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Vector Network Analysis with Up to 48 Ports

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The sales volume of smartphones and tablets with wireless Internet connections has already exceeded that of traditional mobile phones and desktop PCs. Multiband front end modules as well as components for GPS, WLAN and Bluetooth applications are an essential part of these new devices. In a mobile phone, the number of signal paths increases with the number of integrated components and technologies. This also increases the number of test ports at which a front end module must be measured in order to ensure the stringent requirements are met, e.g., with respect to insertion loss or selection during production. This makes vector network analysis with more than 20 ports, or even 30 ports in the future, a must.

Traditional vector network analyzers (VNA) with four ports still require a significant measurement effort because the user needs to consider which measurement ports on the device under test (DUT) must be measured simultaneously. All unconnected ports on the DUT should be terminated to prevent unwanted signals from influencing measurement results. In addition, the user must screw the DUT on and off again multiple times to measure all DUT ports. This not only increases the test effort, but also significantly increases measurement times. Increasing the number of test ports on the VNA to match the DUT is the solution to this problem.

Network Analysis with Multiple Ports

The simplest solution is to use external switches to increase the number of ports on the VNA. It is not enough to merely connect a switch module. The hardware must meet the measurement requirements, and the switching must be synchronized with the measurement sequences of the VNA. This requires a complex control program. Calibration of a setup using external switches is also significantly more complex than for measurements with a two-port or four-port VNA. To measure all S-parameters of the DUT, the external switch module must be full crossbar, allowing unrestricted measurements between all ports.

Figure 1 A test solution with 48 ports consisting of one R&S ZNB8 and two R&S ZN-Z84 switch matrices.

Figure 2 The connected switch matrix is shown in the VNA firmware menu. This example shows a 4 × 18 switch matrix.

This setup is complex and expensive but there are practical commercial solutions: Rohde & Schwarz now offers the R&SZN-Z84, an external switch matrix designed to complement the R&S ZNB network analyzer. The base model is equipped with six test ports. When needed, the number of test ports can be increased in groups of six to provide a total of 24 ports. A four-port R&SZNB with two 24-port matrices can therefore support 48 test ports as shown in ***Figure 1***. This makes it possible to measure all 48 × 48 S-parameters of the DUT.

Uncomplicated Matrix Solution

A big advantage of this solution is that it is a plug and play system. All functions required for controlling and using the R&SZN-Z84 are already integrated in the R&SZNB firmware (see ***Figure 2***). The switch matrix can be connected to the VNA via USB, LAN or the special Direct Control digital interface, and is automatically detected by the VNA. The matrix ports can be used just as with a standard two-port or four-port VNA.

Calibration is very easy using automatic multiport calibration units. The R&SZNB firmware detects the calibration units as soon as they are connected via USB. The calibration menu displays which ports on the calibration unit must be connected to which ports on the switch matrix. A higher number of ports on a calibration unit results in fewer required calibration steps. This saves time and reduces errors. Currently, calibration units with up to eight ports are available. ***Figure 3*** offers an overview of the calibration of twelve ports using a four-port calibration unit.

RF Characteristics and High Flexibility

The Rohde & Schwarz solution offers flexibility without compromising the measurement characteristics. The R&S ZN-Z84 switch matrices have a modular design and are available with two or four input ports and with six, twelve, 18 or 24 test ports. This means they can be used with a two-port or four-port R&SZNB, and up to two switch matrices can be connected to a four-port model. As a result, users can find the ideal combination for their current application.

When using multiport solutions, simple operation is just as important as good RF characteristics. Besides good test port matching, a low insertion loss of the used switches is particularly critical because it affects the available output power, the sensitivity and the trace noise. A low insertion loss improves long-term and temperature stability and allows longer calibration intervals.

The insertion loss of the R&SZN-Z84 is between 3 and 5 dB at 2 GHz, depending on the matrix topology. The high 0.1 dB compression point of 20 dBm at 2 GHz for the electronic switches makes it possible to measure active components.

If the level stability and dynamic range are not sufficient when using the matrix, it is possible to combine a 2xN R&S ZN-Z84 switch matrix with a four-port R&SZNB. This makes two additional test ports available for measuring active components with up to 27 dBm output power or filters with up to 140 dB dynamic range. The flexibility of the solution is shown in ***Figure 4***.

Figure 3 Overview of the calibration of twelve ports using a four-port calibration unit (a) and the first calibration step using an eight-port calibration unit (b) four calibration steps are necessary.

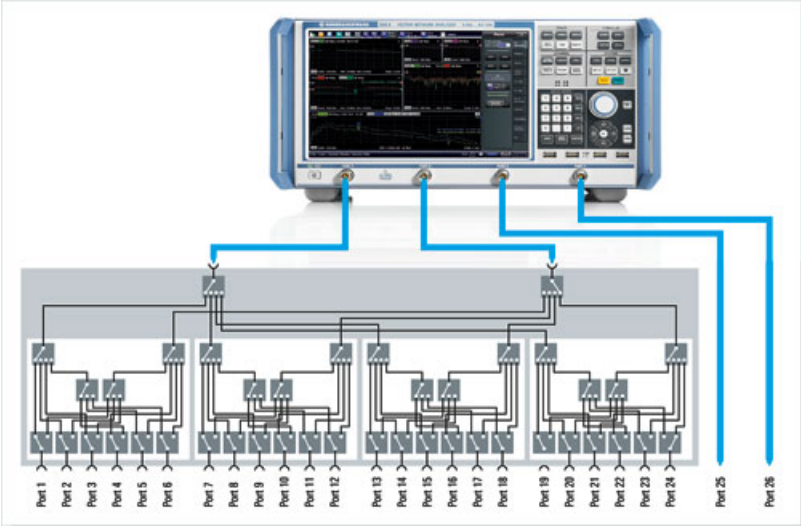

Figure 4 A 2 × 24-port matrix connected to a four-port VNA (26 test ports are available to the user).

There is an increasing need in production and development for solutions that make it possible to measure multiport components with more than four ports using a network analyzer. The R&SZNB in combination with the R&SZN-Z84 switch matrix is the ideal test solution. The matrices increase the number of test ports to 48 ports and permit full-crossbar measurements.

Thanks to the firmware, measurements are as easy to configure as with a conventional two-port or four-port VNA. The system is easily calibrated using a multiport calibration unit with up to eight ports. The system's good RF characteristics, such as a high compression point and low insertion loss, permit measurements using high power levels and a wide dynamic range.

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