If you have space for only one wire antenna, K5QY suggests building this off-center fed dipole for 40 meters that also plays well on 20, 15, and 10 with just the autotuner built into most HF rigs today.

An Optimized 40 Through 10-Meter Off-Center-Fed Dipole

BY DICK SANDER,* K5QY

For hams who want to operate HF but are constrained to small lots, the off-center-fed (OCF) dipole makes a great antenna. Unlike more popular antennas such as a G5RV or an open-wire feed antenna, an external antenna tuner is not required — just the transceiver's built-in autotuner. The total length is 66 feet, so it fits snugly in a small lot. It also lends itself well for a simple and effective Field Day antenna and was used as such in 2013 with great results. When used as an inverted-V, this antenna design has a SWR under 3:1 on the 40-, 20-, 15-, and 10-meter bands. When operated as a horizontal dipole, the SWR is even better. *Photo A* shows the OCF dipole under test.

Computer Optimizing

First, I'll describe how the antenna works. If you look at antenna catalogs at the 40 through 10-meter OCFs, you'll notice that they generally do not operate on 15 meters. That is because the SWR is over 4:1 on that band. Because the radiating lengths are different, the voltages that appear at the feedpoint can be excessive and balun damage can occur. An external tuner will satisfy the SWR at the transceiver, but it does nothing to change the voltages at the balun. This design produces acceptable feedpoint voltages on 15 meters as well as 40, 20, and 10, using a 4:1 balun at the feedpoint.

To enable multibanding a dipole using a single feedline without traps, it is necessary to find the highest current point possible for each band. This result is a compromise in the feedpoint impedance. So in order to find that best high current trade-off, computer modeling allows optimizing the element lengths. After the lengths are determined and antenna impedance is known, a matching device such as a 4:1 current balun can be used to transform to a lower impedance and calculate SWR into 50-Ohm coax. *Figure 1* shows current peaks and feedpoint impedances for a dipole model at 40, 20, and 10 meters. The lengths for my horizontal OCF dipole model legs finalized at 27 feet and 41 feet. *Table 1* shows the feedpoint SWR for each band on the OCF as compared with a traditional center-fed 40-meter dipole. *Figure 2* shows an SWR sweep from 6.9 to 28.9 MHz for the OCF.

For an inverted-V configuration, the feedpoint changes as the ends draw together. An apex angle of 90° should be the minimum for an inverted-V. *Figure 3* shows the SWR sweep

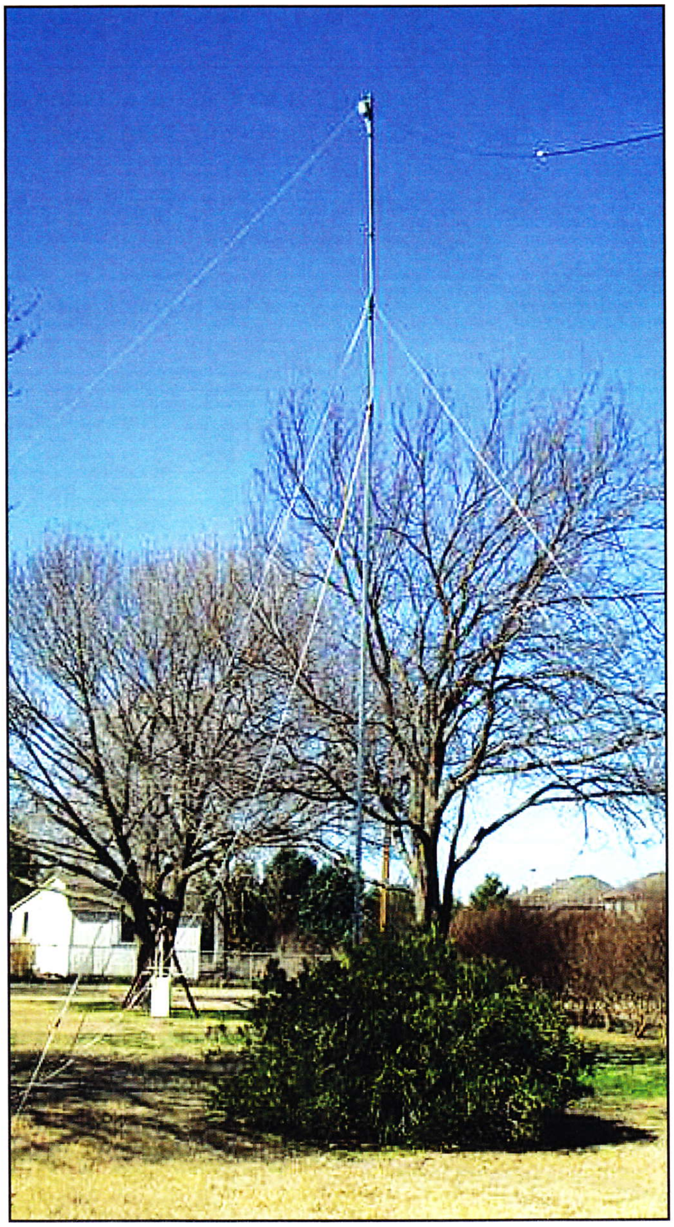

Photo A. The 40-, 20-, 15-, 10-meter off-center-fed antenna in an inverted-V configuration during testing. The apex height is 33 feet.

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from 6.9 to 28.9 MHz for an inverted-V angle of approximately 135°. In both configurations the SWR is below 3:1.

3-Dimensional OCF Radiation Patterns

Figure 4 shows three-dimensional radiation patterns and current distribution of the OCF inverted-V antenna for each band. These patterns were modeled at a 37-foot apex because that is the height of my Field Day mast. On 40 meters, the antenna acts very much like any dipole at that height with radiation mainly broadside. On 20 meters, the pattern is mainly endfire. On 15 meters, the main pattern is broadside with multiple lobes in each direction. On 10 meters, because of the height and length of the antenna, there are multiple lobes in all directions and multiple take-off angles as well.

Feeding OCF Dipoles and Vees

A 4:1 current balun is typically used when matching an OCF antenna. This transforms the unbalanced 50-Ohm coax to the higher antenna impedance. This type of balun is often termed a current balun because of its tendency to force equal (but opposite in direction) currents in each leg of the balanced connection, irrespective of the voltages on those legs.

For this article I'm not describing how to build a 4:1 current balun. Commercial baluns and the internet contain plenty of information about them. One thing you must keep in mind for your balun is that it should have two ferrite cores. I built a two-core Guanella current balun from the AE6YC winding and wiring data website (Do a web search for "AE6YC balun project"). It worked out very well.

On-The-Air Testing

I tested at a 33-foot apex height because most small lots would not have the room at greater heights to keep the apex angle as wide as possible. When I actually had the antenna up, it was necessary to "tweak" it a bit. I started out with the antenna a foot longer on each end for trimming. I discovered by both modeling and trimming that the short 27-foot leg should be left alone. Adjust only the 41-foot leg in very small

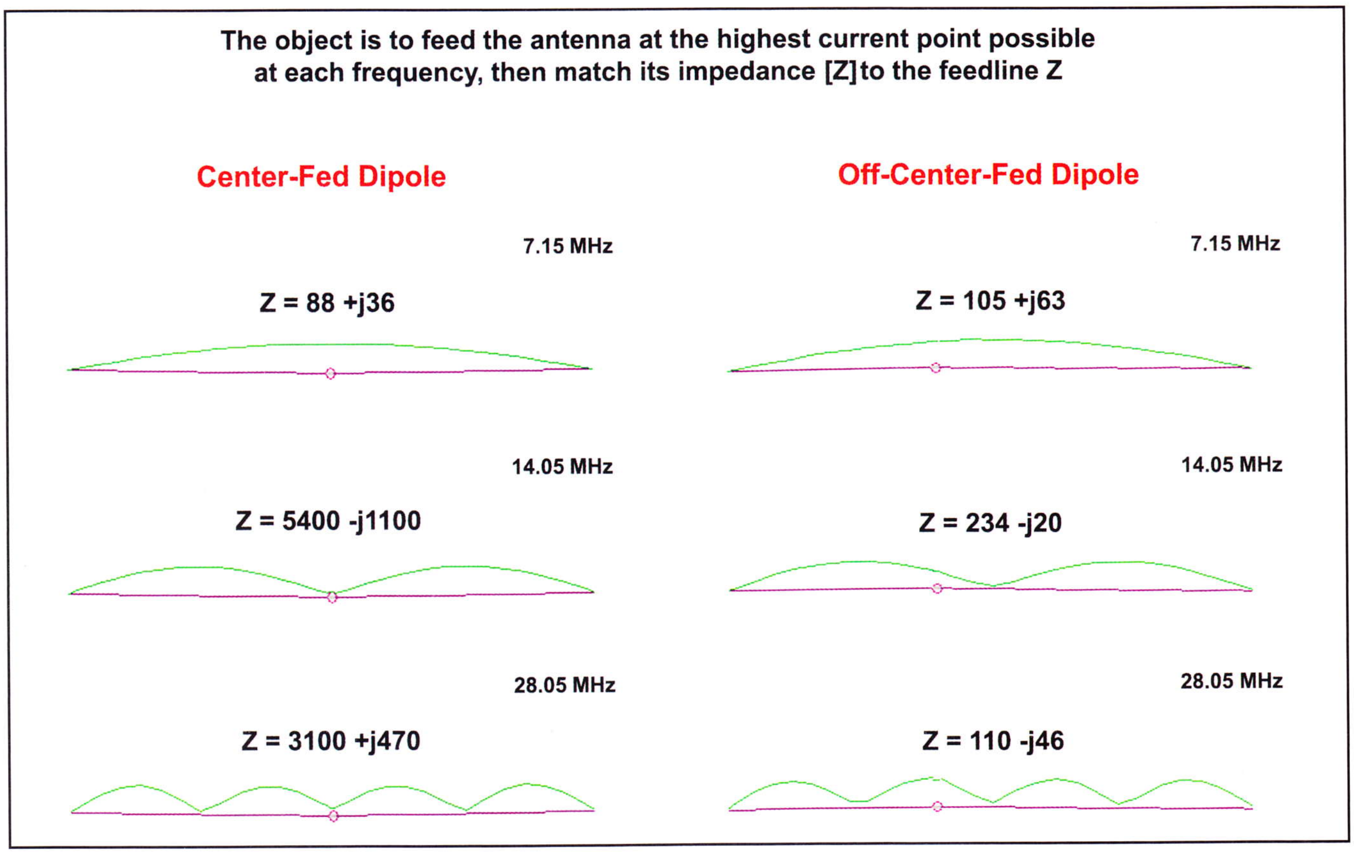

Figure 1. Current peaks and feedpoint impedances for each band at 40, 20, and 10 meters, with a traditional center-fed 40-meter dipole on the left and the off-center-fed version on the right. See Table 1 for SWR values.

Band	Center-Fed Dipole **SWR**	Feed Method	Off-Center Fed Dipole **SWR**
40m	88+j36/50=**2.2:1**	50-Ohm Coax	105+j63/50=**3.0:1**
40m	200/88+j36=**2.4:1**	4:1 Balun	200/105+j63=**2.1:1**
20m	5400-j1100/200=**28:1**	4:1 Balun	234-j20/200=**1.2:1**
10m	3100+j470/200=**15.9:1**	4:1 Balun	200/110-j46=**1.9:1**

Table 1. Feedpoint SWR for center-fed 40-meter dipole (left column) and off-center fed dipole (right column) on 40, 20, and 10 meters (see Figure 1 a graphic representation of current peaks). SWR is listed on 40 meters using both a 50-Ohm direct feed and a 4:1 balun. On 20 and 10 meters, SWR is listed with a 4:1 balun only.

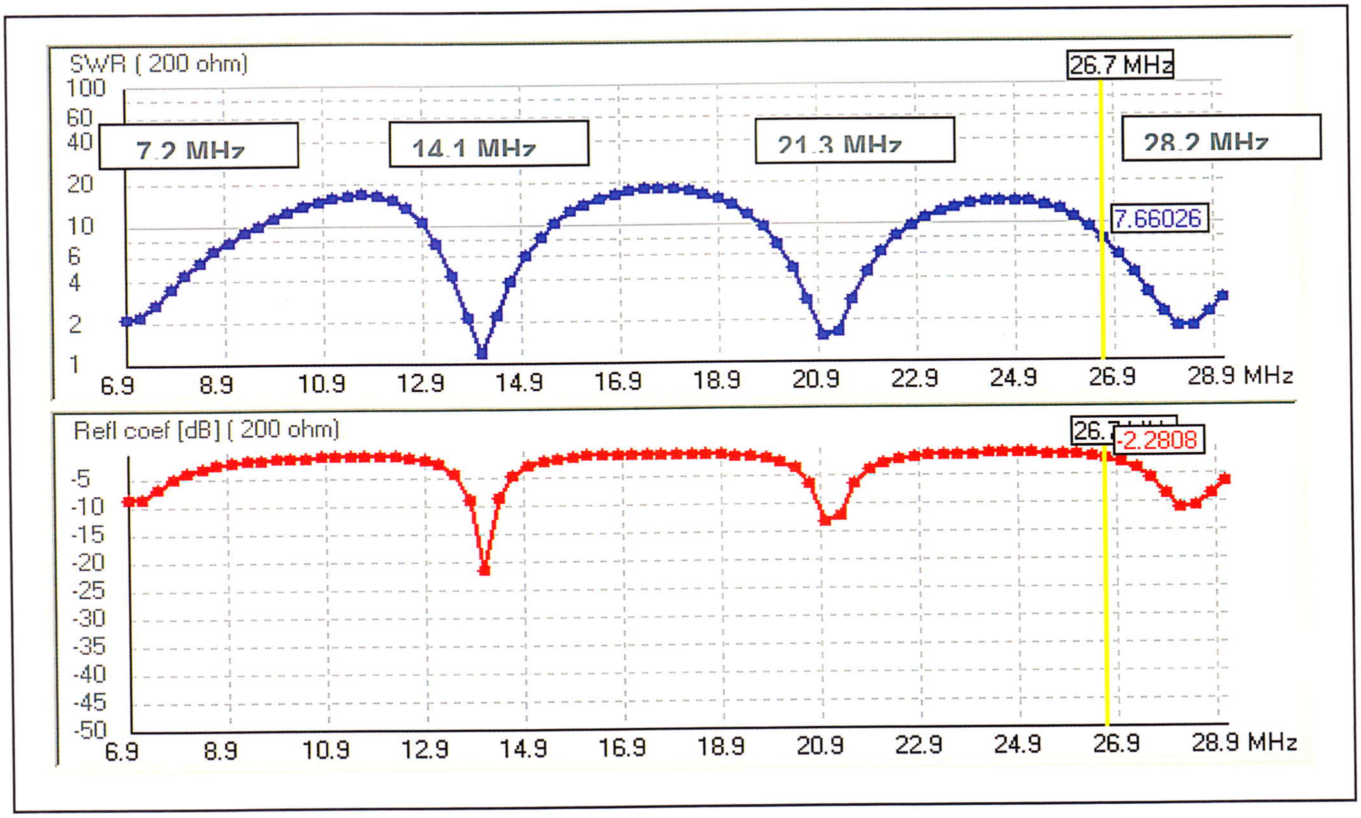

Figure 2. SWR sweep from 6.9 to 28.9 MHz for the horizontal OCF with 27-foot and 41-foot legs.

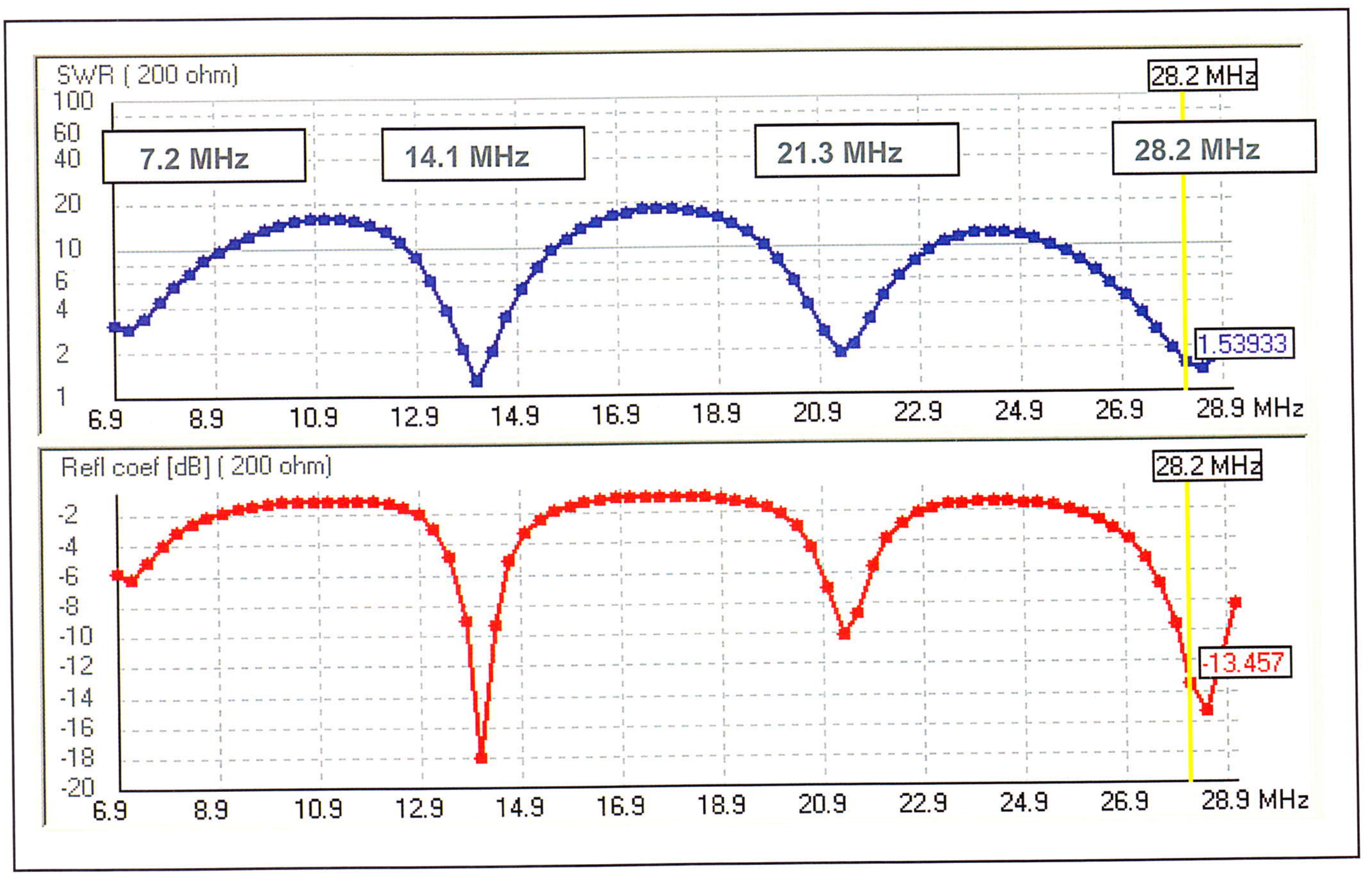

Figure 3. The SWR sweep from 6.9 to 28.9 MHz for an inverted-V OCF with an apex angle of approximately 135° with 27-foot and 41-foot legs.

increments. It has the effect of raising all bands at once. *Figure 5* shows an actual 40-, 20-, 15-, 10-meter SWR sweep of my OCF inverted-V at 33 feet.

Before I took down the OCF antenna, I spent several weeks doing A-B comparisons between my good homebrew 4-band 29-foot vertical with 12 radials and the vee at 33 feet. I made 30 contacts spread over different times and bands. I also used my S-meter and observed at least 90 more stations during this testing period. The short end was pointed northeast and the long end pointed southwest.

For`a general summary of performance comparisons:

- On 40 meters under 600 miles in W5

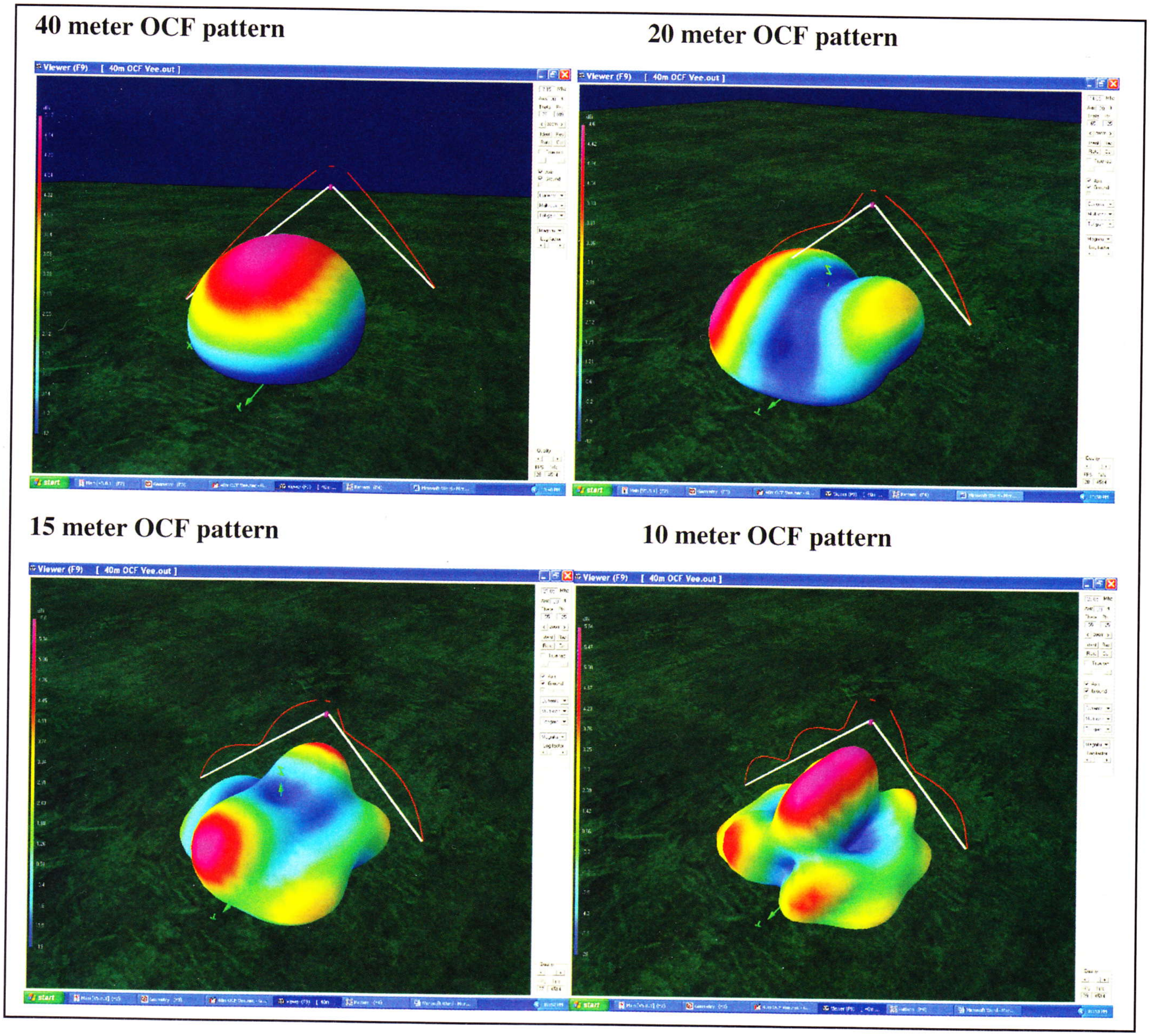

Figure 4. 3-D radiation patterns and current distributions of the OCF inverted-V antenna are shown for each band.

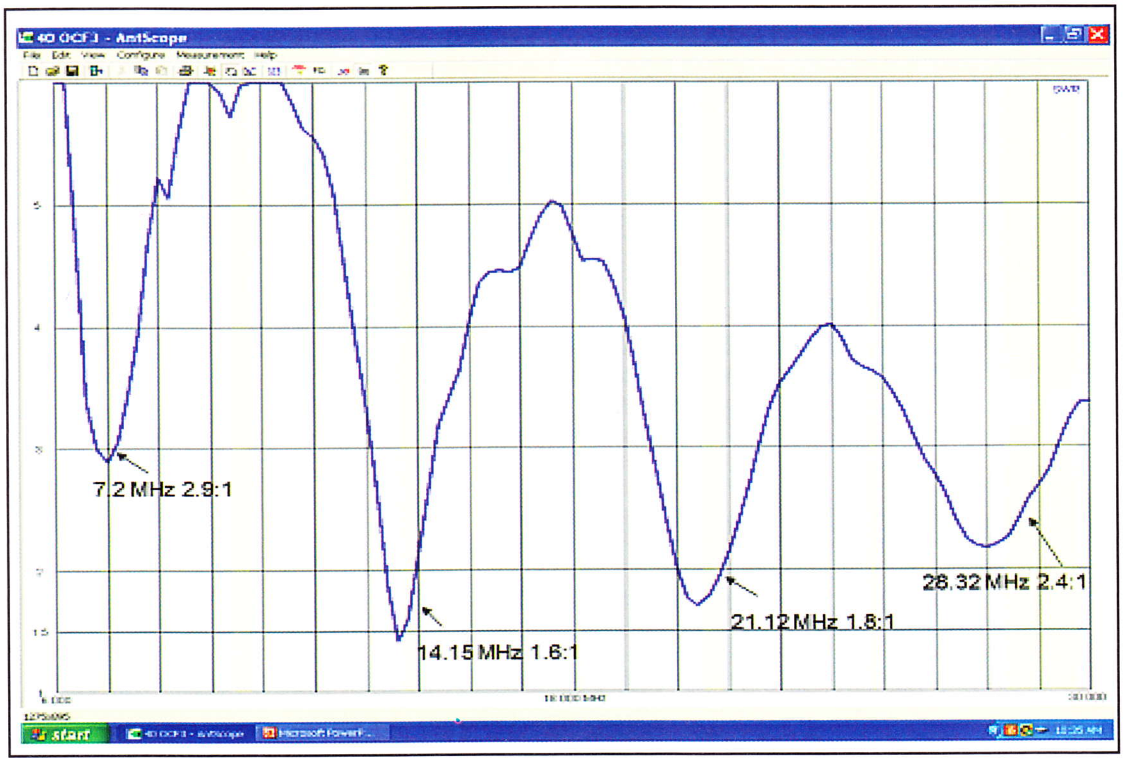

Figure 5. My actual 40-, 20-, 15-, 10-meter SWR sweep of the OCF inverted-V at 33-foot apex height. SWR listed in the above curve is for approximately the center of each band. When connected to my transceiver, the autotuner quickly matches the antenna.

QSO groups, the OCF was best; and the vertical was best into each coast

- On 20 meters, into each coast the vertical was better 16 times and the OCF was equal or better 12 times
- On 15 meters, the vertical was equal or better 6 times and the OCF was better 20 times; and finally
- On 10 meters, due to poor conditions when I operated, I made no contacts on the vertical but did manage contacts on the OCF with Brazil, Australia, and New Zealand.

Final Thoughts and Comments

It is well worth studying the various radiation patterns because the orientation of the OCF on a particular band could yield better results for your needs. Also, remember that the real radiation efficiency of a dipole over a short vertical is several dB better, so don't be fooled thinking that there is not RF energy in the pattern nulls of any dipole, and don't worry if you've only got one fixed direction in which to install it.

I took the antenna to the 2013 Field Day and operated mainly 20- and 40-meter CW with it, working several hundred QSOs during my shift. Some contacts were made on 15 meters, but conditions were poor. It performs well for a dipole and meets my design criteria to operate on 15 meters, especially when just cutting the legs to length and connecting it through a balun and raising it up.