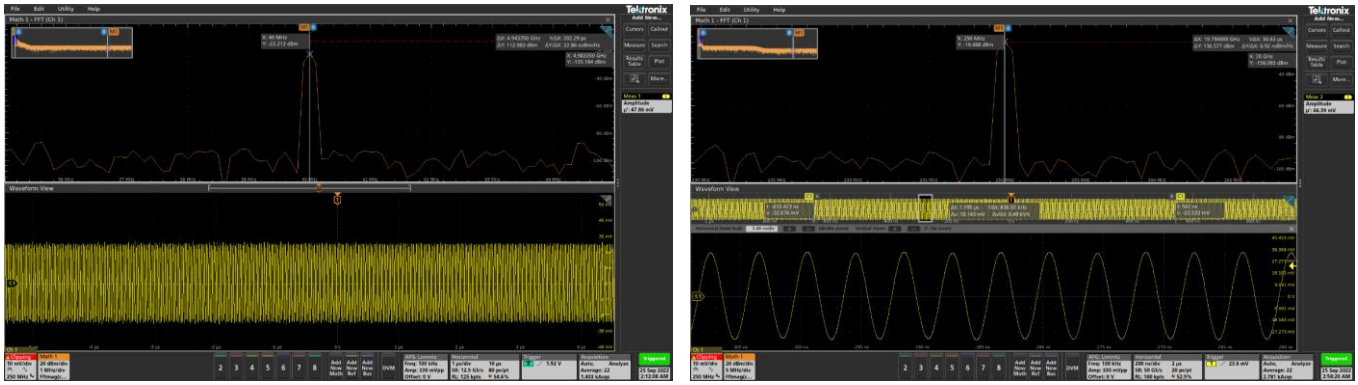
The P2124A probe is used for PSNR and other noise immunity tests. The probe combines a power rail voltage with a modulation (noise) signal. The combined voltage is used to drive the DUT, which can then be tested for performance in the presence of the noisy power supply. The modulation signal can be any 50-Ω analog signal within the bandwidth limits of the probe (Fig. 3).

Two solder-tabbed terminals are used at the probe tip to connect the modulator to the DUT. A SMPM connector at the back end is used to connect the analog modulation source. A 4-pin modulation electronics connector at the back end of the probe connects the external power supply and provides tip voltage sense signals for remote

sensing. The probe includes the water-cooling system and supports the connection of two probes simultaneously.

The P2124A supports the QSFP-DD-Hardware-Rev6.x requirement for QSFP Double Density 8X and QSFP.OSFP 4X pluggable transceivers and similar power supply output noise and tolerance testing specifications (OSFP Octal Small Form Factor Pluggable Module Rev. 5) including AEC cable and optical module sinusoidal power supply noise tolerance. The probe can be used by manufacturers or end-users to verify OEM compliance with the requirements. A remote sense module is provided to support optimum voltage compliance for the DUT.

The P2124A is priced at $18,000. For more information, see the website or contact the company at 1-877-914-PICO.



(a) (b)

Fig. 1. The P2124A modulates the bus voltage into a 0.6-Ω load with 5.5-A dc bias and a 40-MHz modulation signal (a). While the response is attenuated due to various elements of the test setup, because attenuation due to the interconnects has been eliminated, it's possible to achieve modulation up to 250 MHz (b) by increasing the amplitude of the input modulation source.

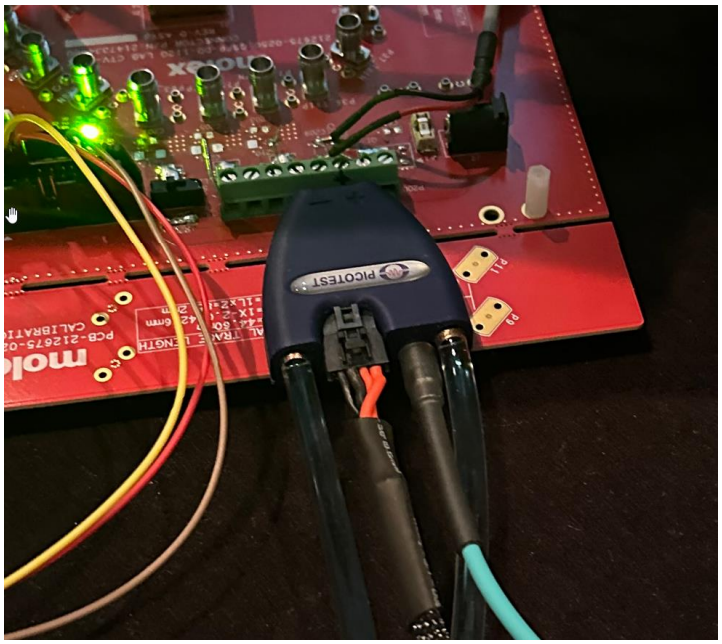
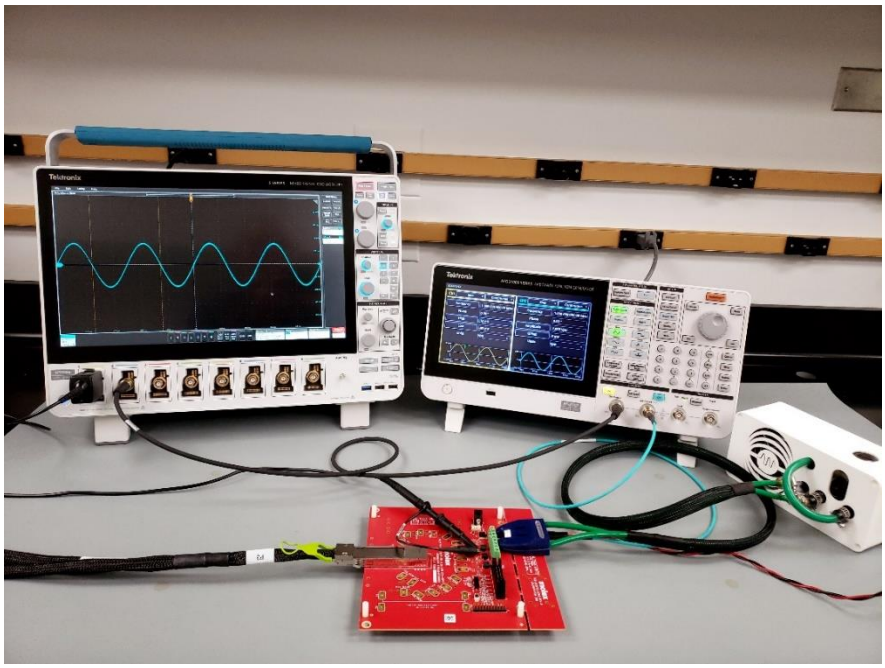


Fig. 2. The P2124A is a GaN-based probe used for PSNR and other noise immunity tests. The probe combines a power rail voltage with a modulation (noise) signal. The combined voltage is used to drive the DUT, which can then be tested for performance in the presence of the noisy power supply voltage. The modulation signal can be any 50-Ω analog signal within the bandwidth limits of the probe. The compact head on the P2124A eliminates interconnect inductance by bringing the line injector electronics into the probe head.



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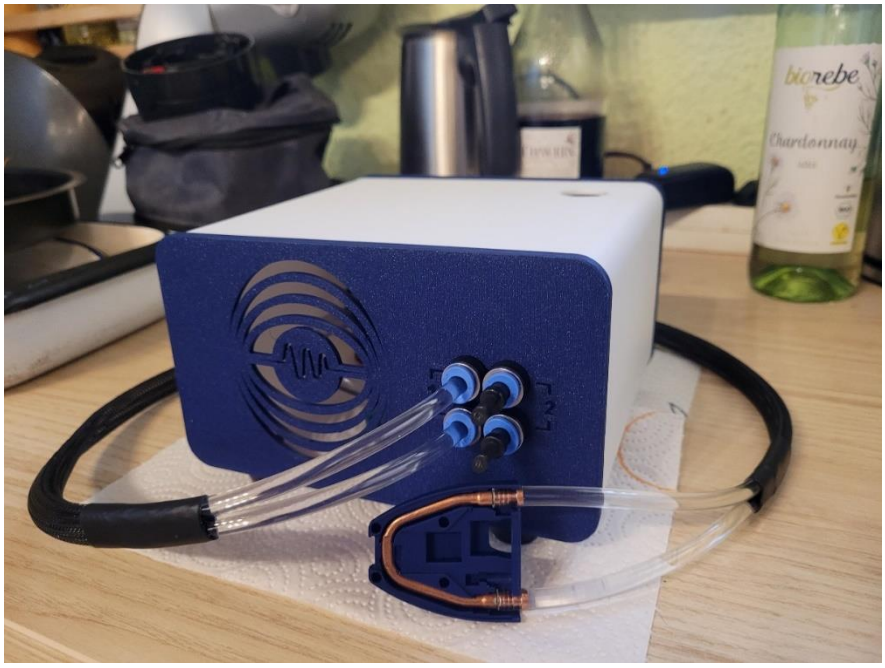

(b)

Fig. 3. Sample PSNR test setup using the Picotest P2124A and the Molex Transceiver board (a). Water cooling technology is used to keep the high-powered probe electronics under optimum conditions (b).