Playing with antennas - part 1

Kenneth Wyatt - October 11, 2012

As EMC engineers, we use many types of antennas - many broadband, these days. As a traveling EMC troubleshooter/consultant, I reply on small collapsible DIY antennas for troubleshooting, as described in an earlier blog posting.

In order to characterize these adjustable antennas versus frequency, it's useful to be able to measure them with different element lengths extended, so that you know about where to set the length for the specific harmonics of interest. Using the new Regal DSA815TG spectrum analyzer with tracking generator, and VSWR (voltage standing wave ratio) option, you can determine both the resonant frequency and VSWR, or how well the antenna is matched to the 50-Ohm coax cable.

In this case, I wanted to characterize the DIY "precision dipole" I made. By connecting a 20 dB coupler as shown, and performing a "Cal Open" to normalize the display, connecting the antenna, then pressing "VSWR", you can read out the VSWR at the resonant point. In this specific case, I'm measuring about a 2:1 VSWR at a frequency of about 91 MHz.

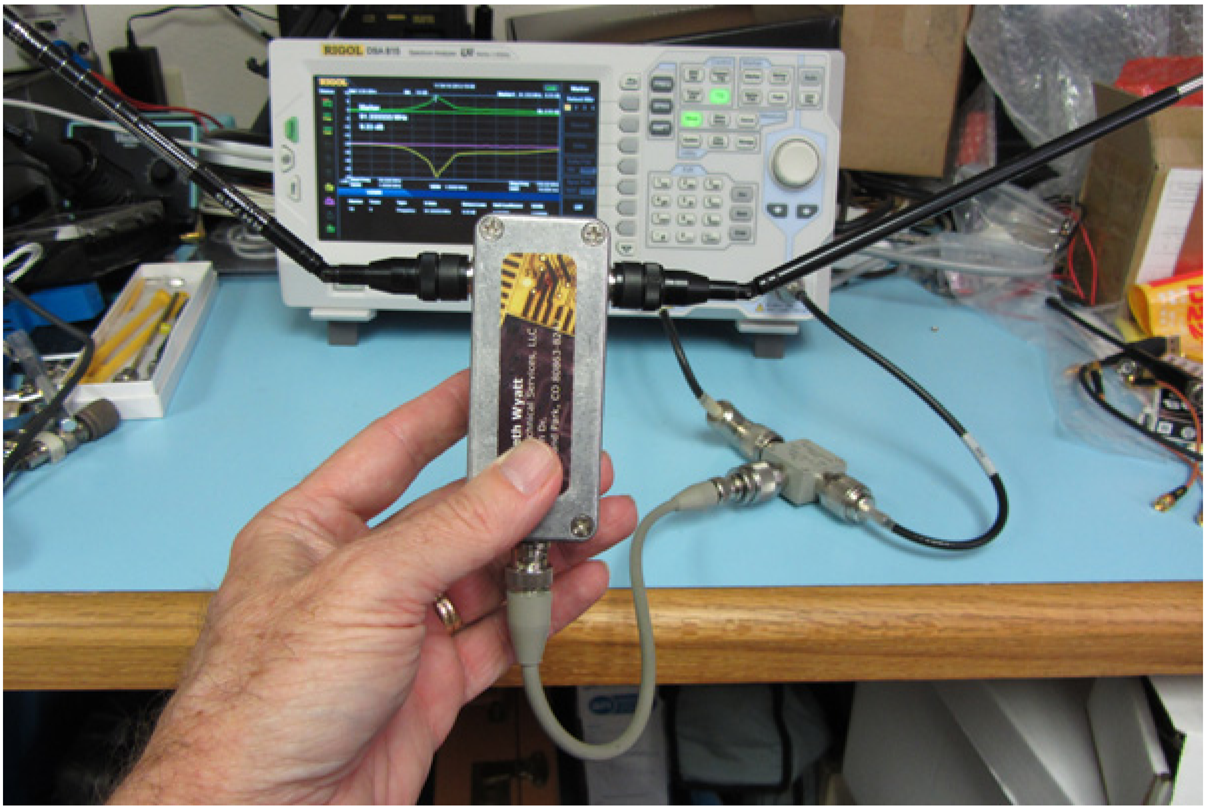

Figure 1 - Here's the setup for measuring VSWR for the DIY dipole antenna.

To hook up the 20 dB coupler (in this case, a Mini-Circuits ZFDC-20-5, 0.1 to 2000 MHz), connect the tracking generator output to the coupler "OUT", the "CPL" connector goes to the analyzer input and the "IN" connects to the antenna under test. If you purchased the VSWR option for the analyzer, just connect the fixture to the front "N" connectors.

First, set the upper and lower frequency limits. I also used a vertical 5 dB per division, so I could see finer changes. You'll then want to normalize the test setup including any attached coax using the

"CAL OPEN" soft key under the "Meas Setup" front panel button. Then press the "VSWR" soft key and connect the antenna.

Something to keep in mind is that as the coax length increases, the resulting VSWR measurement of an attached antenna becomes less accurate. For example, if you were to test a 100-foot roll of typical coax cable, it ought to measure pretty close to 1:1 with an open circuit, due to cable losses! Attaching an antenna to this won't tell you anything.

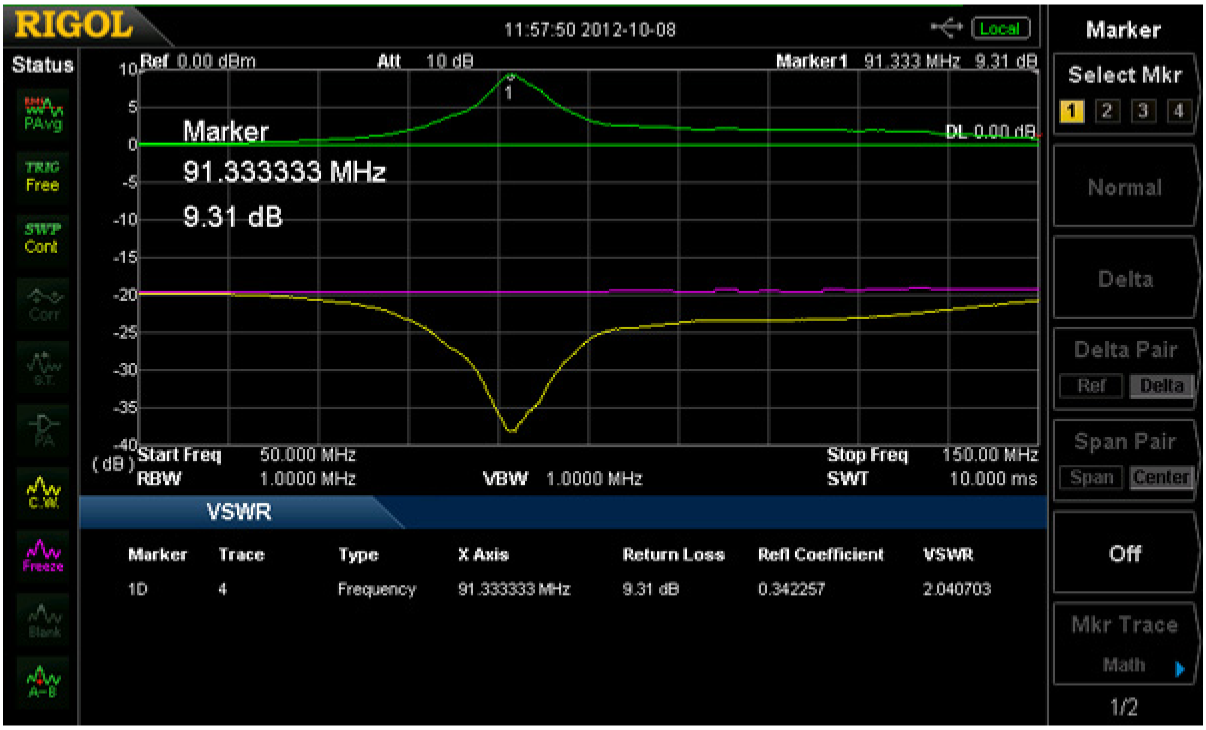

Figure 2 - The resulting screen shot showing the resonant frequency of about 91 MHz and the calculated reflection loss of 9.31 dB and associated VSWR of about 2.0:1 - not too bad of a match to the 50-Ohm coax cable. The green trace is return loss, the purple trace is the normalized data and the yellow trace is the raw data.

As you can see, by adjusting the telescoping elements at a slight angle upwards or downwards, you can achieve the best match to the 50-Ohm coax. With the elements out straight, I was only getting a 3:1 VSWR. Obviously, handholding the antenna, as well as making the measurement close to other objects, will not yield the most accurate measurement, but for the purposes of this little experiment, it suffices.

By recording the resonant frequency versus number of telescoping sections extended, you can characterize your antenna versus frequency. However, for the purposes of troubleshooting, whether the antenna is perfectly resonant at the frequencies of interest, or not, is not really that important. Only when you want to make an accurate emissions measurement, is it important to adjust this "precision dipole" to the exact resonant dimensions.

When troubleshooting, I extend the elements out enough to pick up viewable signals and then tape it down to a non-metallic surface about a meter away. By watching the spectrum plot of the harmonics in question, I can tell right away whether I'm making progress in determining the source and coupling path.