Array Solutions VNAuhf Vector Network Analyzer

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Previously I had the opportunity to review the Array Solutions VNA2180 Vector Network Analyzer.[2] I found the VNA2180 to be a highly accurate instrument that permitted me to analyze circuits in my home lab to accuracy levels I haven't seen since the measurement capabilities of my pre-retirement microwave lab! However the VNA2180 is limited to a maximum frequency of 180 MHz and much of my tinkering involves projects above this, and so I wanted something that covered up to at least 450 MHz. Enter the VNAuhf, a 5 kHz to 1200 MHz vector network analyzer.

The VNAuhf is an extended frequency range version of the VNA2180. Table 4 compares the differences between these two products. The complete VNAuhf specifications may be found on the Array Solutions website.

First — A Word About Calibration

Like any VNA, the VNAuhf must be calibrated using calibration standards so setup cables and connections and VNA imperfections can be removed from the measurement process. The VNAuhf calibration kit includes precision short and open terminations, a precision 50 Ω load, and two 14 inch LMR-240 cables with N male connectors. The terminations and load consist of N-male-to-SMA-female adapters with the appropriate SMA termination or load attached.

The short is close to ideal over the VNAuhf 1200 MHz frequency range. The open is more critical, as fringing capacitance leads to errors at higher frequencies. This fringing capacitance is measured and removed as part of the calibration process. Because the same type of adapter is used for the open and short, the reference plane between the two is very similar over the VNAuhf frequency range.

The most critical calibration item is the precision broadband 50 Ω termination. Thanks to friends in the microwave lab of a local company, I measured the Array Solutions 50 Ω termination on an HP/Agilent 8722D vector network analyzer. The SMA 50 Ω termination return loss exceeded 40 dB through 1200 MHz. When the SMA termination was installed on the N-to-SMA adapter (the actual calibration load), the worst-case return loss was 32 dB at 1200 MHz (SWR ≈ 1.05:1), improving to better than 40 dB return loss below about 650 MHz (SWR ≈ 1.02:1) — a very good load indeed!

Preparing to Use the VNAuhf

The VNAuhf software runs under recent versions of *Windows*. No software installation is required — the software can run directly from a folder, flash drive or CD. Included with the VNAuhf are the calibration kit, a 120 V ac power supply and a USB interface cable. A padded carrying case is optional.

After downloading a zip file from **www.w5big.com** which includes the latest software and manual, extract the software and run the program. You will need to set up the proper COM port. When the VNAuhf USB cable is plugged into the computer, the *Vista*, *Windows* 7 and *Windows* 8 operating systems will automatically find the correct USB driver for you. Older versions of *Windows* may require you to load the proper driver, available online. Set the COM port in the VNAuhf setup menu, and then close and restart the program.

Calibration is easy, as you simply attach the appropriate termination when prompted. Once calibrated, there is no need to recalibrate each time you use the instrument. Recalibration is necessary only if you change the measuring setup.

Using the VNAuhf

My first test investigated the performance of a ¼ wave 2 meter ground plane antenna on 2 meters and 440 MHz (70 centimeters). Since the 70 centimeter band is approximately three times the frequency of the 2 meter band, I wanted to evaluate the standard 2 meter 19 inch whip as a ¾ wave whip on 70 centimeters. Figure 7 shows the measured SWR and return loss performance. As you can see, the SWR in the repeater part of the 70 cm band is about 2.5:1. This is not too bad, and is tolerated by many dual-band transceivers. One could better optimize the antenna for both bands by using the VNAuhf to trim the 2 meter whip for resonance a bit higher in frequency. This would improve the

[2]P. Salas, AD5X, "Array Solutions VNA2180 Vector Network Analyzer," Product Review, *QST*, Mar 2011, pp 57-59.

Bottom Line

The Array Solutions VNAuhf is an accurate lab-grade instrument that covers up to 1200 MHz, yet is priced to be affordable for the sophisticated home experimenter.

Table 4
VNAuhf vs VNA2180 Key Performance Specifications

Parameter	VNAuhf	VNA2180
Frequency range	5 kHz to 1000 MHz (usable to 1200 MHz)	5 kHz to 180 MHz
Output into 50 Ω (programmable)	–13 dBm to –33 dBm	+7 dBm to –13 dBm
Impedance measuring range	5 kΩ	10 kΩ
Port B return loss	20 dB minimum	30 dB minimum
Max interference input while measuring	0.1 V RMS (–7 dBm)	1.4 V RMS (+16 dBm)
Dynamic range	90 dB/200 MHz 70 dB/500 MHz 60 dB/1 GHz	100 dB/50 MHz 80 dB/160 MHz

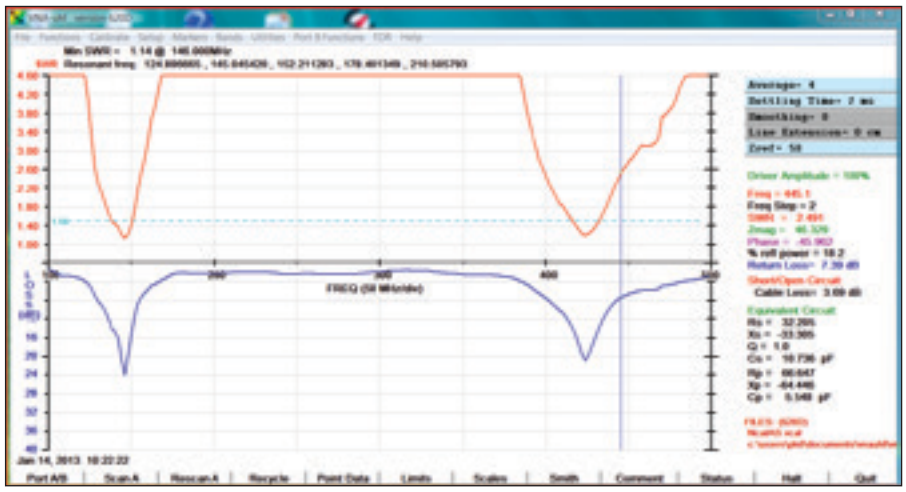

Figure 7 — SWR and Return Loss evaluation of a 19 inch whip on both 2 meters and 440 MHz.

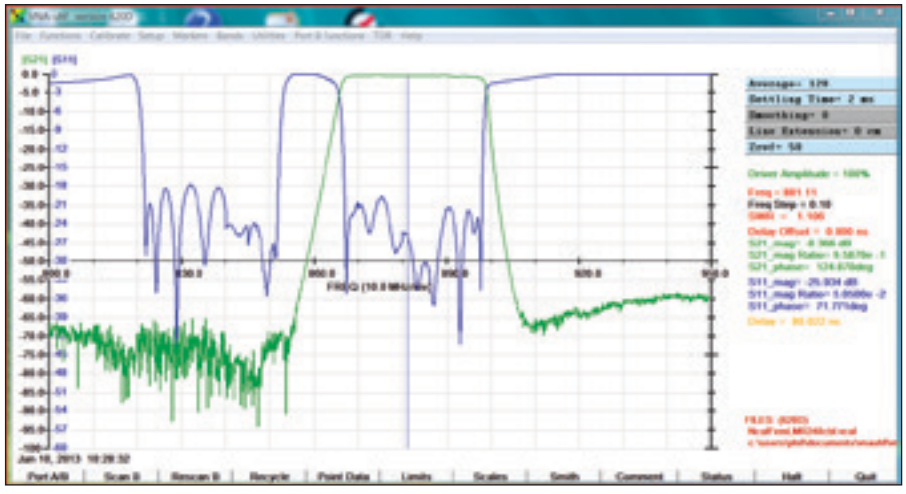

Figure 8 — Cellular duplexer performance measured by the VNAuhf.

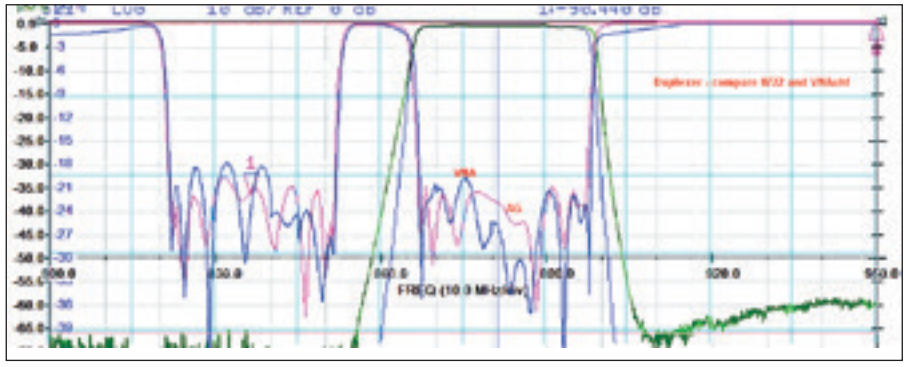

Figure 9 — VNAuhf and Agilent 8722D performance overlay

445 MHz performance while still giving good 2 meter performance.

Next I looked at a much higher frequency device to assess the extended range capability of the VNAuhf. I was fortunate to acquire an 800-900 MHz cellular duplexer, thanks to Brad Wick WØCO. I connected the duplexer antenna port to the VNAuhf PORT A and the duplexer TX port to the VNAuhf PORT B, and I terminated the duplexer receive port in the precision 50 Ω load. The VNAuhf measured performance is shown in Figure 8. The duplexer transmit and receive return loss is shown by the blue curve, and the transmit insertion loss and TR isolation is illustrated by the green curve. The actual duplexer TR isolation is much greater than that indicated, but the measurement is limited by the 60-70 dB dynamic range of the VNAuhf at these high frequencies.

Next I took the duplexer to the local microwave lab and measured it on the HP/Agilent 8722D. The difference in the TR isolation is due to the 80-90 dB dynamic range of the HP/Agilent VNA. In order to look at the difference between the VNAuhf and HP/Agilent 8722D, the two curves were overlaid as shown in Figure 9.

As you can see, the return loss and insertion loss data is very close between the two instruments. This is excellent correlation, especially considering that the Agilent 8722D setup included extremely expensive precision loads and cables (good to 40 GHz), whereas the VNAuhf utilized the Array Solutions lower-frequency loads and cables.

Of course, there are many other applications for the VNAuhf. Circuit and antenna design and evaluation are obvious. As an example, I've been using it to precisely calibrate attenuators, and characterize the directivity and coupling of UHF couplers purchased on popular online auction sites.

Conclusion

The VNAuhf is an accurate instrument suitable for both personal and industrial lab environments. Software and firmware updates are available for download at no charge. The software can be run in demo mode to get a feel for the product prior to purchasing. For additional measurements and applications, refer to the VNA2180 and AIMuhf reviews previously published in *QST*. Additional information is also available at **www.w5big.com**.

Manufacturer: Array Solutions, 2611 North Beltline Rd, Suite 109, Sunnyvale, TX 75182; tel 214-954-7140; **www.arraysolutions.com**. Price (US version): VNAuhf $1895; VNA-PC carry case, $49.