Microwaves&RF

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Get Your Hands Dirty with These VNA Tools

By offering affordable VNAs and a unique set of tools, this company is one that people should know about—especially those in search of a VNA solution.

Recently, I have had the opportunity to get my hands on a couple of the latest vector network analyzers (VNAs) on the market today. In a sense, these new instruments are redefining the VNA, which has traditionally been built in the form of a large box that combines both measurement and display capabilities. While such traditional VNAs are not likely to disappear anytime soon, some of today's VNAs are being built in smaller portable sizes. This smaller size is made possible due to the display functionality being offloaded from the VNA itself to an external PC.

Another company recently provided me with its own PC-controlled VNA as part of a demo kit. That company, MegiQ (www.megiq.com), is one that may be unfamiliar to some. However, MegiQ is a company that certainly deserves to be recognized among today's VNA suppliers. This article presents a closer look at the company's VNA capabilities based on my experience with the demo kit.

1. This is the VNA included in the demo kit. It covers a frequency range of 400 MHz to 6 GHz.

VNA DEMO KIT

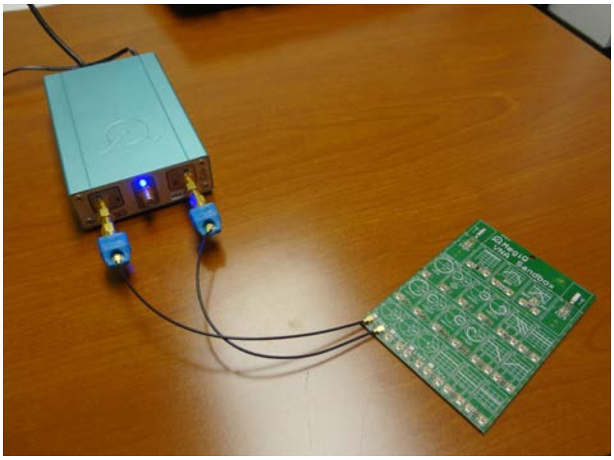
The demo kit included the VNA-0460e, which is a full 2.5-port VNA that covers a frequency range of 400 MHz to 6 GHz *(Fig. 1)*. Since the specifications of the MegiQ VNAs were already reported in a recent article, those won't be discussed in detail here. Readers are encouraged to check out that article, as well as visit MegiQ's website, for more information concerning VNA specifications.

Getting back to the demo kit, it also included the VNA Sandbox along with a number of additional accessories. These accessories included UFL cables, SMA-to-UFL adaptors, and SMA-to-SMA adaptors. Of course, the relevant documentation was also included.

2. This is a photo of the VNA Sandbox, which contains a variety of RF circuits.

EXPLAINING THE VNA SANDBOX

The VNA Sandbox is actually something very unique that MegiQ offers *(Fig. 2)*. It is essentially a board that contains a number of simple RF circuits. Each of these circuits can be



3. Shown is the VNA Sandbox being used to perform a calibration. UFL cables are used to connect the VNA to the VNA Sandbox.

measured with a MegiQ VNA—or any VNA for that matter—via UFL connectors. In addition, every circuit is numbered on the board (more on this later).

Among the circuits included on the VNA Sandbox are several resonant circuits, as well as a few different filters. It also contains antennas, an attenuator, an amplifier, and a varactor-based voltage-controlled lowpass filter. For each circuit, with the exception of the two antennas, the board shows a simple illustration of the response that it produces. MegiQ's website also contains documentation that provides more information concerning the VNA Sandbox circuits.

So what is the purpose of the VNA Sandbox? Essentially, it is intended to help users become better acquainted with performing VNA measurements. Those who are new to using a VNA can learn much by taking advantage of the VNA Sandbox. Proving this point is the Complutense University of Madrid (UCM), as the university is utilizing MegiQ's VNAs and VNA Sandbox to teach students how to perform VNA measurements.

Additionally, the VNA Sandbox includes *Open*, *Short*, *Load*, and *Thru* ports to enable users to perform one- or two-port calibrations. Thus, besides containing various RF circuits for measurement purposes, the VNA Sandbox also essentially functions as a calibration kit. *Figure 3* shows a calibration being performed. In Fig. 3, the VNA is connected to the *Open* ports of the VNA Sandbox.

One aspect of the VNA Sandbox that should be noted is that it actually contains two *Open*, *Short*, and *Load* ports each. This enables users to perform calibrations more quickly by simultaneously connecting both *Port 1* and *Port 2* of the VNA to the respective ports for the *Open*, *Short*, and *Load* calibration steps, as seen in Fig. 3.

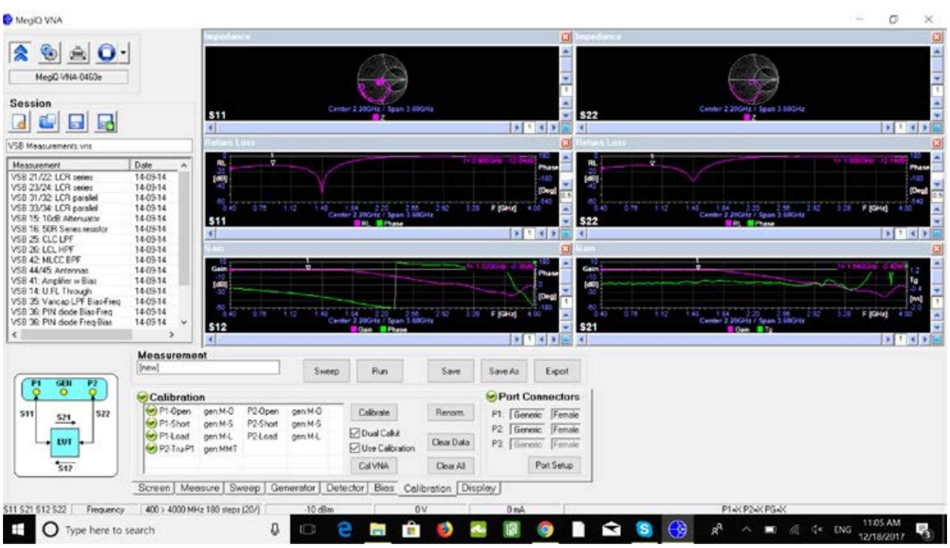
PUTTING THE SANDBOX TO WORK

Of course, once calibration was performed, the next step was to actually measure some of the circuits on the VNA Sandbox. Performing measurements required using MegiQ's VNA software, which can be downloaded from the company's website.

One nice thing about the software is that it allows users to load built-in measurement files for the circuits on the VNA Sandbox. Loading one of these measurement files basically configures the settings of the VNA software for that specific circuit measurement. Of course, users can also manually configure their own settings.

As an example, let's say that one wants to measure the lowpass filter on the VNA Sandbox, which is designated as circuit 25. That user could load the measurement file titled "VSB 25: CLC LPF." Loading this file subsequently displays four S-parameter graphs. It also displays two Smith charts for the input and output impedances, respectively. *Figure 4* shows the actual measured data of the lowpass filter. Shown are plots for insertion loss and return loss along with two Smith chart displays.

One feature that is included with the VNA-0440e and VNA-0460e models is a built-in bias generator, which was mentioned in the article referenced earlier. To demonstrate this ca-



4. The measured data of the lowpass filter on the VNA Sandbox is shown here.

pability, let's take a look at the amplifier on the VNA Sandbox. The amplifier is designated as circuit 41.

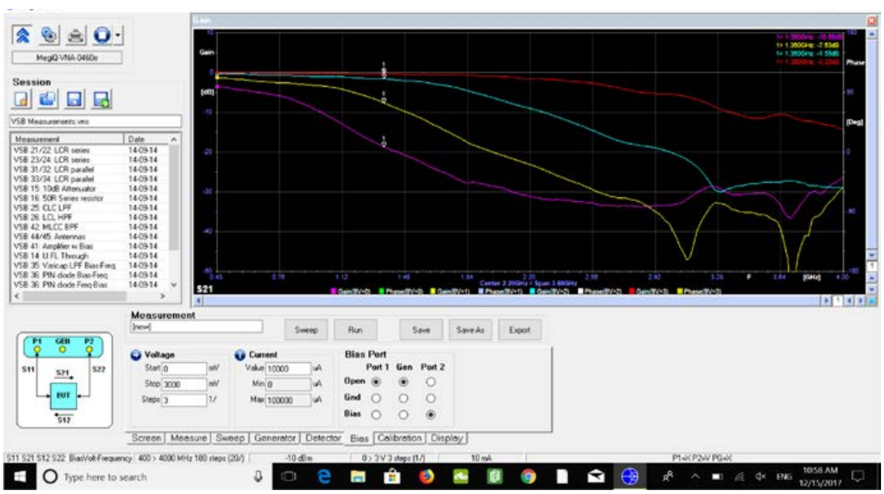
One way to measure the gain and return loss of this amplifier is to load the measurement file titled "VSB 41: Amplifier w bias." With this configuration, measurements are performed over a frequency range of 400 MHz to 4 GHz. *Figure 5* shows the measurement results of the amplifier. Four S-parameter plots are shown: gain (S21), reverse isolation (S12), input return loss (S11), and output return loss (S22).

Furthermore, these measurements were performed by utilizing the VNA's aforementioned internal bias generator to power the amplifier. Thus, no external power supply was needed in order to make these measurements. The bias was provided from *Port 2* of the VNA and applied to the amplifier's RF output pin. The bias conditions were set at 5 V and 55 mA (note that this was changed from the measurement file's default conditions of 10 V and 70 mA).

5. The amplifier was measured by utilizing the VNA's internal bias generator. Shown is the measured data.

Furthermore, while the amplifier measurements just described were carried out using fixed bias conditions, users also have the option to apply swept-bias conditions. For example, let's take a look at the varactor-based voltage-controlled lowpass filter, which is circuit 35 on the VNA Sandbox. Since this circuit is designed using varactor diodes, its frequency response is dependent on the applied voltage.

By loading the measurement file titled "VSB 35: Varicap LPF Bias-Freq," the bias voltage can be swept from 0 to 3 V in increments of 1 V. Measurements are performed at each bias condition. *Figure 6* shows the insertion loss of the varactor-based lowpass filter at all four bias conditions.



6. Shown is the insertion loss of the varactor-based filter at four different applied voltages thanks to the VNA's swept-bias capability.

One last point that should be mentioned is that swept-power measurements can also be performed. This capability allows users to measure an amplifier's 1-dB compression (P1dB). In fact, the P1dB of the amplifier on the VNA Sandbox can be measured by loading the measurement file titled "VSB 41: Amplifier 1dB Comp." With this configuration, the power is swept from −15 to +5 dBm.

7. Shown is the SMA-connectorized bandpass filter used as the DUT.

BEYOND THE VNA SANDBOX: MEASURING SMA-CONNECTORIZED COMPONENTS

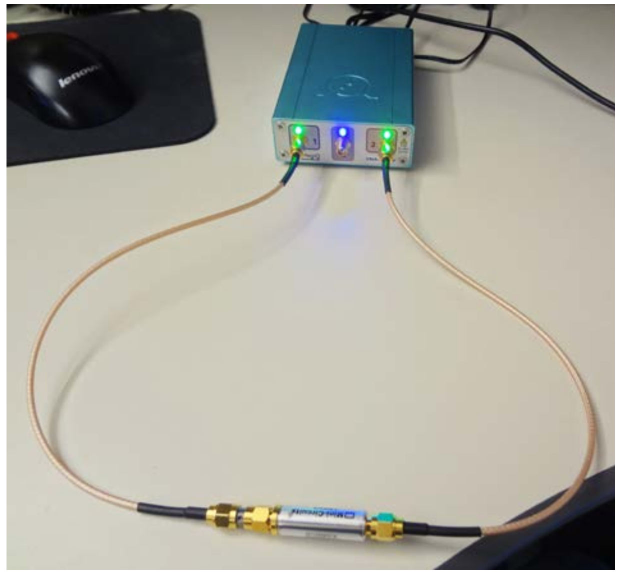
The measurements described solely involved the VNA Sandbox, which only contains UFL connectors. To gain a deeper understanding of MegiQ's VNAs, a measurement example of an SMA-connectorized bandpass filter will now be

8. This photo shows the SMA calibration kit that was included with the demo kit.

presented. The device-under-test (DUT) in this measurement example is Mini-Circuits' VBFZ-1400-S+ bandpass filter *(Fig. 7)*. This filter has a passband from 1,350 to 1,450 MHz.

Of course, calibration was required prior to performing any measurements. To measure an SMA-connectorized component, the proper calibration kit file was imported from a USB stick. Once this step was completed, calibration was performed with the SMA calibration kit over a frequency range of 400 MHz to 3,400 MHz *(Fig. 8)*.

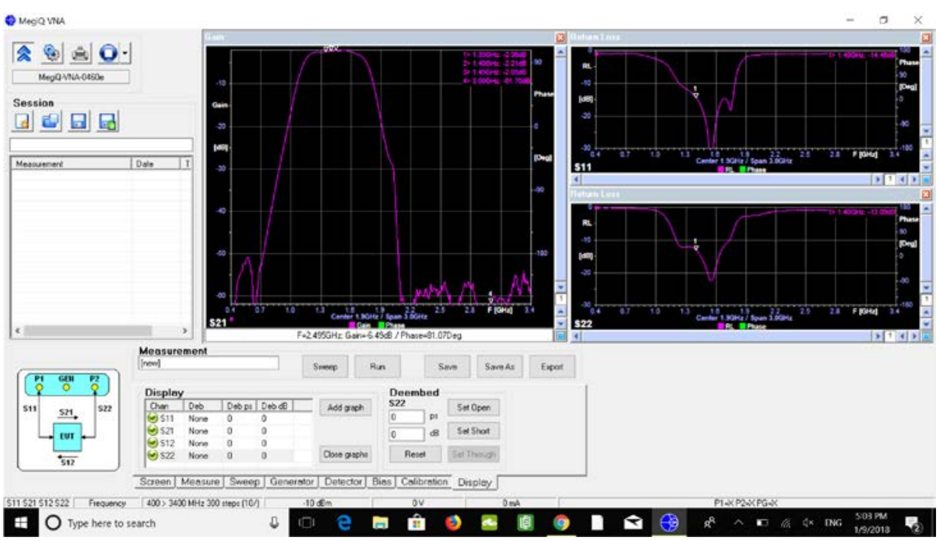
Figure 9 shows the VNA connected to the DUT. *Figure 10* displays plots of measured data. As can be seen, the plots look nice and smooth. In essence, the data agrees with the results one would obtain when performing the same measurements with any currently available VNA. These results therefore demonstrate that MegiQ's VNAs can deliver performance that is comparable to other VNAs on the market today.



9. This photo shows the filter connected to the VNA.

CONCLUSION

In summary, MegiQ has proven that it offers quality VNA solutions at an affordable price. The company's VNAs include some features—most notably the built-in bias generator—that are typically only found in more expensive high-end VNAs. In addition, the VNA Sandbox is a good educational tool for anyone who wants to learn more about VNAs. While MegiQ may not be the first name that comes to mind when thinking of VNA suppliers, the company is surely a legitimate one that is worthy of recognition. If you're in the market for a VNA, don't overlook MegiQ.



10. Shown are the measured insertion loss and return loss of the filter.