

## ***Two-Port Probe Revamps Impedance Measurement For PI And PDN Applications***

[Picotest's](#) P2102A is a two-port "browser" probe especially designed for measuring power integrity applications including VRM (voltage regulator module) impedance and stability and power distribution network (PDN) impedance. The probe comes with multiple interchangeable heads in different sizes, allowing fast and repeatable power rail testing capability (Fig. 1).

"The increase in awareness of the critical nature of this measurement and the proper design of the PDN impedance is really timed well for the release of this probing solution," stated Steve Sandler, CEO of Picotest, frequent Power Integrity industry lecturer and How2Power contributor. "The ability to measure low and ultra-low impedances combined with the browsing capability is unmatched. I believe this will enable many engineers to perform two-port shunt-through impedance testing where they might have not had the opportunity or capability in the past."

The P2102A can measure submilliohm power rail impedances up to bandwidths of 300 MHz (dependent on calibration). The probe comes with four swappable heads—1206, 0805, 0603, and 0402—sizes that match common output capacitor sizes. Additionally, it is available in different attenuations (1X, 2X, 5X, and 10X). This allows flexibility for users to measure across a wide range of voltages.

The Picotest P2102A probe is a unique 50-Ω transmission line with a true four-point connection (two signal lines and two ground lines). This precision supports a variety of measurements including impedance (two-port series and shunt-through), transient step load, ripple, noise TDT/TDR and clock jitter. It has significant advantages compared with active probes and other types of passive probes. A powerful added benefit is that you can use Picotest's noninvasive-stability measurement (NISM) algorithm, included in most VNAs, to assess the power supply's stability at the same time as you assess the PDN.

In the past, performing PDN impedance measurement required soldering of coax or preparing the PCB with RF connectors for measurement. The P2102A is referred to as a "browser" probe for its ability to easily and quickly be moved from point-to-point/rail-to-rail simply by reseating the probe points. The probe achieves low inductance at the tip to mitigate space constraints on a dense PCB, while eliminating the need to add additional SMA connections or other test points necessary for impedance measurements.

It is especially useful when there are multiple rails to test. Repeated measurements are simplified because connection is by simply touching the tip to an output capacitor. The rugged, ergonomic design and small form factor allow the user to get into tight places. The slim body with extended tips provides good visibility of the target. Picotest's PDN Cable, which reduces losses and errors in low impedance testing, is used to connect the probe to the instrument. In short, this two-port P2102A probe is best suited for VRM, power plane and decoupling measurements.

The two-port probe also allows transient step load browsing since it can be used to transmit a load current step through one port, while measuring the voltage response from the other port, simultaneously. The probe is compatible with all equipment including vector network analyzers (VNAs), oscilloscopes and spectrum analyzers.

The probe is designed to work with the traditional two-port shunt-through impedance setup, including the J2102B common-mode transformer or J2113A ground isolator, which eliminates the dc ground loop present on most instruments. A source power amplifier such as the OL000168 B-AMP 12 can help measure ultra-low impedance magnitudes.

For those unfamiliar with PDN measurements, some background may be in order. High-speed printed circuit board (PCB) design requires well designed power delivery networks (PDNs) to support today's FPGAs and custom mixed-signal ASICs. The PDN contains important impedance information that can tell a designer how a system will react to dynamic currents. Vendor information for a VRM's output impedance is not generally available and not always accurate when it is. Further, measuring ultra-low impedance on multiple VRMs or a multi-topology VRM is a challenge for any design engineer.

The two-port shunt-through measurement is the gold standard for measuring output impedance in the sub-milliohm region, says Picotest. But it can be a challenging measurement. It is not always possible to make these measurements without direct SMA connections to the PCB when a designer makes these types of

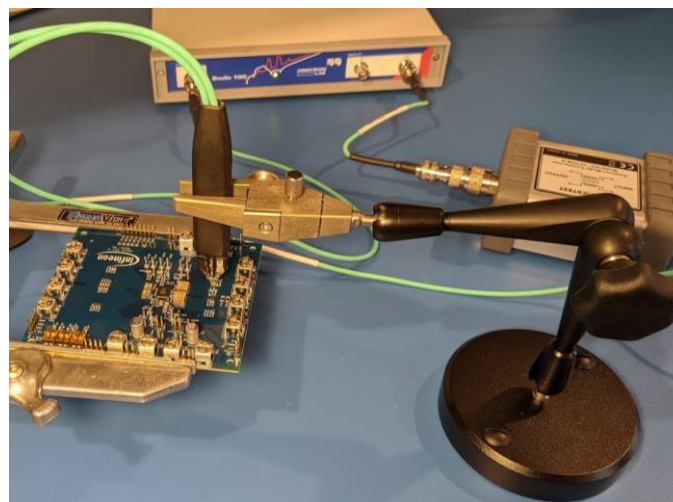
measurements with a VNA as the method of connecting the DUT requires attention to detail to ensure inductance is minimized to allow an accurate measurement.

PDN problems are significant and costly. They can often require a board spin to fix. To get the most out of your VNA, you need to use the right probes and accessories to ensure your measurement is successful. With a browser probe like the P2102A you can quickly characterize multiple VRMs to ensure stability (see Fig. 2) or even check if your model is accurate during your initial PDN design.

The price of the P2102A is \$2995 in single quantities and includes a SOLT (short open load through) and isolation calibration board. For more information on the probe, see the [website](#) or contact the company at 877-914-PICO.



*Fig. 1. The P2102A PDN probe enables PDN low and ultra-low impedance measurements for power integrity applications. In the past, performing PDN impedance measurement required soldering of coax or preparing the PCB with RF connectors for measurement. The P2102A is referred to as a "browser" probe for its ability to easily and quickly be moved from point-to-point/rail-to-rail simply by reseating the probe points. The probe can measure submilliohm power rail impedances up to bandwidths of 300 MHz; comes with four swappable heads in sizes that match those of common output capacitors and is available in different attenuations, for measuring across a wide range of voltages.*



*Fig. 2. In this test setup, the P2102A PDN browser probe and the OMICRON Lab Bode 100 VNA make a noninvasive stability margin measurement (NISM) using a two-port shunt-through impedance measurement on a linear regulator. According to the vendor, "The big 'WOW!' is that we obtained the phase margin from the impedance measurement at the regulator's output capacitor using NISM. It is a great capability to be able to accurately assess stability at hundreds of megahertz or higher without lifting any wires (which would interfere with the measurement)."*