A Broadband 80/160 Meter Dipole

An easy to build single wire antenna for 160 and 80 meters
with a better than 2 to 1 swr across the 80 meter band.
by
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I read Rick Littlefield's article in the June 2008 issue of QST on off center fed dipoles and was intrigued by the idea that the antenna could be extended to cover 80 meters. Rick discouraged doing this in his article because of ground effects. However, I thought it would be useful to play around with antenna designs similar to his using the EZNEC program. What I really wanted was a broad band 80 meter dipole with less than a 2 to 1 swr from 3.5 to 4 MHz. It would also be nice to have it work on 160 meters.

It didn't take long to discover (using EZNEC) that an off center fed dipole 244 feet long, 15 feet off the ground, over rocky mountainous soil, and made of #18 copperweld wire (a hidden antenna in my restricted antennas subdivision), would give a fairly low swr on both 160 and 80 meters when fed about 46 feet off one end using a 4 to 1 balun (200 ohms). However, the tuning was not broad on 80 meters as I had wanted. The next step in attempting to tune the antenna was to put a capacitor in the middle of the 244 ft long dipole. I noticed that the capacitor produced a new resonance below 80 meters while having little effect on the resonance already centered at 3.9 MHz. As I lowered the series capacitance, I observed that the lower resonant point could be tuned upward to within 80 meters. I was able to resonate the dipole at both 3.6 and 3.9 MHz. The swr was low across the whole 80 meter band! However, there was no 160 meter resonance. I put in a series resonant LC circuit across the first capacitor and that created a new resonant point inside 160 meters. With great glee I e-mailed my friends who were both amazed and skeptical that the antenna would work on both 160 and 80 meters with broad tuning on 80 meters. Figure 1 below shows the modeled SWR plot on both 160 and 80 meters of the original antenna design as well as the final and actual antenna SWR plot when measured on my ICOM 756 Pro III inside the ham shack (the black dots).

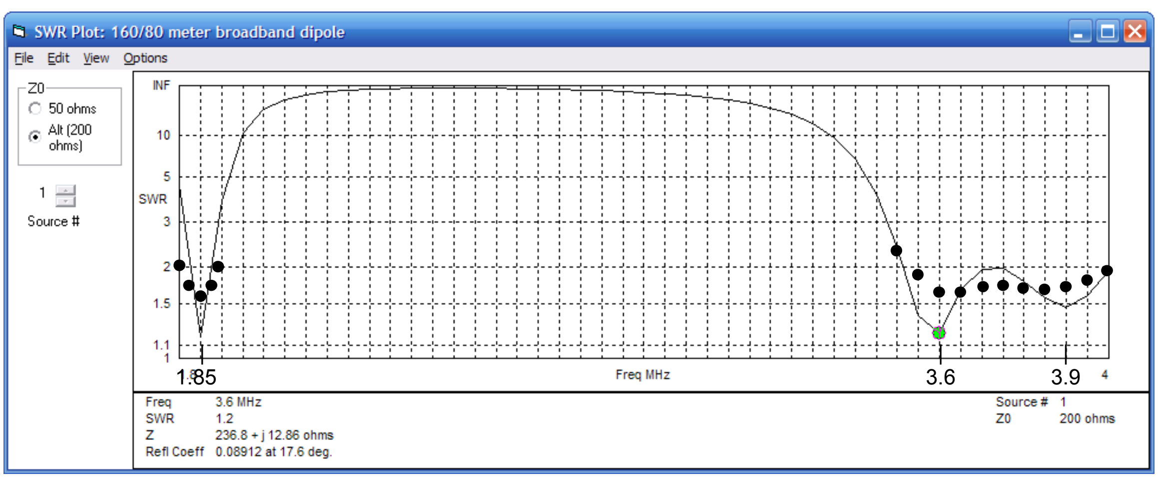

Figure 1. Theoretical SWR of the antenna versus the actual SWR at the rig.

The theoretical antenna dimensions were previously described. The original tuned circuit at the center of the dipole for that theoretical design consisted of a capacitance of 50 pF in the center of the 244 ft dipole and across that was a series LC circuit of 68 uH and 120 pF. However, I was not able to wind a coil with enough inductance to get the 68 uH (not enough wire in my junk box). I spotted a 20 meter trap on a multiband antenna in my junk pile that looked like it might have enough inductance. I put it on my MFJ-259b meter and it had 55 uH at 2 MHz. I could make this resonate on 160 meters by changing the series capacitance from 120 pF to 150 pF. Now I was ready to put it up and test it.

The first thing I did was put up the 244 ft dipole without the LC circuit at the center. I wanted to verify that the original antenna and balun would resonate on both 80 and 160 meters. I purchased the W2AU 4:1 balun from a local ham outlet. I supported it from the center of a small tree in my back yard at a height of about 18 feet. Then I ran the 46 ft leg over to my fence. I then ran the other 198 ft leg to the far corner of my back yard. The two legs were not directly opposite. EZNEC predicted that the small angle made no difference. The 198 ft leg was really long. I had to raise the end of the antenna to 13 feet just to keep the sag in the middle from making the antenna too low (about 10 ft initially). My yard is lower where the sag was most, otherwise, the antenna would have been even lower to the ground. The antenna resonated beautifully on 80 meters, just as predicted, and did not resonate at all on 160 meters. Uh oh, the skeptics might be right.

I thought that possibly the W2AU balun did not have enough inductance on 160 meters and that this could affect the resonance on 160 meters. This is a common problem for off-center fed antennas. I decided to isolate the whole balun further from ground by wrapping 18 turns of RG8x on two 2.4 inch type 43 ferrite toroids stacked together. This did the trick. Now the antenna had a nice resonate point on both 160 and 80 meters just as EZNEC had predicted. Figure 2 shows a schematic of the final antenna design. Figure 3 shows the final installation of the W2AU balun and ferrite choke.

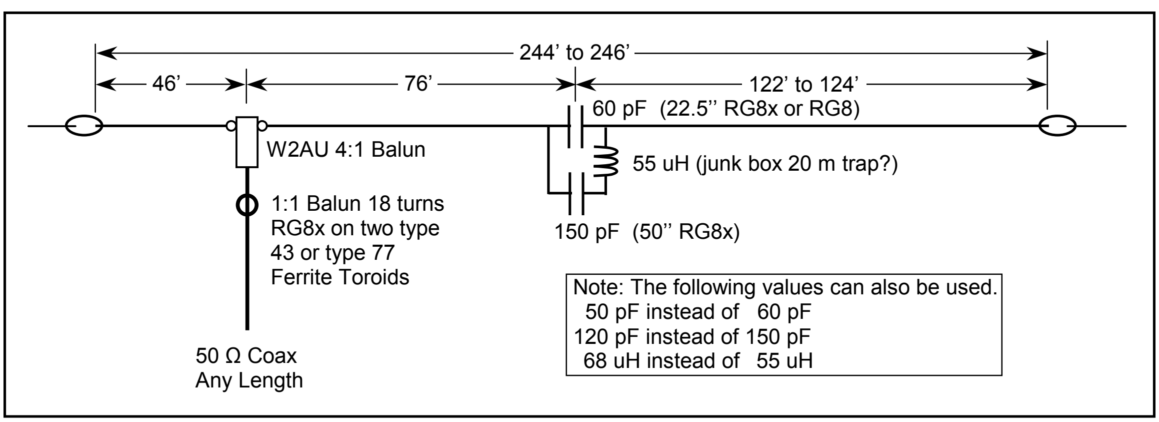

Figure 2. Circuit details for the broadband 80/160 meter antenna.

Figure 3. W2AU Balun and ferrite choke.

After successfully verifying that the antenna would resonate on both bands, I proceeded to install the center coil and capacitors. Figure 4 shows the assembly. The capacitors are lengths of RG8x coax. The EZNEC program predicted that the capacitors would need to be 60 pF and 150 pF when used with the 55 uH coil shown in figure 4.

Figure 4. Center of antenna coil and capacitors (RG8x coax).

The 150 pF capacitor (RG8x) is on the left and is clearly visible as being in series with the 55 uH coil. Start out with this length of coax at 55 inches. It will be trimmed a little bit at a time to bring the 160 meter resonant point to where you want to operate on that band. My final length was 50 inches. The 60 pF capacitor is the RG8x coax on the right. If you run 1000 watts on the lower end of 80 meters, you will probably need to use RG8 coax. The RG8x in the above picture failed and I had to replace it with 22.5 inches of RG8 coax. The 60 pF capacitor connects across the coil and 150 pF capacitor. Start out with a length of 26 inches of coax and then trim a little bit at a time to bring the lower end of the 80 meter band to approximately resonate at 3.55 MHz. The final length of this coax was 22.5 inches for my antenna. When trimming these capacitors, trim one and then the other, since they have a small interaction with each other. Bring both lower frequencies upward in the same tuning process. Before you begin this capacitor tuning process, it is important that the antenna is resonanted on the upper end of the 80 meter band before putting in the coil and capacitors. After this picture was made, I gunked the open coax joints with silicone cement in an attempt to keep water out.

The nice thing about these coax capacitors is that if you mess up, you can start all over with fresh new lengths of coax. When I put a kW into the antenna on 80 meters, the open end of one of the capacitors arced over. I then prepared the coax ends as shown below in figure 5 and that has prevented further arcing when high power is put into the antenna. Note that I also had to replace the RG8x 60 pF capacitor with RG8 because the RG8x failed internally when run at 1000 watts.

Figure 5. Preparation of the open ends of the capacitors to prevent arcing.

I put in a center plastic pipe to support the weight of the center of the antenna. The coax capacitors are wrapped on the antenna wire so the coax will be supported. Figure 6 shows the final installation. Springs on the ends of the antennas allow movement of the tree and are shown in figures 7 and 8.

Figure 6. Plastic pipe support and resonant LC circuits at the antenna center.

Figure 7. Antenna spring used to tie the 46 ft leg to the fence.

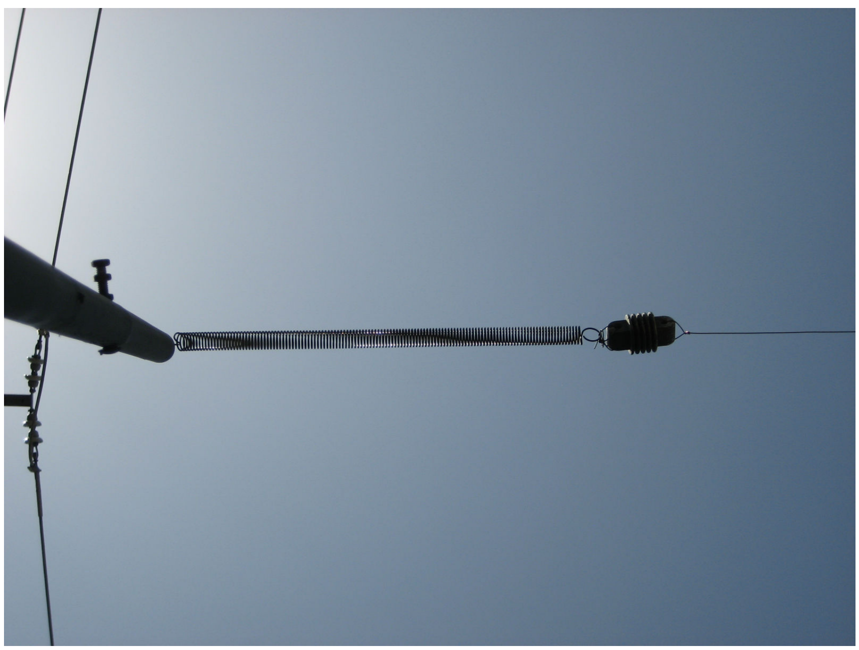

Figure 8. Antenna spring used to tension the 198 ft leg.

This article can be found at K5GP's web site http://egpreston.com at http://egpreston.com/K5GP_broadband_80_meter_antenna.pdf

EZNEC files can be downloaded at: http://egpreston.com/EZNEC.ZIP . File 2 is the design in this paper, file 4 is a 48'x89' rectangle version, file 5 is a 65' square version, and file 6 is a 60' tower version using larger conductor. There is also a 40/30/20 meter version. The EZ files had to be saved as .zip files to get access to them. Info on zipped files is here: http://netforbeginners.about.com/od/downloadingfiles/f/faq_zip2.htm .