This is not your father's antenna analyzer ... or, for that matter, yours five years ago. If you're used to taking single-frequency measurements, check out the swept-frequency readout of the Array Solutions AIM 4170.

CQ Reviews:

The Array Solutions AIM 4170 Antenna/Lab RF Analyzer

BY PHIL SALAS,* AD5X

Along with SWR meters and VOMs, I'll bet that one of the most-commonly owned and used accessories 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 (direct digital synthesis) 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.

Photo A– The AIM 4170 is packaged with everything necessary for operation. (Photo courtesy Array Solutions; all other photos by the author)

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 bandpass 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 5" × 4" × 1.5" 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. As an alternative, you can read the antenna impedance with the AIM 4170 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,

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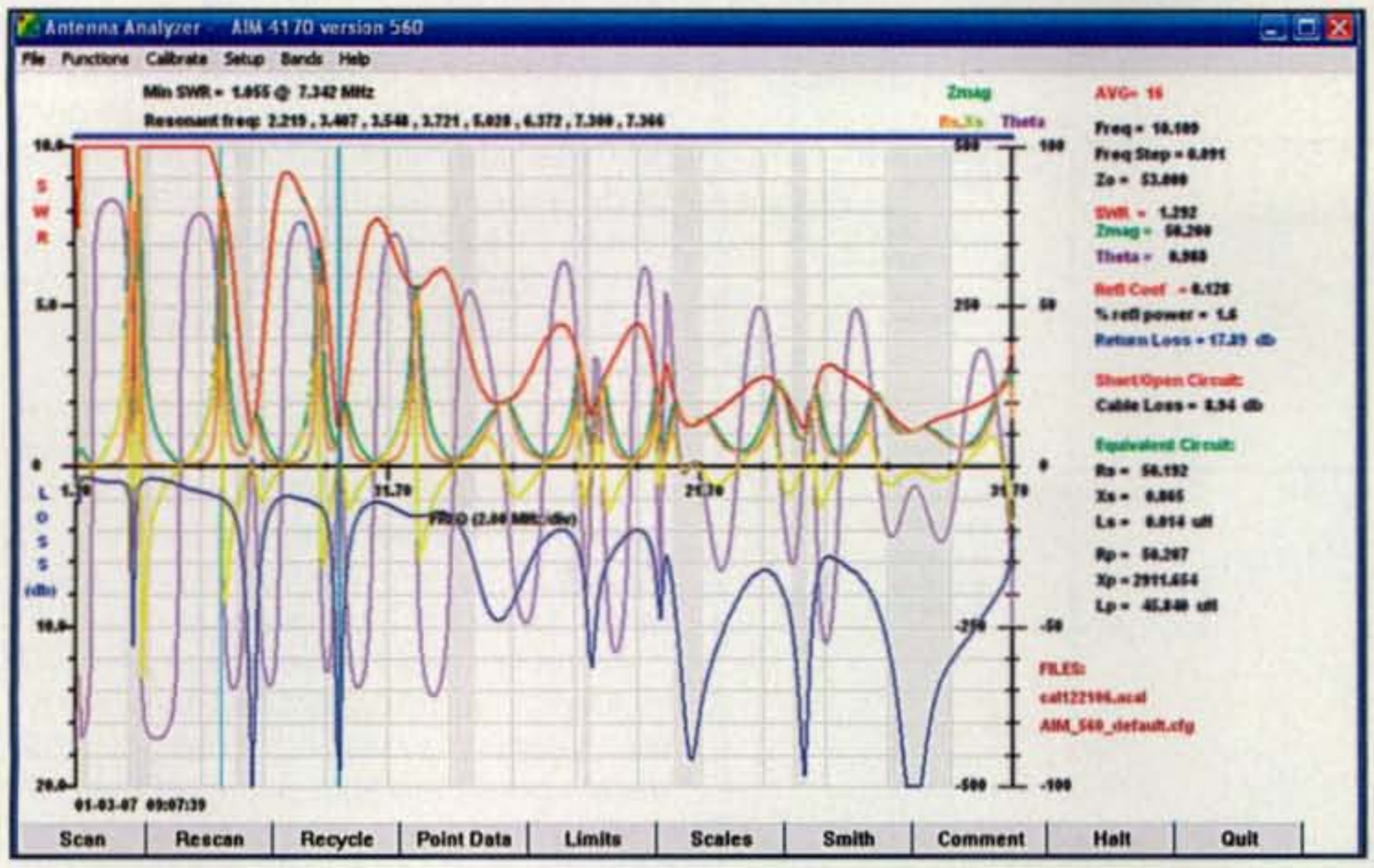

Photo B– Massive amounts of data can be plotted. The user can decide what is important and turn off the undesired plots.

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. Finally, too, 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!

Using the AIM 4170

The AIM 4170 comes with pretty much everything you need (see photo A). 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.

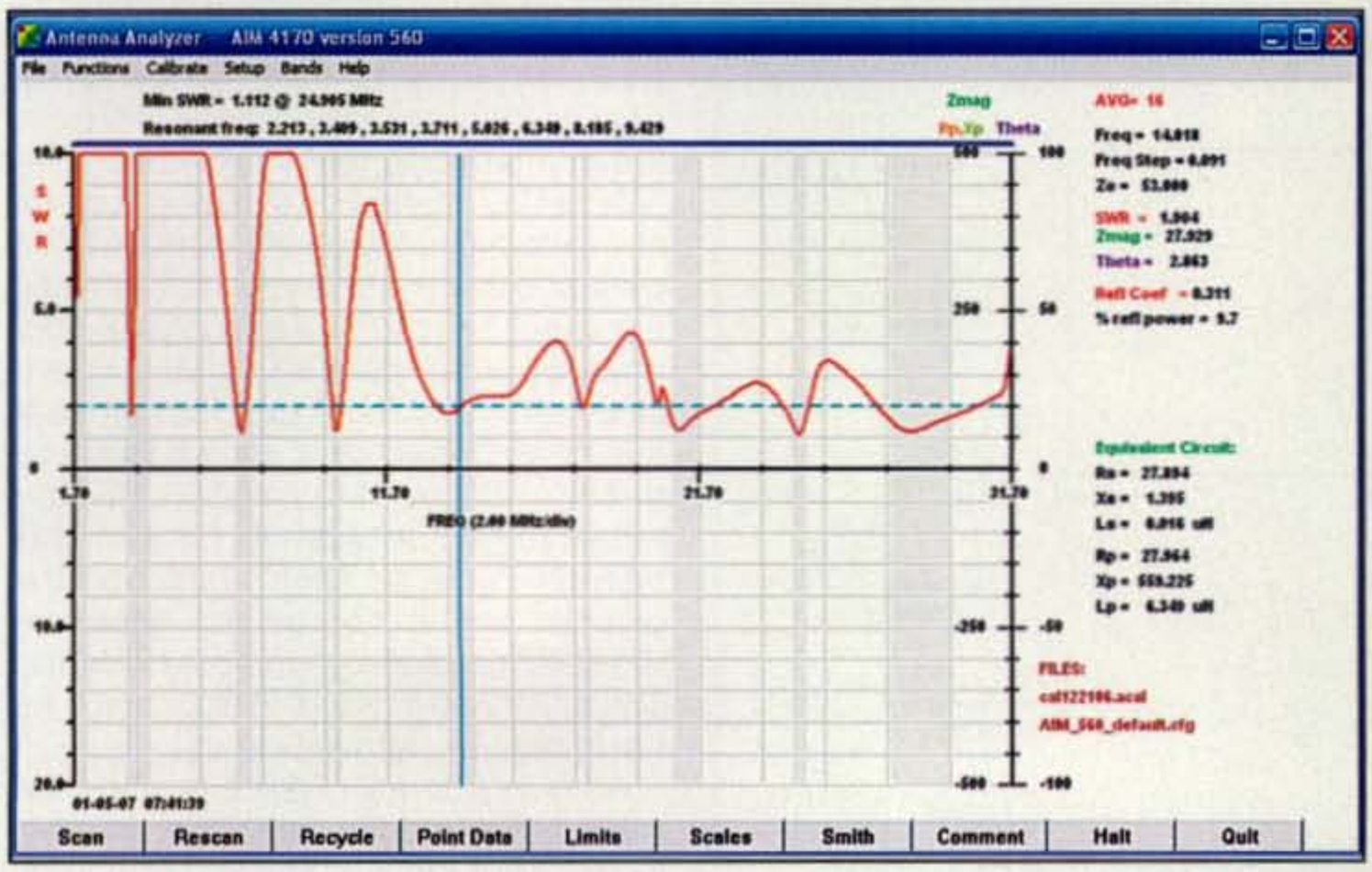

Photo C– The 1.7–29 MHz SWR swept response of the Butternut vertical.

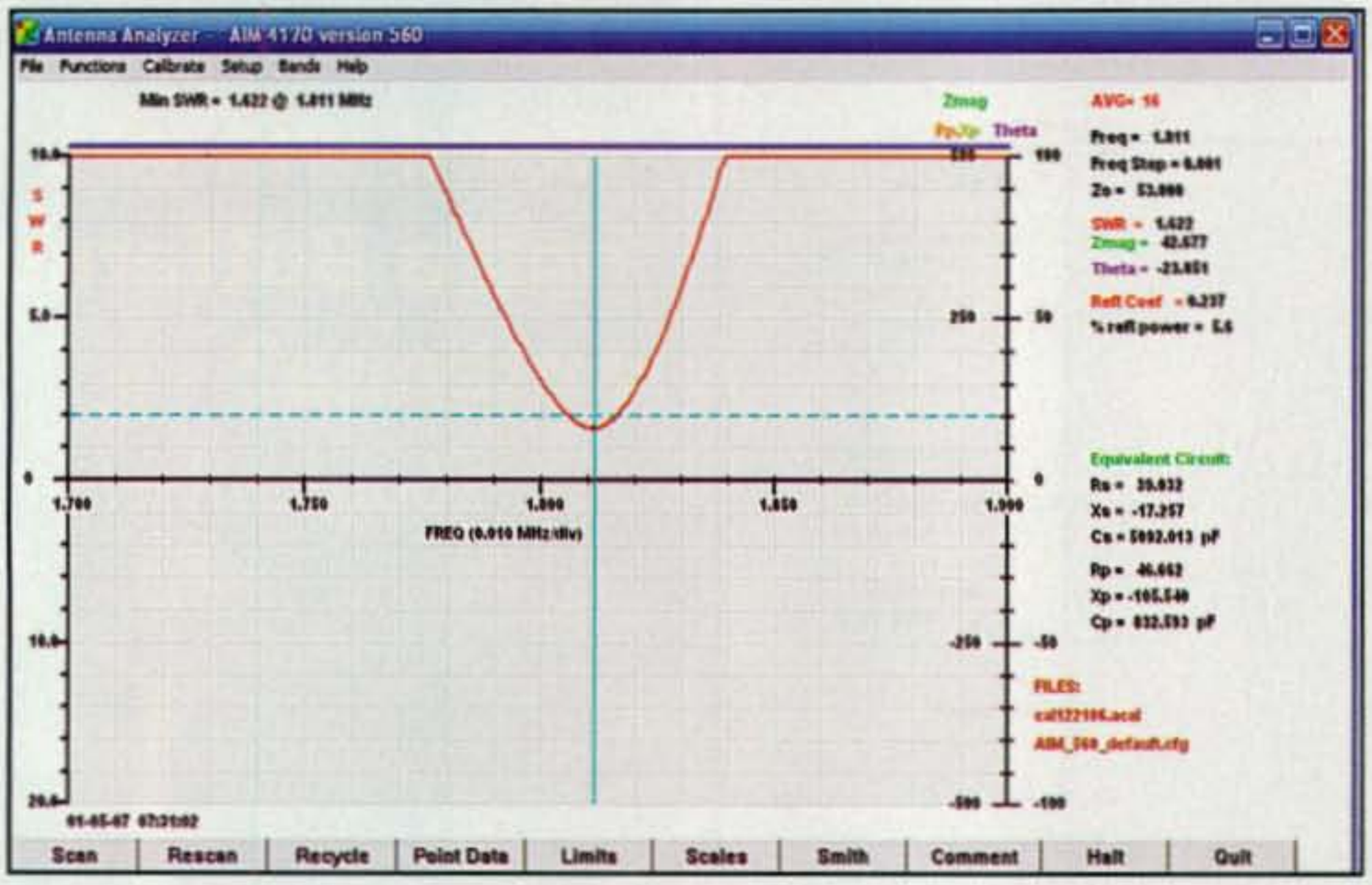

Photo D– The Butternut 160-meter swept response.

There is the CD with software and a printed quick-start guide as well. 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.

Now it is time to get down to business! First I wanted to look at the broad-band 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 an MFJ-259B antenna analyzer. However, I had never looked at the broad-band responses, since this 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 B. 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.

The full SWR sweep of photo C clearly shows the individual band resonances of the Butternut vertical. I took a closer look at 160 meters (see photo D), 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.

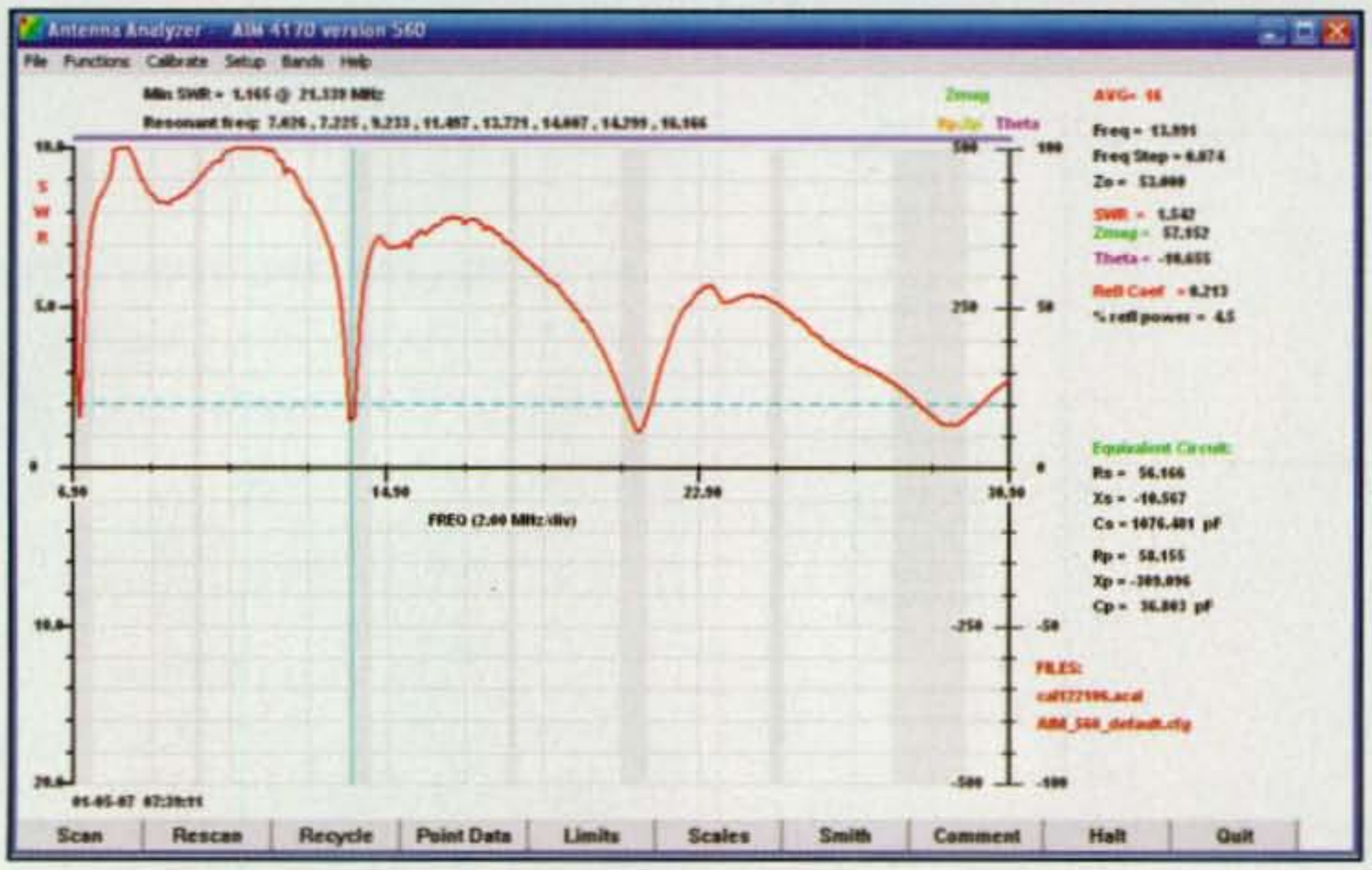

Photo E– Swept response of the MFJ-1775 rotatable dipole.

Photo E 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 F shows a 40-meter sweep of this antenna.

As mentioned earlier, the AIM 4170 includes internal bandpass 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 "flaky," 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 50-KW AM broadcast station on 1080 kHz. Photo G 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 150-mV peak maximum level of the AIM 4170 is not being exceeded by KRLD, although it is close! This "Band Scan" feature can also be valuable in helping to figure out who is overloading your receiver on Field Day!

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 setup necessary to actually directly measure the crystal parameters. 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 crystals. 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 seconds the screen shown in photo H appeared. As I said before—a trivial effort!

Another interest of mine is using the AIM 4170 as a signal generator for making receiver measurements. The nominal output level is 30 mV RMS into 50

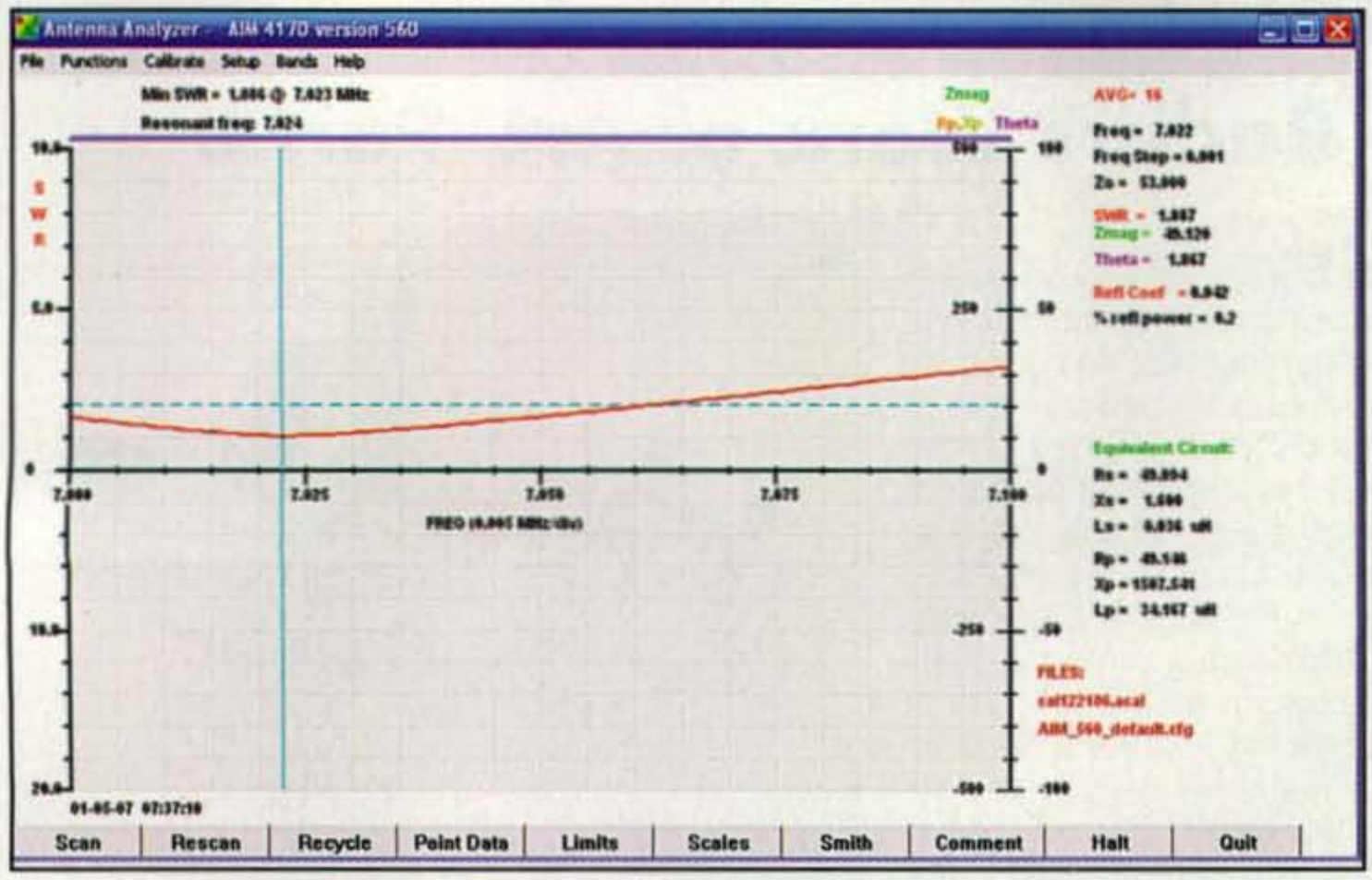

Photo F– The MFJ-1775 40-meter swept response.

ohms, which means you need about 56 dB of attenuation to give you a 50-µV 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 with a stable and accurate RF source for tests and measurements.

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 <http://www.w5big.com>, as well as a demo program that runs without the hardware.

Wishes

While the AIM 4170 does almost 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, especially for outside tuning of an 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 quickly will become an indispensable item once you begin using it. Plus, with software and firmware updates available for download at no charge, you won'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 website 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: <http://www.arraysolutions.com>. Price is $400. ■

Photo G– Band scan of the AM broadcast band.

Photo H– The 12-MHz crystal parameter measured data.