Product Review: The Array Solutions VNAuhf Vector Network Analyzer
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Introduction

I previously had the opportunity to review the Array Solutions VNA2180 Vector Network Analyzer (QST, Mar 2011, pp 57-59). 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 180MHz and much of my tinkering involves projects above this, and so I wanted something that covered up to at least 450MHz. Enter the VNAuhf 5KHz-1200MHz Vector Network Analyzer.

Figure 1: Array Solutions VNAuhf Vector Network Analyzer, Supplied Accessories, and Optional Carrying Case. Foam cutouts in the carrying case are for any additional connectors and adapters needed.

VNAuhf Description

The VNAuhf vector network analyzer is an extended frequency range version of the VNA2180. Table 1 compares the feature differences between these two products. The complete VNAuhf specifications are given in Table 2:

Table 1: VNAuhf vs VNA2180 performance specification

Parameter	VNAuhf	VNA2180

Frequency Range	5KHz to 1000MHz (usable to 1200MHz)	5KHz to 180MHz
Output into 50 ohms (programmable)	-13dBm to -33dBm	+7dBm to -13dBm
Impedance Measuring Range	5K ohms	10K ohms
Port B Return Loss	20dB minimum	30dB minimum
Max interference input while measuring	0.1Vrms (-7dBm)	1.4Vrms (+16dBm)
Dynamic Range	90dB/200MHz 70dB/500MHz 60dB/1GHz	100dB/50MHz 80dB/160MHz

Table 2: VNAuhf Complete Specifications

Parameter	Specification
Frequency Control	Digital Synthesizer
Frequency Range	5KHz-1200 MHz
Stability	+/- 25 ppm
Frequency Step Size	1 Hz minimum
Calibration	Software controlled
ADC resolution	12 bits
SWR measuring range	1 to 20
Impedance Measurement Range	1 ohm to 5K ohms
Phase Angle	+/-180 degrees (true phase)
RF Output	0.035Vrms (-13dBm) nominal output Z = 50 ohms.
Spurious output	–30dBc or better
Max stray RF input while measuring	0.1V peak (-7dBm)
Max safe RF input	5V peak (+24dBm)
S21 nominal dynamic range	90dB to 200MHz, 70dB to 500MHz, 60dB to 1GHz
Port B nominal input impedance	50 ohms - Return Loss greater than 20dB.
RF Interfaces (Ports A & B)	Type N-female connectors
PC Interface	Optically isolated USB w/FTDI chipset.
Display	Graphics output on PC. Mouse controlled cursor for digital parametric readout. User-specified frequency markers. SWR audible tone & speech output. Displayed parameters: SWR, S11, Return loss, |Z|, Phase angle of |Z|, S21, R_S, X_S, R_P, X_P, and uH or pF. Two Smith Charts with zoom, phase offset and markers. Data can be remotely referenced.
Power Requirements	11-15 VDC, 500mA max (power supply included)
Dimensions (approx)	7” x 5.3” x 1.5” (17.8 x 13.5 x 3.8 cm)

First – A word about calibration

Like any VNA, the VNAuhf must be calibrated. Calibration requires calibration standards so set-up and VNA imperfections can be removed from the measurement process. The VNAuhf calibration kit includes precision short and open terminations, a precision 50 ohm load, and two 14” LMR-240 N/male-to-N/male cables. 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 (reflection magnitude = 1) over the VNAuhf 1200MHz frequency range. The reflection coefficient of the short is dependent only on its length offset between the VNAuhf output and the actual short location.

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 ohm termination. Thanks to friends in the microwave lab of a local company, I measured the Array Solutions 50 ohm termination on an HP/Agilent 8722D vector network analyzer. The SMA 50 ohm termination return loss exceeded 40dB through 1200MHz. When the SMA termination was installed on the N/SMA adapter (the actual calibration load), the worst-case return loss was 32dB at 1200MHz (SWR≈1.05:1), improving to better than 40dB return loss below about 650MHz (SWR≈1.02:1) – a very good load indeed! See Figure 2.

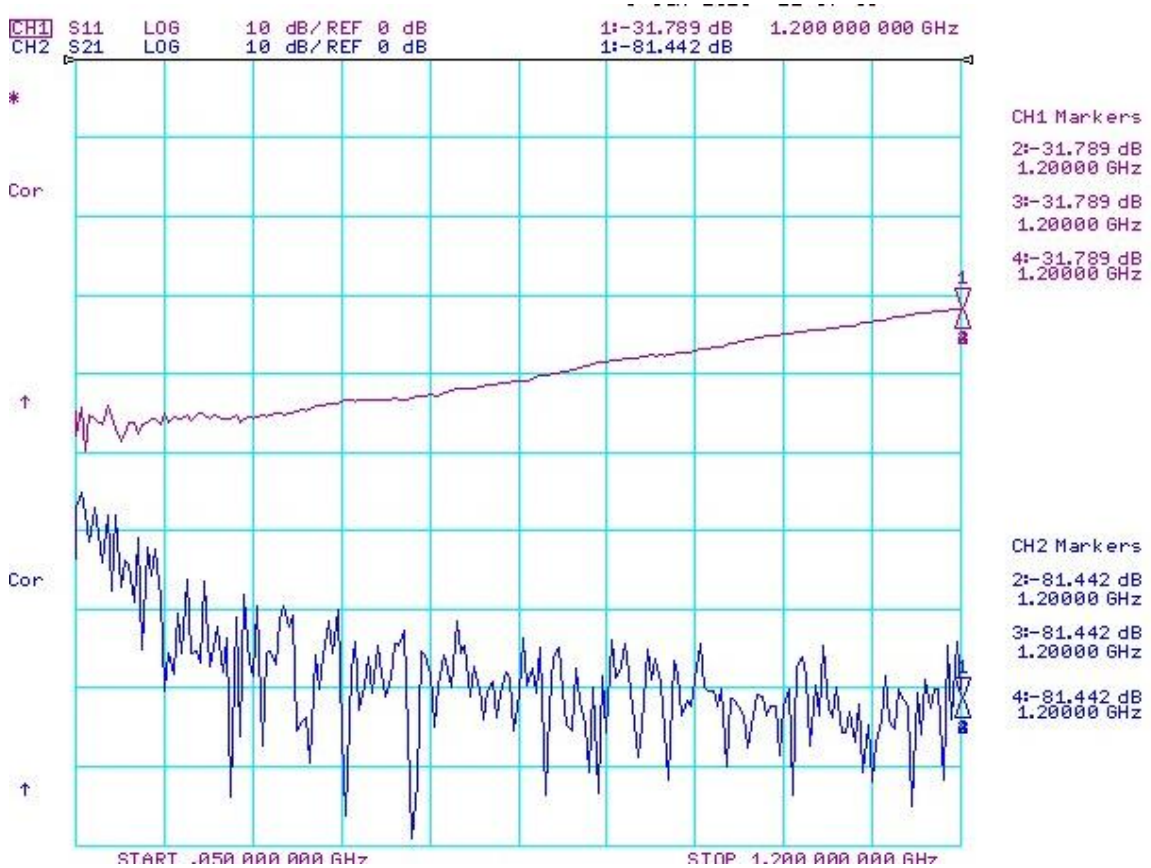

Figure 2: HP/Agilent 8722D measurement of Array Solutions precision 50 ohm load

<u>Preparing to use the VNAuhf</u>

The VNAuhf software has been tested with Windows 2000, XP, Vista, and Win7 & 8 32/64 bit. Like all Array Solutions AIM and VNA products, no software installation is required - the software can run directly from a folder, flash drive or CD. Included with the VNAuhf are the precision calibration loads, a 120VAC power supply (or optional DX power supply with Australian, European, US and UK adapters), two N-male terminated cables, and a USB interface cable (the padded carrying case is optional).

After downloading a zip file from www.w5big.com which includes the latest software and manual, unzip 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, Vista, WIN7 and WIN8 operating systems will automatically find the correct USB driver for you. Older versions of Windows may require you to load the proper driver (the driver web address is provided in the VNAuhf manual). Now set the proper COM port in the VNAuhf set-up menu, and then close and re-start the VNAuhf program.

Calibration is easy, as you simply attach the appropriate termination when prompted. And once calibrated there is no need to recalibrate each time you use the instrument. I.e., the calibration is stable and only needs to be re-done if you change the measuring set-up originally calibrated.

Using the VNAuhf

My first test involved investigating the performance of a ¼-wave 2-meter ground-plane antenna on both 2-meters and 440MHz. Since the ¾-meter band is approximately three times the frequency of the 2-meter band, I wanted to evaluate the standard 2-meter 19" whip as a ¾-wave whip on ¾-meters. Figure 3 shows the measured SWR and return loss performance. As you can see, the SWR in the repeater part of the ¾-meter 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 using the VNAuhf by trimming the 2-meter whip for resonance a bit higher in frequency. This would improve the 445MHz performance while still giving good 2-meter performance.

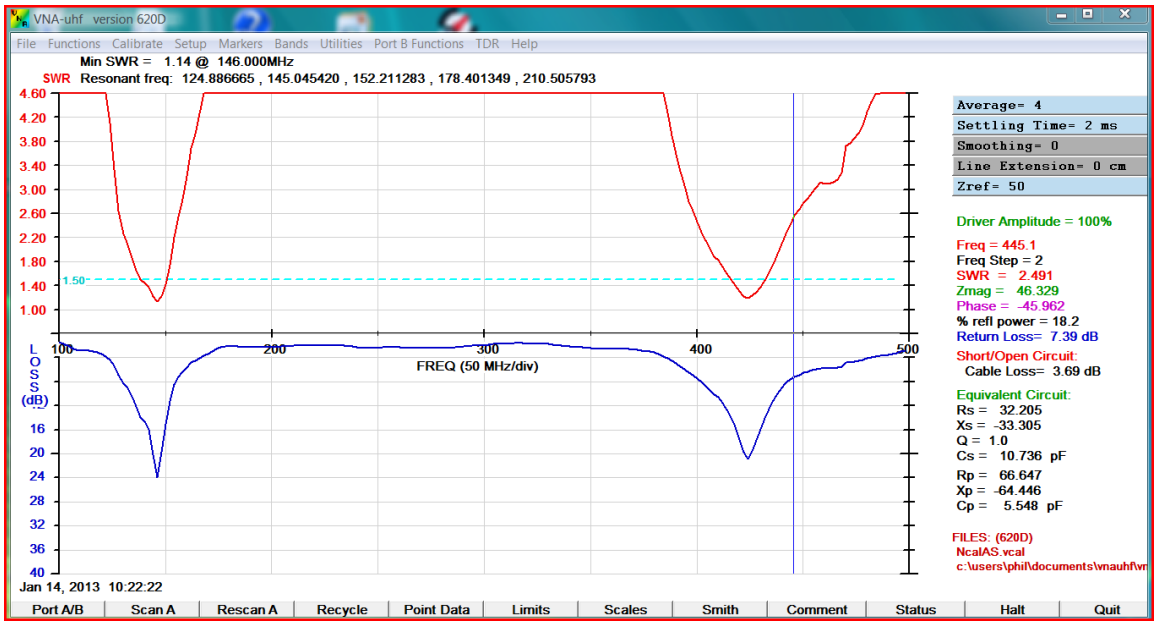

Figure 3: SWR and Return Loss evaluation of a 19" whip on both 2-meters and ¾-meters

Next I looked at a much higher frequency device so as to assess the extended range capability of the VNAuhf. I was fortunate to acquire a 800-900MHz cellular duplexer, thanks to Brad Wick W0CO. I connected the duplexer antenna port to the VNAuhf PortA, the duplexer TX port to the VNAuhf PortB, and I terminated the duplexer receive port in the precision 50 ohm load. The VNAuhf measured performance is shown in Figure 4. The duplexer transmit and receive return loss is shown by the blue curve, and the transmit insertion loss and T/R isolation is illustrated by the green curve. The actual duplexer T/R isolation is much greater than that indicated, however the measurement is limited by the 60-70dB dynamic range of the VNAuhf at these high frequencies.

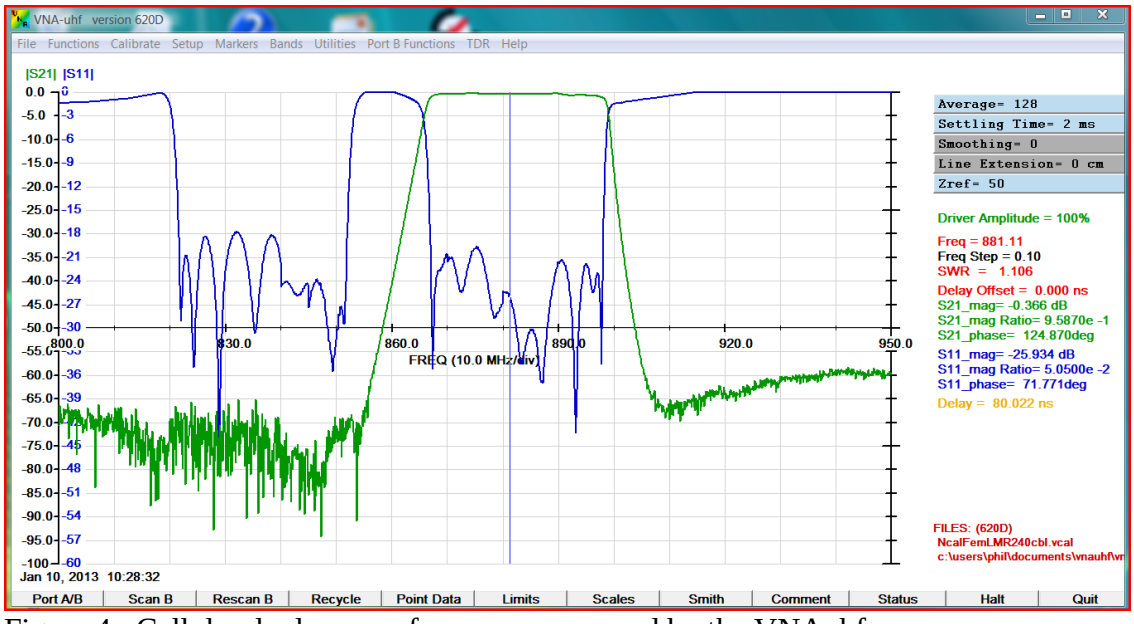

Figure 4: Cellular duplexer performance measured by the VNAuhf

Next I took the duplexer to the local microwave lab (Figure 5) and measured it on the HP/Agilent 8722D.

Figure 5: VNAuhf and HP/Agilent 8722D

This performance measurement is shown in Figure 6. The difference in the T/R isolation is due to the 80-90dB dynamic range of the HP/Agilent VNA.

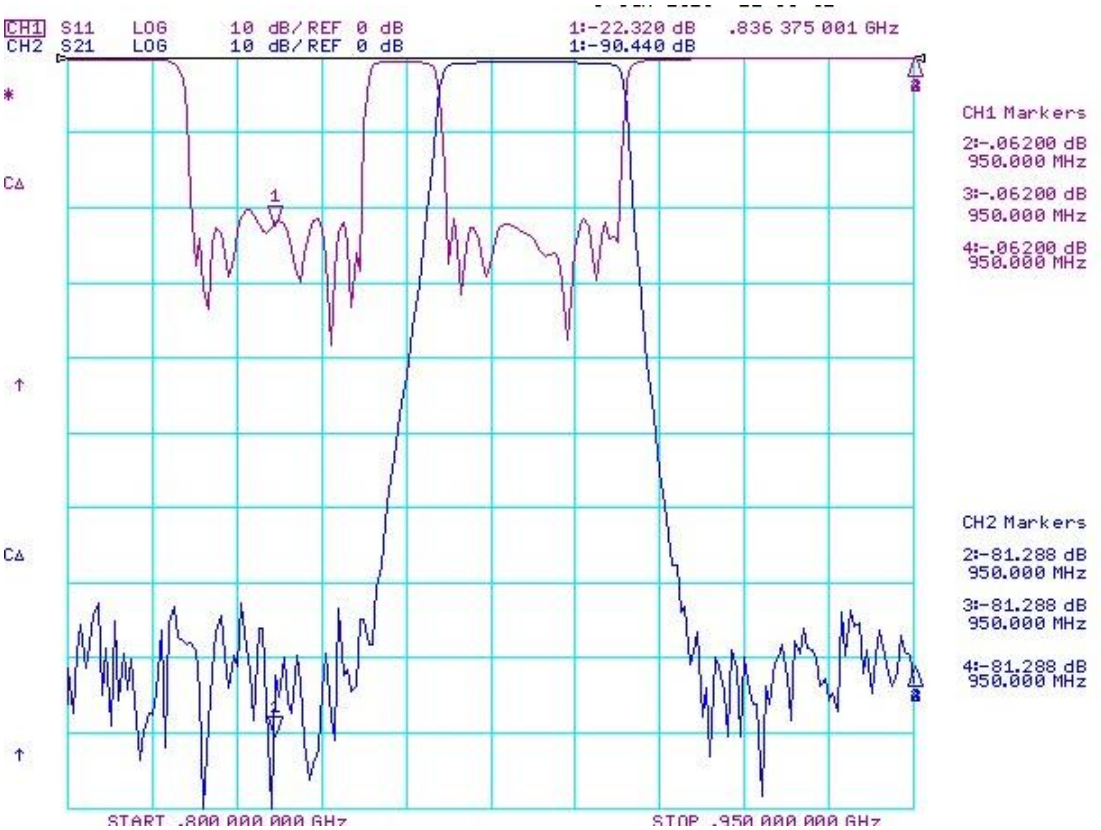

Figure 6: HP/Agilent 8722D measurement of the cellular duplexer

In order to look at the difference between the VNAuhf and HP/Agilent 8722D, the two curves were overlaid as shown in Figure 7.

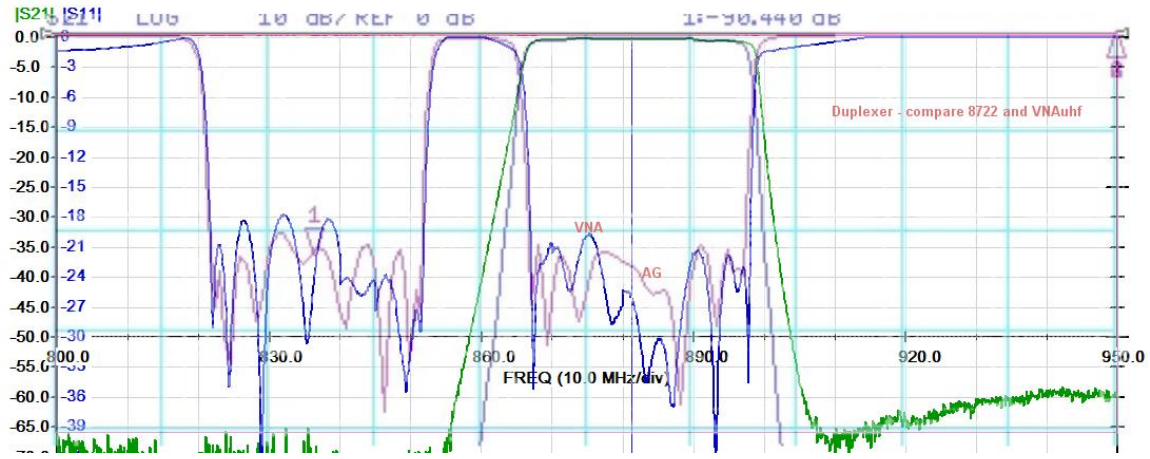

Figure 7: VNAuhf and Agilent 8722D performance overlay

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 40GHz), whereas the VNAuhf utilized the Array Solutions lower-frequency loads and cables.

Of course, there are many other applications you'll find 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 that I have purchased on popular on-line auction sites.

Conclusion

The VNAuhf vector network analyzer is an extremely accurate instrument suitable for both personal and industrial lab environments. Software and firmware updates are continually available for download at no charge. And the software can be run in demo mode to get a feel for the product prior to purchasing - or even use the demo mode to load files provided by others for analysis without even owning a VNAuhf! For additional measurements and applications and Port A performance, refer to the VNA2180 and AIMuhf reviews previously published in QST. Additional information is also available at www.w5big.com.