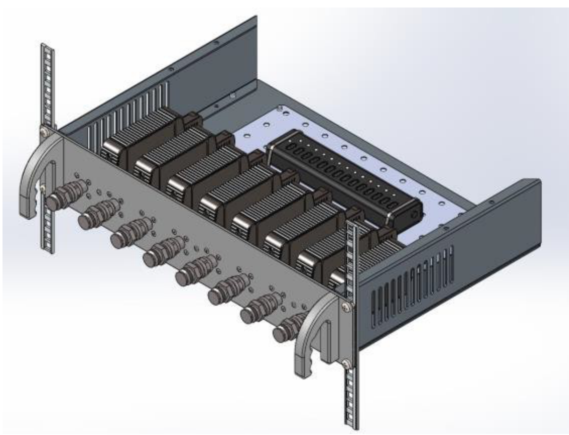
INTRODUCTION TO RNVNA, A MULTIPORT VNA SYSTEM

05/01/2020

Background

In many applications it is necessary to make multiport measurements. The RNVNA links up to 16 1-Port analyzers together into a multiport network analysis system. Each of the 16 analyzers will make individual vector reflection measurements and scalar transmission measurements from port to port. In other words, S_{11}, S_{22}, S_{33} and so on will be complex measurements and S_{21}, S_{31}, S_{41} and so on will be scalar only measurements.

Description



Each 2RU rack shelf can house up to eight 1-Port VNAs. Reflectometer models are available with frequency ranges of 1 MHz to 6 GHz (R60), 85 MHz to 14 GHz (R140) and 1 MHz to 18 GHz (R180). The shelves can only be populated with one model of VNA. It isn't possible to mix them at this time. A powered hub is used to aggregate the separate units to a single USB connection with the host computer and to supply the needed power to the VNAs.

The software assigns each VNA to a port number. In a first-time setup, the VNAs will be plugged into the hub one at a time from left to right to assign ports 1 through 8. Ports 9 through 16 on the second shelf are processed in the same way. The software will remember these VNA designations. Users need to make sure each VNA is assigned to the correct port number by checking its serial number.

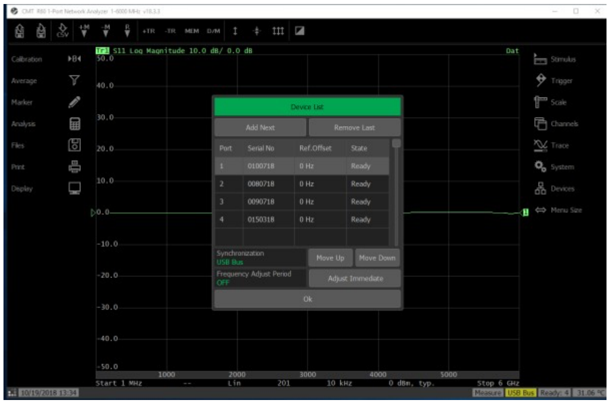


Fig. 1 Assign each VNA to a port number

Remember to assign a frequency correction period if the optional FD-16 reference syncing module is not purchased. The first VNA is assigned as the reference and additional VNAs are adjusted to precisely match its frequency. This is necessary to assure that measurements between VNAs are properly centered in the middle of the receiver's IF bandwidth.

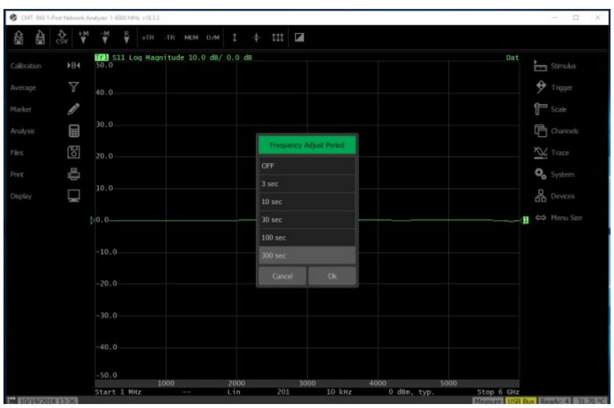


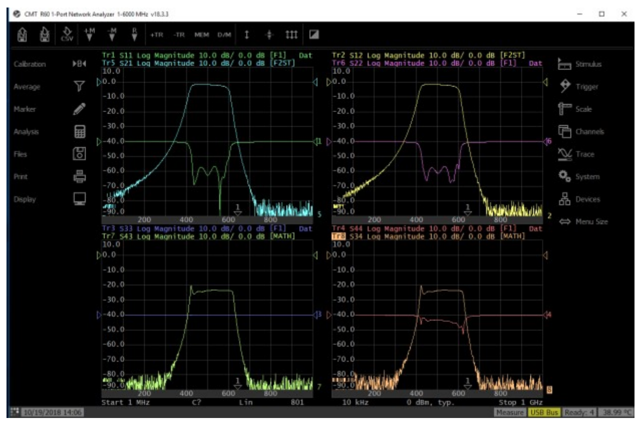
Fig. 2 Assign frequency correction period

Calibration

To simplify the calibration process, it is highly recommended that an Automatic Calibration Module (ACM) is used. This will greatly reduce the time spent calibrating. The calibration process will be described here using an ACM but if a mechanical kit is used the process is much the same, just more tedious.

Under “Calibration”, choose “Autocalibration” and set the source port to 1 and the receiver port to 2. Attach the ACM between ports 1 and 2 of the RNVNA shelf. Select “Perform Auto- Orientation” to allow the ACM to determine which ports are connected to which side of its body. Press the “Calibrate” button and wait for the process to finish. Now remove the connection to port 2 and connect port 3 to the ACM. Choose Receiver Port 3 and Perform Auto-Orientation and then press “Calibrate” once again. Repeat this procedure attaching ports 4 and up, changing the receiver port designation each time and pressing the calibration button. For N ports you will have performed N-1 connections and calibrations. At this point the system is calibrated. Each Sii measurement will be designated with [F1] to indicate full 1-port calibration. Each S1i measurement will show [F2ST] to indicate Full 2-Port Scalar Thru and each Sij where i is not equal to 1 will show “MATH” which means the VNA has calculated those terms based on the previous measurements. The performance of this calculation is very accurate.

Measurement



With the ports calibrated, one can now make vector 1-Port measurements and scalar measurements between ports. The next chart shows simultaneous measurement of two bandpass filters. Since the two filters were so similar, the connection from port 3 to the filter was loosened until the response degraded enough to be completely different from the measurement of the filter on ports 1 and 2.

Similarly, one could make measurements of antenna arrays and be able to quickly evaluate the VSWR of each antenna and its isolation to all other antennas in the system. Limit lines and limit tests could be added for fast production test.

Accessories

Two optional modules are available for the RNVNA solution:

TD-16 module: This module increases measurement speed for the RNVNA solution. This module distributes the trigger signal from the VNA in port 1 to other VNAs in the system. The measurement is a lot faster with this module (typically 3 to 5 times faster) because the VNAs are synced by USB communication when the trigger signal is not shared.

Please note that this is not the only way to increase measurement speed. If the RNVNA solution only contains up to four 1-Port VNAs, using RF cables and Tee connectors to connect the trigger signal of each VNA will achieve the same measurement speed.

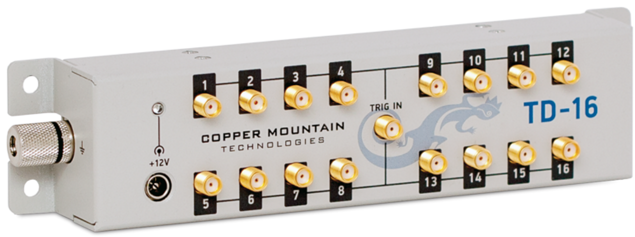


Fig. 3 TD-16 module

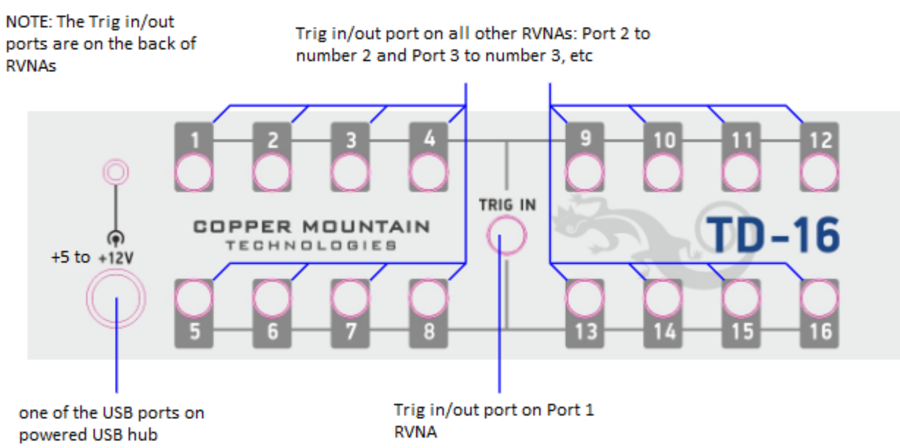


Fig. 4 TD-16 module connection diagram

FD-16 module: This module adjusts the frequency of each 1-Port VNA and thus eliminates the need for software frequency adjustment.

Each 1-Port VNA has a 10 MHz reference signal inside which is used to generate the RF signal that comes from the VNA port. However, in real life all 10MHz reference signals are a bit different from each other. For example, one might be 9.99 MHz and another might be 10.01 MHz. Thus, having the reference signal connected among each 1-Port VNA eliminates this difference. When the FD-16 module is used, the software settings need to be updated by going to “system” -> “Reference source” -> “linked”.

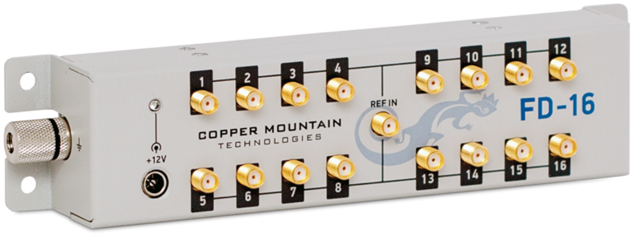


Fig. 5 FD-16 module

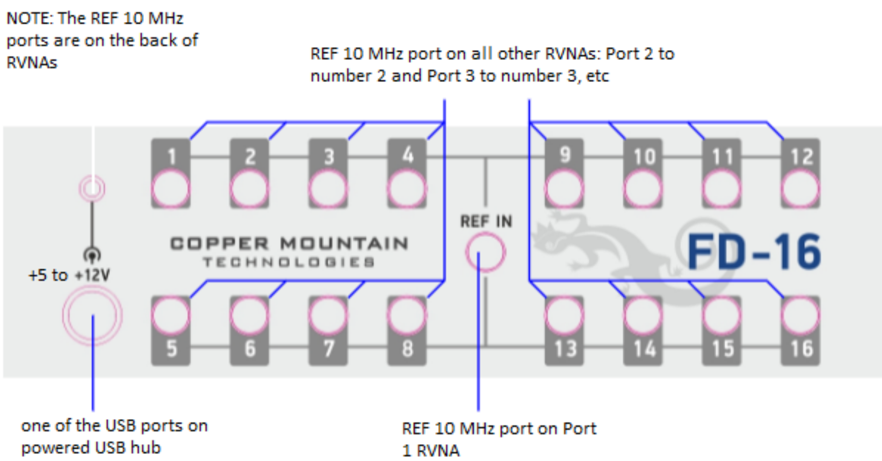


Fig. 6 FD-16 module connection diagram

A Truly Scalable Solution

Each RNVNA shelf can be populated with any number of VNAs up to eight units but the system can be ordered with as few as two VNAs and then scaled up as production requirements change.