Keysight Technologies
More Test in Less Space: Driving Down the Size of Test

Application Brief

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KEYSIGHT TECHNOLOGIES

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As silicon wafers, wireless devices and military systems have increased in complexity, multi-port vector network analysis with S-parameters has become an indispensable tool. A few years ago, vector network analysis with four-port capability was a common need. A variety of next-generation products then entered the market, requiring 8-port measurements, and some manufacturers responded. The trend continued with the following generation requiring 16-port capability, and 32-port requirements are on the near horizon.

A three-part test challenge: Reducing the size of VNA test systems while increasing capacity and capability

Along with this trend, many organizations are seeking to drive down the size of test with more capability per cubic inch in their test stations. This is a subset of the larger need to drive down the cost of test to help ensure ongoing profitability as prices erode in wireless communications or as business models change in aerospace and defense.

These long-term trends highlight three specific needs:

- The need to test highly complex devices in much less time without sacrificing accuracy
- The need to test multiple devices—and test in greater numbers—at a single test station
- The need to reduce the size of the test stations used to test multiple wafer sites or complex devices

The modular solution: Get more into your test system—and get more out of it

Many system developers have implemented multi-function testers within a single PXI chassis. As the chassis fills up, fewer slots are available to incorporate VNA capability. A one-slot PXI vector network analyzer (VNA) is ideal for this situation.

On the production line or in a wafer fab, there is a growing need to test multiple devices or multiple wafer sites at a single test station. Examples include mobile handsets, military radios and increasingly dense silicon wafers. In such situations, one of the key needs is to reduce the overall size of the test solution. The ability to install multiple 2-port PXI VNAs in a single chassis provides a tremendous space reduction when compared to using multiple benchtop analyzers on the production line or alongside a probing station (*Figure 1*).

As devices become increasingly complex, the need to easily characterize a full set of S-parameters on a large number of ports continues to increase, with 8, 16, or more ports. Examples include RF front-end modules (FEMs), multiple-input/multiple-output (MIMO) antennas, smart antennas and phased-array transceiver modules. Total characterization of an FEM used in mobile handsets requires S-parameter measure-

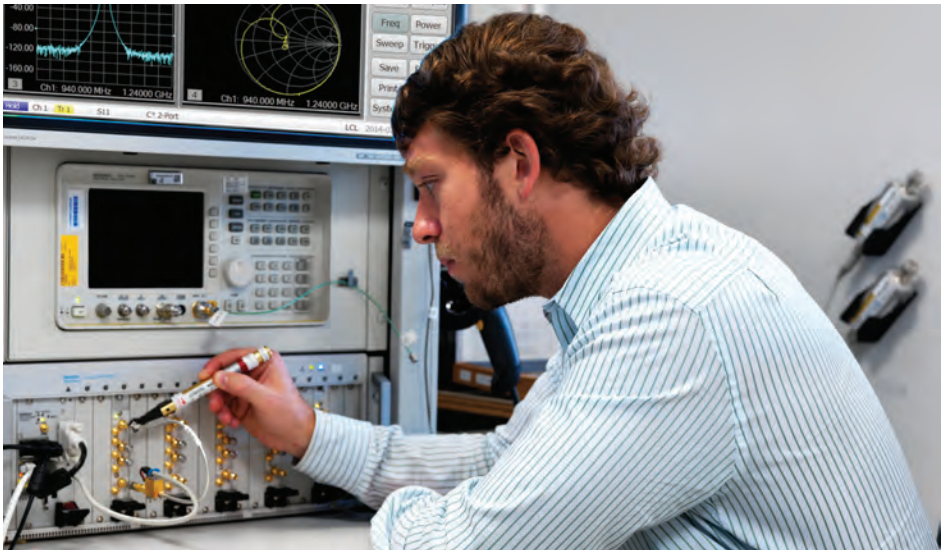

FIGURE 1. Adding a pair of 2-port PXI VNAs to an existing test station enables powerful device characterization without expanding system height or footprint.

ments on 10 or more ports. In addition, full N-port correction is needed to ensure accurate results.

Engineers designing MIMO antennas need to investigate antenna mutual coupling, which can affect system performance. They can do this through channel measurements, and this entails simultaneous S21 measurements for all combinations of transmit and receive antennas. Here, too, full N-port correction is needed to ensure accuracy.

Whether the focus is on multi-site testing or characterization of multi-port devices, the configuration should be easy to change through software instantiations of "N-port" VNA instruments within a single chassis. For example, a single chassis containing eight 2-port VNAs could be configured as four 4-port VNAs, two 8-port VNAs, one 16-port VNA, or a myriad of other combinations.

Comparing benchtop and modular VNA approaches

In multi-site testing, today's typical solutions use either a VNA with a switch matrix or multiple standalone VNAs. Compared to using a switch matrix, a PXI-based approach created around one-slot PXI VNAs can enable faster throughput with the ability to make simultaneous measurements on differing numbers of ports, at different frequency ranges, or with segmented sweeps (including power level and IF bandwidth, for example) optimized for speed and accuracy.

Compared to using multiple benchtop VNAs, the compact PXI VNA has several key advantages: lower total cost; smaller footprint and shorter height; and closer placement relative to DUTs or handler stations. Additional advantages include easier scalability when more ports are needed and the ability to add signal analysis, signal generation, and more, in open slots.

For multi-port testing, the available solutions are based on either a multi-port VNA or a VNA plus a switch matrix. Compared to a typical multi-port VNA, the one-slot PXI VNA offers more flexibility in frequency range, and this can mean lower up-front cost and simpler upgrades when moving to higher frequencies. The PXI VNA also offers greater flexibility in port count, letting the system creator add ports in increments of two rather than four, which is common with box VNAs. This level of flexibility also translates into greater uptime: if a module fails, it can be easily removed and replaced.

Compared to a switch-matrix solution, the PXI-based approach has the same advantages in throughput and size described above. In addition, the use of multiple two-port VNAs typically provides higher performance in terms of dynamic range and directivity by eliminating the signal degradation that can be caused by cascaded external switches.

One slot, two ports: The ultimate VNA flexibility

Keysight's 1-slot PXI VNA puts full 2-port capability into a single-slot package with remarkable performance in terms of speed, trace noise, stability and dynamic range. Six models are available, spanning from 300 kHz to 4, 6.5, 9, 14, 20 or 26.5 GHz. Modules can be configured to satisfy all the scenarios described earlier: a 1-slot, 2-port VNA for a compact multi-function tester, up to eight 2-port VNAs in a single chassis, or cascaded modules that create a flexible combination of multi-port VNAs in one chassis (*Figures 2 and 3*). Multiple PXI chassis can be connected and synchronized to enable even greater test capacity in a small footprint. Measurement functionality is scalable through a range of software options.

For more information, visit www.keysight.com/find/pxivna.

FIGURE 2. This versatile multi-port configuration uses eight two-port PXI VNAs in a single chassis.

FIGURE 3. This example multi-site configuration includes a quartet of independent four-port PXI VNAs in a single chassis.

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