Carl Luetzelschwab, K9LA

The AIM4160 Antenna Analyzer

This review focuses on the AIM4160 Antenna Analyzer, designed by Bob Clunn, W5BIG. The AIM4160 does a lot in a small package, and it may be just what you're looking for to help with your contest antenna efforts.

If you've been a contester for many years, it is likely that you've followed a similar path to mine with respect to measuring the very basic performance of contest antennas. I started out in the early years with a simple SWR meter. It allowed me to adjust the antenna for a low SWR reading — but I didn't know anything more than the SWR, which represents an infinite number of impedances. My next step was the acquisition of a Palomar antenna noise bridge. Compared to today's standards, the Palomar bridge was crude — but it did give reactance, in addition to resistance, of the antenna under measurement. One of the limitations of these two earlier measurement systems was that a source was needed — a transmitter for the SWR meter and a receiver for the Palomar bridge.

My current antenna analyzer is an MFJ-259B. It's similar to several other antenna analyzers that are on the Amateur Radio market.[1] These antenna analyzers contain a source, and thus are very portable for in-field use. Some can even resolve the sign of the reactance, which is handy if you're familiar with a Smith chart and have a desire to go through antenna matching exercises. Although the MFJ-259B has helped tremendously with my antenna projects, it does not resolve the sign of the reactance, nor does not have the ability to generate a hard copy of the data for subsequent analysis or comparison to new data. That's where the AIM4160 comes in.

Introduction to the AIM4160

The AIM4160 measures the complex impedance at each frequency of interest in the range of 0.1 to 160 MHz, thus covering from below 160 meters to just above 2 meters. The test frequency is generated digitally and band-pass filters are used to reject stray signals (like broadcast stations). A 12-bit analog to digital converter digitizes the raw data, which includes the true phase to resolve the sign of the reactance.

The digitized data is sent to your PC (or laptop) via the RS232 port (or via a USB port with a user-obtained adapter cable). Some of the parameters calculated by the PC include: SWR referenced to any impedance; resistance and reactance at the cable input; resistance and reactance at the antenna terminal; resistance and reactance of discrete components; return loss; reflection coefficient; cable length; cable impedance; cables loss; distance to fault (open or short); Smith chart display, and quartz crystal parameters (for those designing filters). The scanned data can be saved or printed. In essence, the AIM4160 is a poor man's network analyzer.

To learn more about the AIM4160, visit **www.w5big.com**. You can download the most recent version of the informative (and substantial) manual. And W5BIG compared the accuracy of the AIM4160 to the antenna analyzers reviewed in the May 2005 issue of *QST* — this is at **www.w5big.com/TestResults.htm**.

Some Unique Features of the AIM4160

The AIM4160 does a lot of unique things compared to my MFJ-259B. Here's a short, but not all inclusive, list of the ones that really stand out:

- Reports SWR in Morse code for remote tuning (within earshot) of antenna.
- Easily 'backs out' the effect of a length of cable to get the true antenna terminal impedance.
- Measures crystal parameters for the design of filters.
- Easily saves a hard copy of results for subsequent analysis or for A-B comparisons.
- Scalable parameters to allow broad look or close-in look of an antenna's parameters.

Inside Evaluation

To gain familiarity with the AIM4160, I put it through its paces on the kitchen table with my laptop running under *Windows Me*. Since this laptop does not have an RS232 port, I had to buy an RS232-to-USB adaptor cable. How to make this work is nicely covered in the manual.

I measured various loads for my in-house evaluation, both real and complex. My results were on par with the above referenced accuracy comparison.

I also used the AIM4160 to measure a crystal (one of my old 40 meter Novice crystals). The results were as expected with respect to the series resonant frequency, the parallel resonant frequency and the crystal parameters. I did a normal frequency scan, and I also used the *Measure Crystal* command to get a tabular output of the crystal's parameters. Measuring crystals is a very handy option if you're into filter design. And if you're going to measure a lot of crystals, I would make a small fixture to better accept the crystal (my measurement was done by holding the pins of the crystal to the inner pin and the outer shell of the BNC connector on the AIM4160).

In summary, my inside evaluation of the AIM4160 showed it was very easy to use and quickly gave extremely useful results. When I felt comfortable with using it, I anxiously took it outside to measure my 80 meter/160 meter inverted-L.

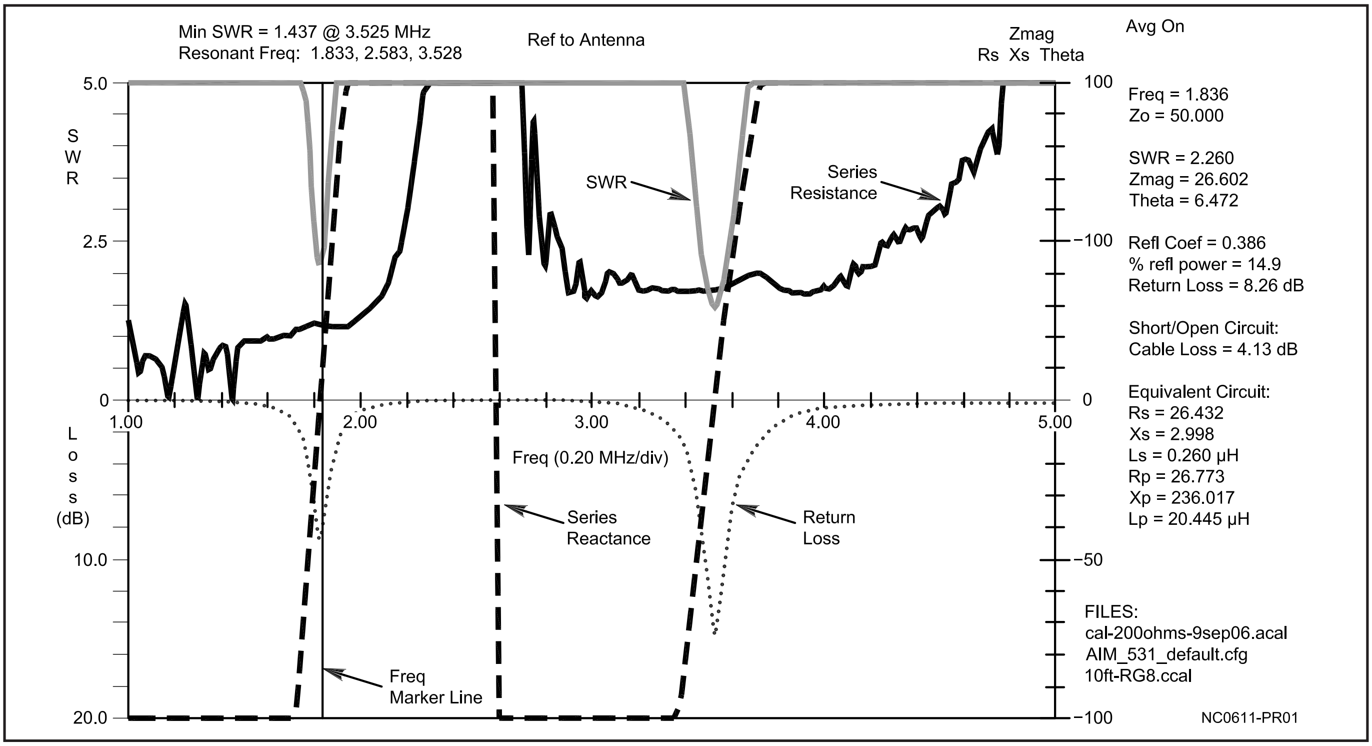
Out in the Field

My antenna for 80 meters and 160 meters is a quarter-wave wire vertical for 80 meters, with a homebrew 80 meter trap at the top. Above the trap, a wire slants back to the house to make it an inverted-L on 160 meters. For ground, I use three 60 foot long elevated radials on 80 meters, and three 120 foot long elevated radials on 160 meters. The top of the vertical wire (including the 80 meter trap) is supported from a convenient limb of an 80 foot tree on the east side of our property. I have a small B&W coil at the bottom of the wire to allow tuning the system to the CW or Phone portion of either band (by using a short jumper wire with alligator clips to short out turns on the coil).

My previous efforts at characterizing this antenna have been to carefully tune my MFJ-259B in 25 kHz increments across both bands, and write down the resulting R (resistance) and X (absolute value of the reactance). With a little playing around and some mental gymnastics, I could guess the sign of the reactance.

The AIM4160 made very short work of that manually-intensive effort. Not only do I have more accurate data now, I have a nice hard copy. See Figure 1 for the normal display generated from the AIM4160. The display on the laptop is in color, but Figure 1 is in gray scale due to publication in *NCJ*. Thus I have added additional annotation to point out which curves are

[1]In the May 2005 issue of *QST*, Joel Hallas, W1ZR, reviewed the Autek VA1, the Kuranishi BR-210, the MFJ-269 (similar to the MFJ-259, but also covers UHF) and the Palstar ZM-30.



SWR, return loss, series resistance and series reactance. The data on the right side of the plot is for the frequency of the vertical marker line.

Note from the text in the upper left hand corner that this antenna, over the evaluated 1 to 5 MHz frequency range, exhibits three resonant frequencies: 1.833 MHz, 3.528 MHz and 2.583 MHz. The first two resonant frequencies are low resistance (about 26 Ω and 36 Ω, respectively), and of course are the desired ones. The last resonance is high resistance (way off the plot, with the upper scale at 100 Ω).

Also note that the files used for this run are given in the lower right hand corner. The calibration file used was the one I ran on September 9 using the furnished short, open and 200 Ω terminations. I also chose to reference the results to the antenna terminal, which means I used the AIM4160 to calibrate the 10 foot length of coax that went from the AIM4160 to the connector at the bottom of my antenna. If I wanted to, I could have re-run the data with an expanded scale to get better resolution in each band.

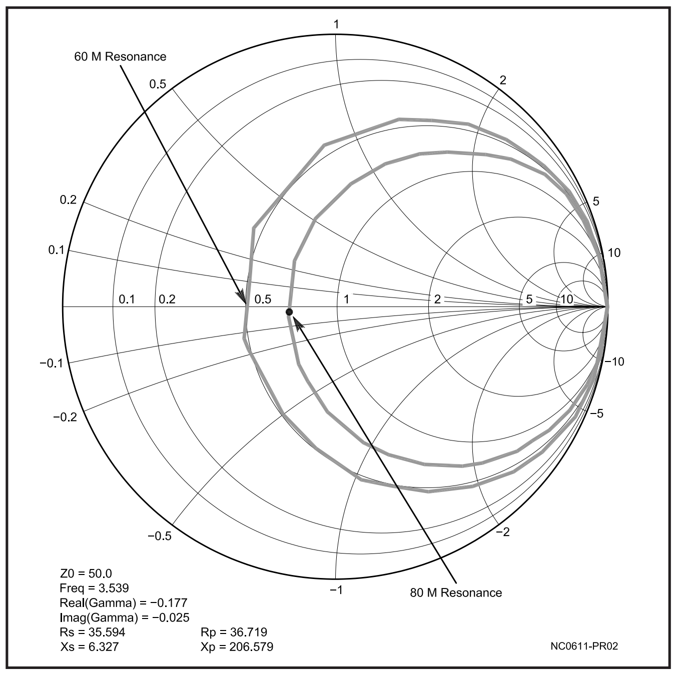
I used the *Averaging* function to smooth out the plot in Figure 1. This is noted in the top right hand corner with the annotation AVG ON.

Figure 2 shows the Smith chart version of the impedances in Figure 1. The dot just to the left of the center of the plot (the center is 1.0, which is 50 + j0 Ω) is a marker at 3.539 MHz. The impedance also crosses the real axis near the 0.5 point (25 + j0 Ω), which is 1.833 MHz. This indeed indicates that the 160 meter SWR is worse than the 80 meter SWR.

Summary

I found the AIM4160 very easy to use. It may not be as portable as my MFJ-259B, since I have to drag my laptop around with the AIM4160, but in my mind, the extra capabilities (better accuracy, better resolution, ability to save scanned files, ability to print hard copies and such) more than make up for that minor issue.

If you're looking for a new antenna analyzer to do some in-depth antenna work, check out this product. It may be exactly what you need.



Price, Availability, and Contact Information

W5BIG advises that the antenna analyzer to be put on the market will be the AIM4170, which has improvements over the AIM4160. The 4170 will go to 170 MHz, it will be in an aluminum box (the 4160 that I evaluated is in a plastic box) and the 4170 will have a few more tweaks to the software.

The AIM4170 will be manufactured and distributed by Array Solutions. Jay Terleski, WXØB, of Array Solutions, expects to offer the AIM4170 at $395. For availability and firm price of the AIM4170, contact Jay at 972-203-2008 or via e-mail at **jayt@arraysolutions.com**. You can also visit the Array Solutions website at **www.arraysolutions.com** NCJ