Review of the Array Solutions AIM 4170 Antenna/Lab RF Analyzer
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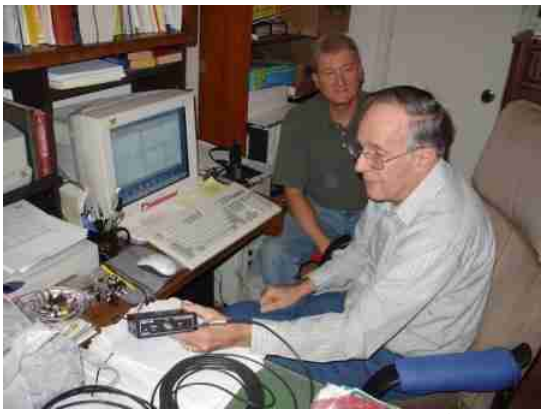
Introduction

After the SWR meter, I bet that the most owned and used accessory in the ham shack is the antenna analyzer. Antenna analyzers have revolutionized our way of measuring and adjusting antennas and related components. Since purchasing an MFJ-207 in the early '90s, I haven't been without one of these pieces of equipment. Over the last several years, antenna analyzers have started evolving from analog, manually tunable fixed frequency measuring devices to DDS software controlled swept frequency devices. One of the newest antenna analyzers on the market is the Array Solutions AIM 4170, designed by Bob Clunn W5BIG. Since Bob lives just one mile from me, I ran over to his house to pick up a unit for this review.



AIM 4170 Designer Bob W5BIG (front) Jay WX0B from Array Solutions.

Photo A: The compact AIM 4170 does and everything and more than you'd expect from a full-featured antenna analyzer.

AIM 4170 Basic Description

The AIM 4170 antenna analyzer covers 100 KHz to 170 MHz using DDS technology. A 12 bit analog to digital converter digitizes the raw data for processing, thereby avoiding diode detector non-linearities. This results in excellent dynamic range and linearity for accurate magnitude and phase measurements. Impedance measurements can range from 1-ohm to 10K ohms, and true phase angle is measured so there is no ambiguity when measuring inductive or capacitive reactance. Internal band pass filters reject out-of-band high power interfering signals which makes the unit very robust in the presence of broadcast transmitters or other high power signals near the measuring frequency. Also, since the internal RF generator is very stable and can be calibrated to WWV, the AIM 4170 can easily be used as a signal source for testing receivers.

The AIM 4170 is very compact at just 5x4x1.5 inches, and weighs only 9.6 ounces (see Photo A). This compact size comes with a bit of a penalty though, as you do need a PC in order run the unit and display the results. However, the AIM-4170 is quite portable even with a laptop computer. It can be mounted remotely at your antenna feed point if desired, with power supplied through a user-provided internal battery. Or you can read the antenna impedance with the AIM4170 located in the shack using the "Refer to

Antenna" function. Here, the software guides you through a cable calibration procedure after which AIM 4170 essentially subtracts-out the feedline, thereby providing the actual antenna impedance data as if the AIM 4170 were located directly at the antenna.

RF parameters that are measured, calculated and displayed include the following:

- SWR referenced to any impedance (1:1 to 20:1)
- Impedance at the cable input or at the antenna terminals
- Return loss
- Reflection coefficient
- Cable length, impedance and loss
- Distance to fault (open or short)
- Smith chart display
- Resistance and reactance of discrete components at the operating frequency
- Quartz crystal parameters

All measured and calculated information can be saved to disk or printed in order to compare before and after results. The data saved to disk includes a .csv file that can be imported into a spreadsheet program for additional analysis off line. And finally, the software has been tested with Windows 95, 98, 2000, and XP and does not even require an installation procedure - it will run directly from the included CD if desired!

Photo B: The AIM 4170 is packaged with everything necessary for operation.

Using the AIM 4170

The AIM 4170 comes with pretty much everything you need (See Photo B). There are three standard calibration loads (open, short, and a standard resistor), a "wall-wart" power supply, and an RS-232 computer interface cable. Since the AIM 4170 uses a BNC connector, a BNC-to-UHF adapter is also included. There is also the CD with software and a printed quick-start guide. Calibration is a snap, requiring no tools or adjustments, and in just a few minutes you'll have everything up and running. If your computer only has a USB interface, you will need to purchase an inexpensive USB-to-serial adapter which is easily installed using simple instructions in the AIM 4170 manual.

So now it is time to get down to business! First I wanted to look at the broadband responses of my Butternut HF-9V vertical with the 160-meter coil, and my MFJ-1775 rotatable dipole. I had set the band resonance points on both antennas with a MFJ-259B

antenna analyzer, however I had never looked at the broadband responses since th is is too difficult and time consuming to do with a manual antenna analyzer. The AIM 4170 will plot simultaneous curves of SWR (red), impedance magnitude (green), reactance (yellow), and the phase angle of the load impedance (magenta) as can be seen in Photo C. However, this is too much information for these preliminary tests - so with a few mouse clicks I turned off everything except the SWR graph. I also enabled the SWR ruler and set it to 2:1 so as to give a feel for the usable bandwidth, and the "Highlight Band" feature so the ham band limits are obvious on the scans.

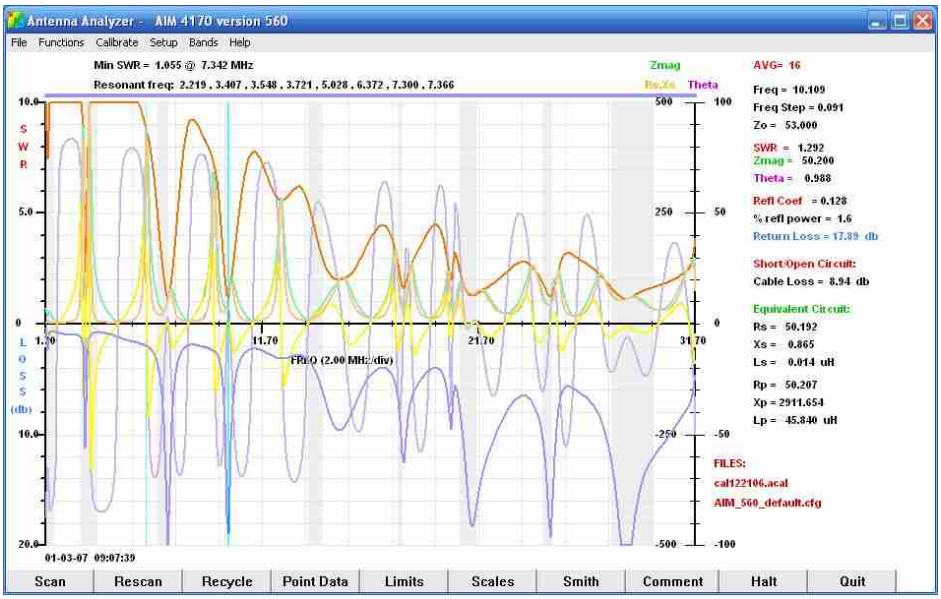


Photo C: Massive amounts of data can be plotted. The user can decide what is important and turn off the undesired plots.

Photo D: 1.7-29 MHz SWR swept response of the Butternut vertical.

The full SWR sweep of Photo D clearly shows the individual band resonances of the Butternut vertical. I took a closer look at 160 meters (see Photo E) since the 2:1 SWR bandwidth is very narrow - as it should be if you have an electrically short antenna and a decent ground system. I use a remote relay to short turns on the 80 meter coil to give 60 meter operation, and shorting these turns also shifts the 160 meter resonance. The AIM 4170 software lets you do a re-trace, holding the original trace in place so you can see the effects of tuning your antenna. Photo F demonstrates this feature by displaying the effective bandwidth expansion I get on 160 meters when I enable the remote relay. Photo G shows the 60 meter sweep when this relay is enab led.

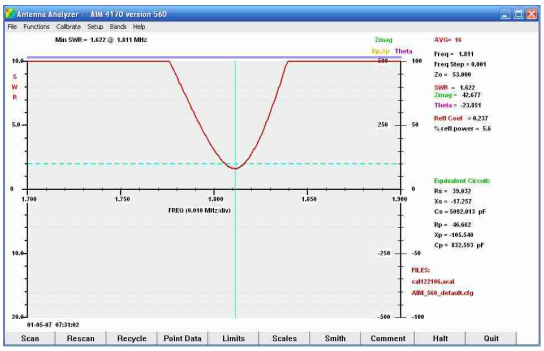


Photo E: The Butternut 160 meter swept Response.

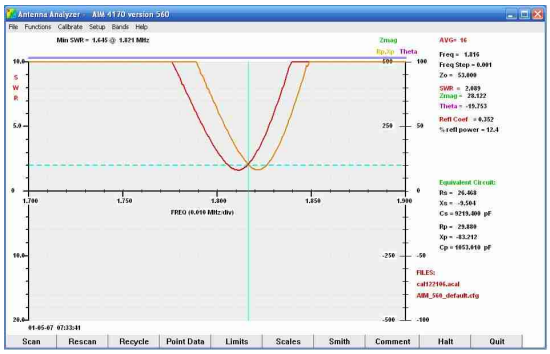


Photo F: Impact of shorting 80-meter turns on the 160 meter resonance region.

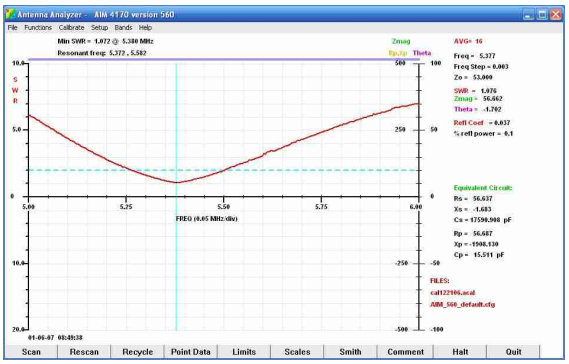


Photo G: 60-meter response of the Butternut vertical with 80-meter turns shorted.

Photo H is the 40-10 meter sweep of the MFJ-1775 rotatable dipole. This is a short dipole (about 14-feet overall length), so the bandwidth is narrow on 40 and 20 meters. Photo I shows a 40 meter sweep of this antenna.

Photo H: MFJ-1775 Swept Response.

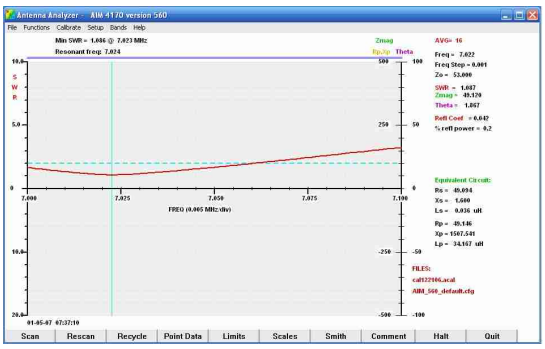


Photo I: MFJ-1775 40-meter swept response.

As mentioned earlier, the AIM 4170 includes internal band pass filters to protect against undesired strong out-of-band signals that can overload the unit and corrupt readings. However, very strong signals may still overload the unit. If the readings on the AIM 4170 appear "flacky", you can use the "Band Scan" feature of the unit, whereby it operates as a spectrum analyzer to help you locate any strong problem signals. My main potential problems occur due to the nearby KRLD 50KW AM broadcast station on 1080 KHz. Photo J is the spectrum scan I took of the AM broadcast band which clearly shows KRLD. The top red line of the scan represents 150 mv peak. Signals above this level may overload the AIM 4170 and make the readings inaccurate. As you can see, the 150mv peak maximum level of the AIM 4170 is not being exceeded by KRLD, though it is close! This "Band Scan" feature can also be valuable in helping to figure out who is overloading your receiver on Field Day!

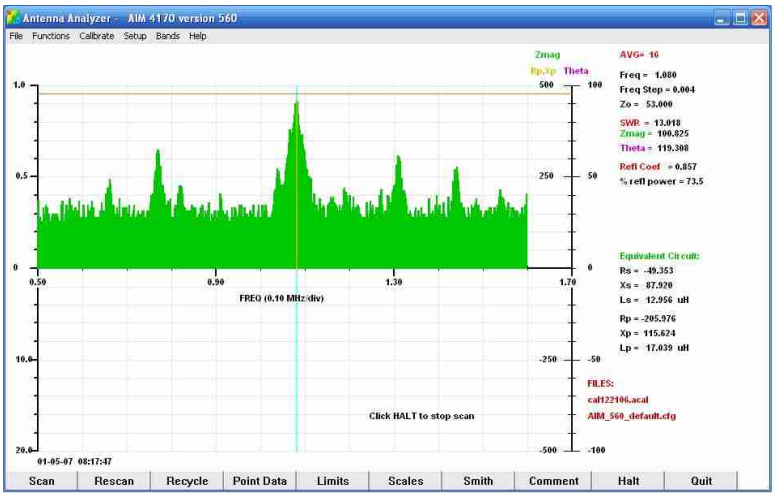


Photo J: Band scan of the AM broadcast band.

Next I wanted to look at some crystal data. While I've built homebrew crystal filters for QRP rigs for many years, I've always used default designs by others as I didn't want to build the test set-up necessary to actually measure the crystal parameters directly. However, the AIM 4170 makes measuring crystal characteristics trivial. My current QRP project is a 30- and 20 meter CW radio using a 2 MHz VFO and a crystal filter made up

of inexpensive 12 MHz microprocessor c rystals. In order to measure the 12 MHz crystals, I used a Banana-to-BNC adapter (Mouser 565-1296). I recalibrated the AIM-4170 with this adapter in place. Then I attached the crystals and clicked on the "Measure Crystal" function. Within seco nds, the screen shown in Photo K appeared. As I said before – a trivial effort!

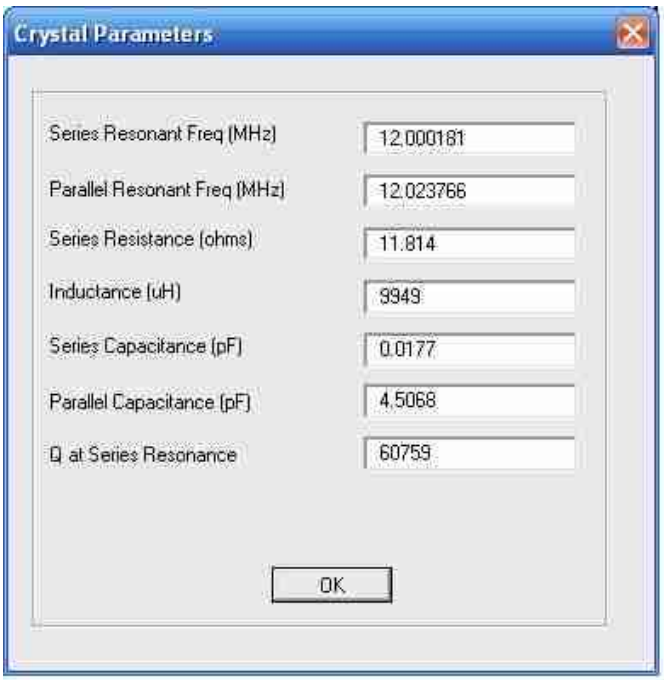


Photo K: 12 MHz crystal parameter measured data.

Another interest of mine is using the AIM 4170 as a signal generator for making receiver measurements. The nominal output level i s 30mv rms into 50 ohms, which means you need about 56 dB of attenuation to give you a 50uv S9 signal. I use the AIM 4170 with a 52 dB fixed attenuator and an MFJ-762 step attenuator (see The Weekender, CQ, September and October 2006) to provide me a stable and accurate RF source for tests and measurement s.

There are many other features and capabilities of the AIM 4170 that I haven't even begun to describe. For everything this device can do, download the complete user manual from www.w5big.com, as well as a demo program that runs without the hardware.

Wishes

While the AIM 4170 does most everything I'd like to see in an antenna and component analyzer, I feel that the need for a PC for operation is somewhat of a hindrance for outside tuning of your antenna. It would be nice if Array Solutions had a compact LCD display with a few buttons that could maybe just enable the SWR function at specific frequencies for outdoor use. And maybe one of these days, expand the capability to include the 450 MHz ham band as well?

Conclusion

The AIM 4170 is a reasonably priced lab-grade antenna and component analyzer that will quickly become an indispensable item once you begin using it. And with software and firmware updates available for download at no charge, you don't have to worry about product obsolescence. I've only touched on the basic capabilities of this unit, so please investigate it further on the web site referenced above. Once you get used to displaying swept responses of your antenna systems, you will find it difficult to go back to single frequency measurements.

The AIM 4170 is available from Array Solutions (www.arraysolutions.com). Price $400.