

160m/80m Broadband Antenna by K5GP

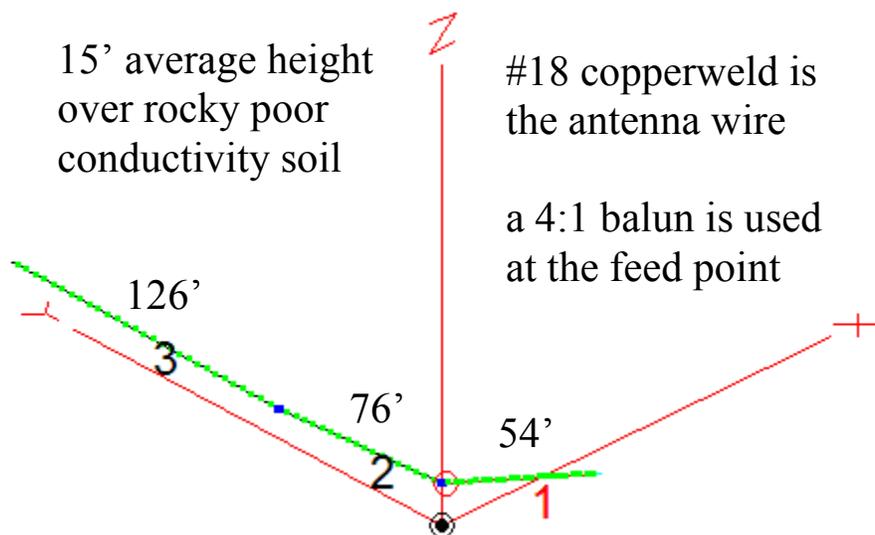
A presentation to CTDXCC September 22, 2008

The 160m/80m broadband antenna design objectives were to have:

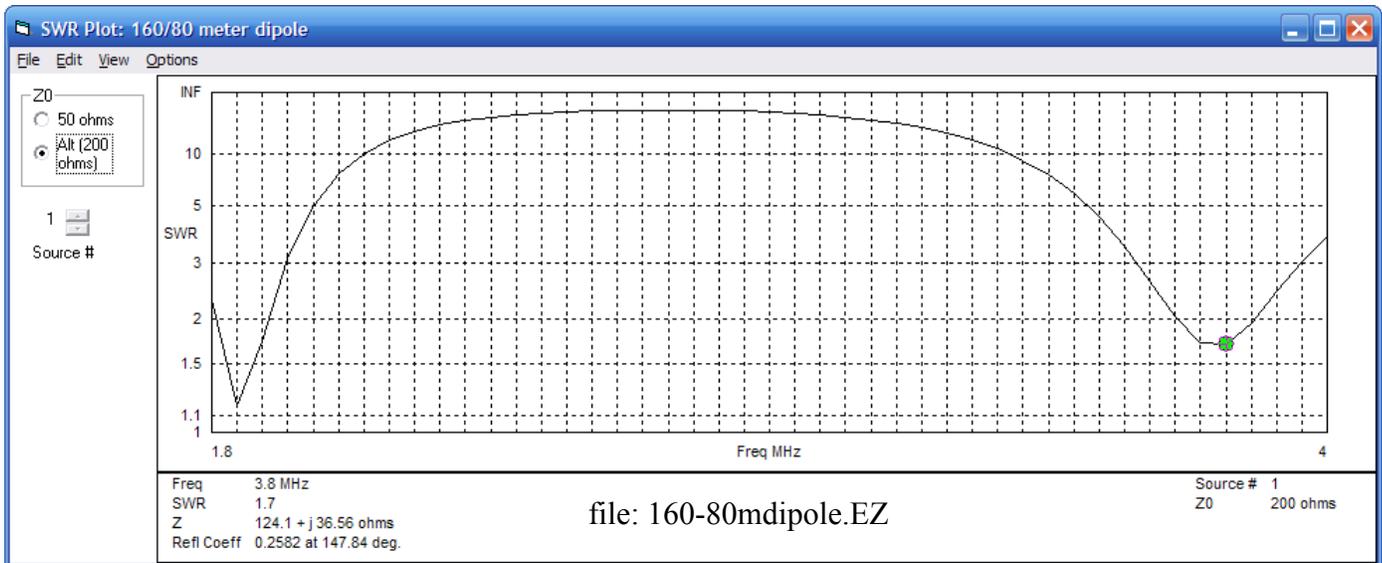
- 160 and 80 m antennas since I had no antennas for these bands,
- the antennas had to be hidden because of covenant restrictions,
- open wire feeders would be too visible to be allowed,
- QRO operation was considered as a necessity for 160 and 80 m,
- a low SWR on both ends of 80 meters is a must requirement, and
- not needing an external tuner would be desirable and convenient.

I began testing several different antenna layouts using the EZNEC <http://www.eznec.com/index.shtml> program. A chance discovery allowed the above wish list to be realized. But first, lets talk about some of the steps that were done leading up the final design. Then I will discuss alternative layouts.

I started out with an antenna layout that would fit along my back property line. The point in the middle represents some sag in the antenna. There is a small tree at the 4:1 balun feedpoint on the Z axis.

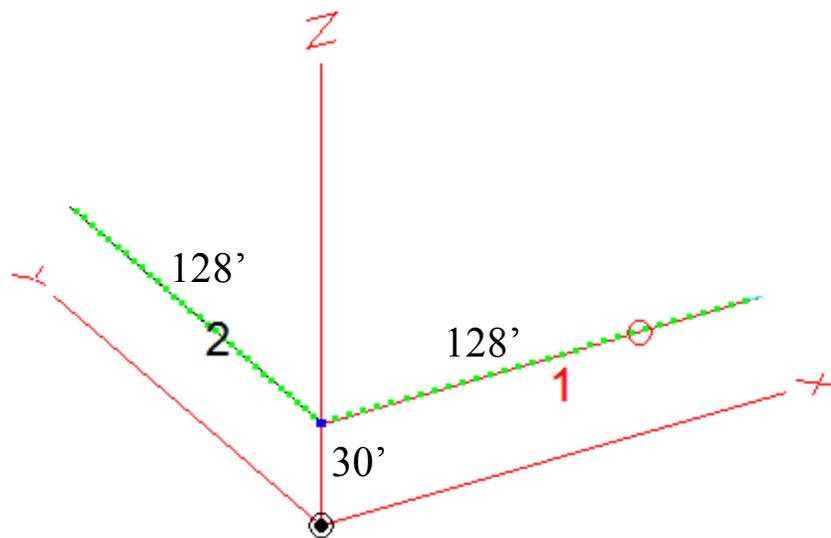


Here is the SWR plot for the antenna for the above layout.

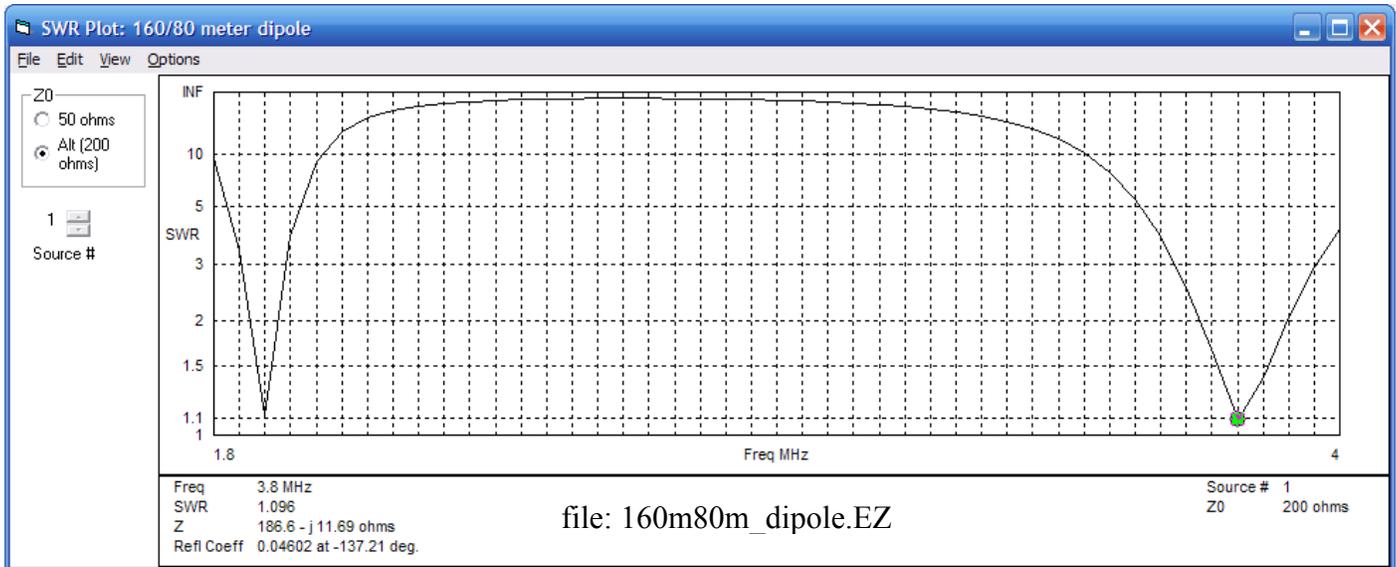


EZNEC files are posted at: <http://egpreston.com/EZNEC.zip>

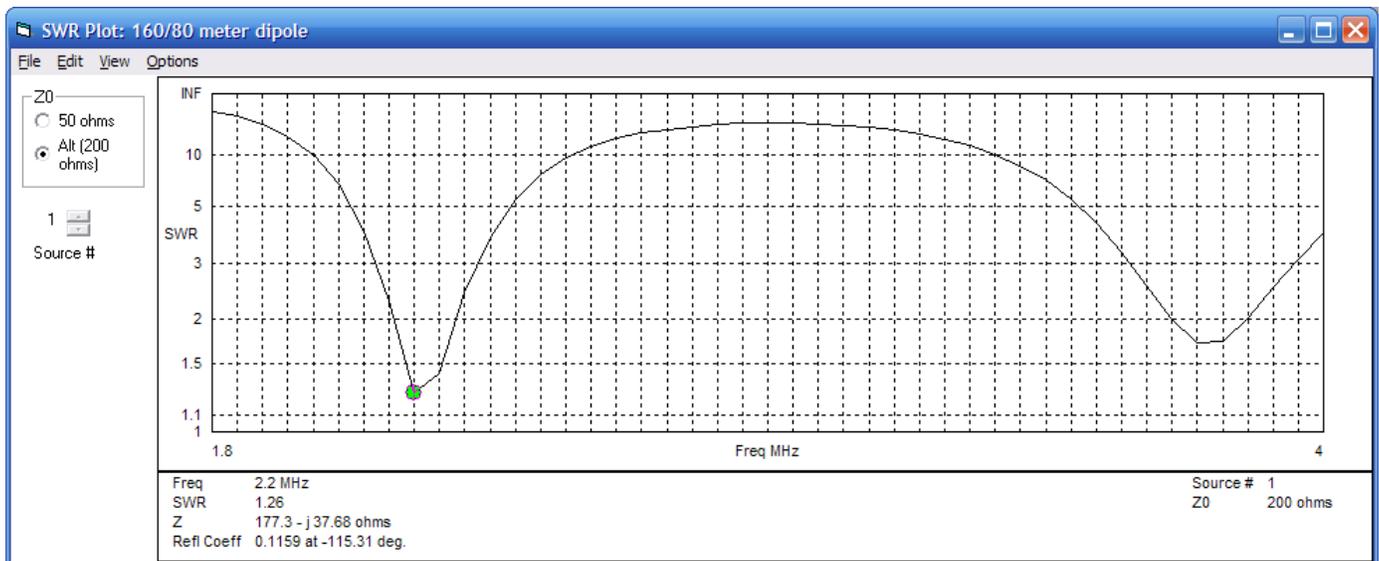
Notice that the 80 meter feed point impedance in the above plot is much lower than 200 ohms. One way to cause the 160 and 80 meter impedances to be about the same is to form the antenna into a right angle as shown below. The 4:1 balun feedpoint is 35 feet from the end.



The SWR for the right angle 160/80 meter dipole is shown below. This is actually a pretty nice dual band antenna if that's all you want. However, there are more exciting developments....

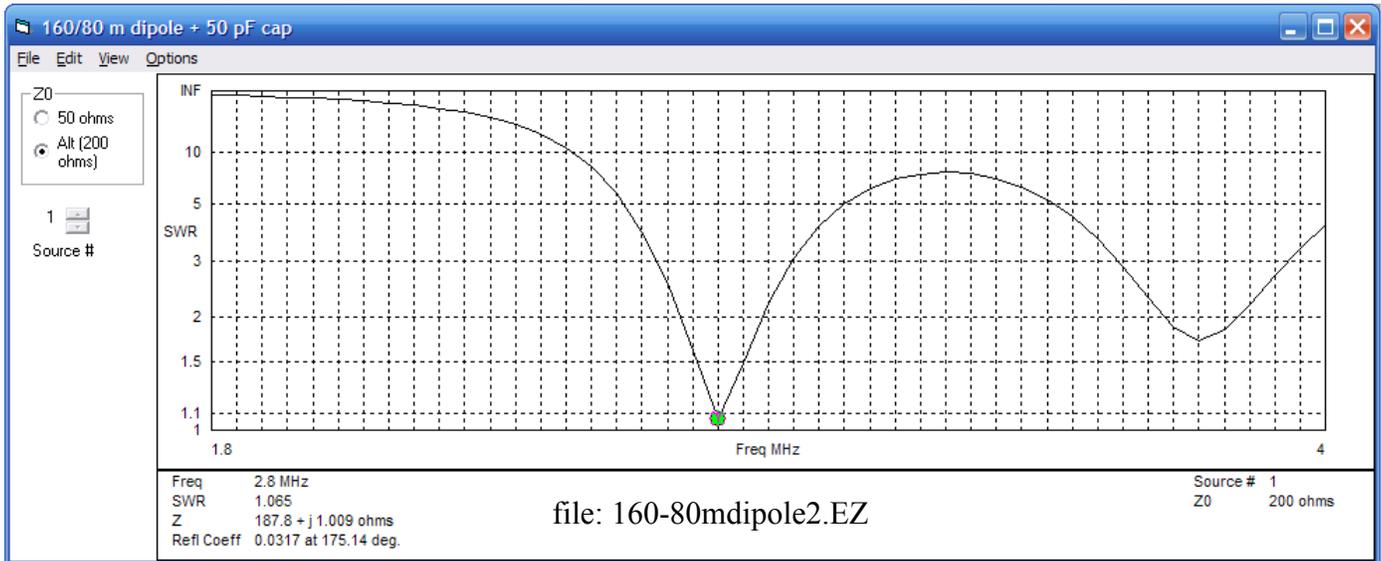


The above antenna works nicely but is not broad enough on 80 m. Going back to the original antenna running along my back property line, I put a 200 pF series capacitor in the middle of the antenna.

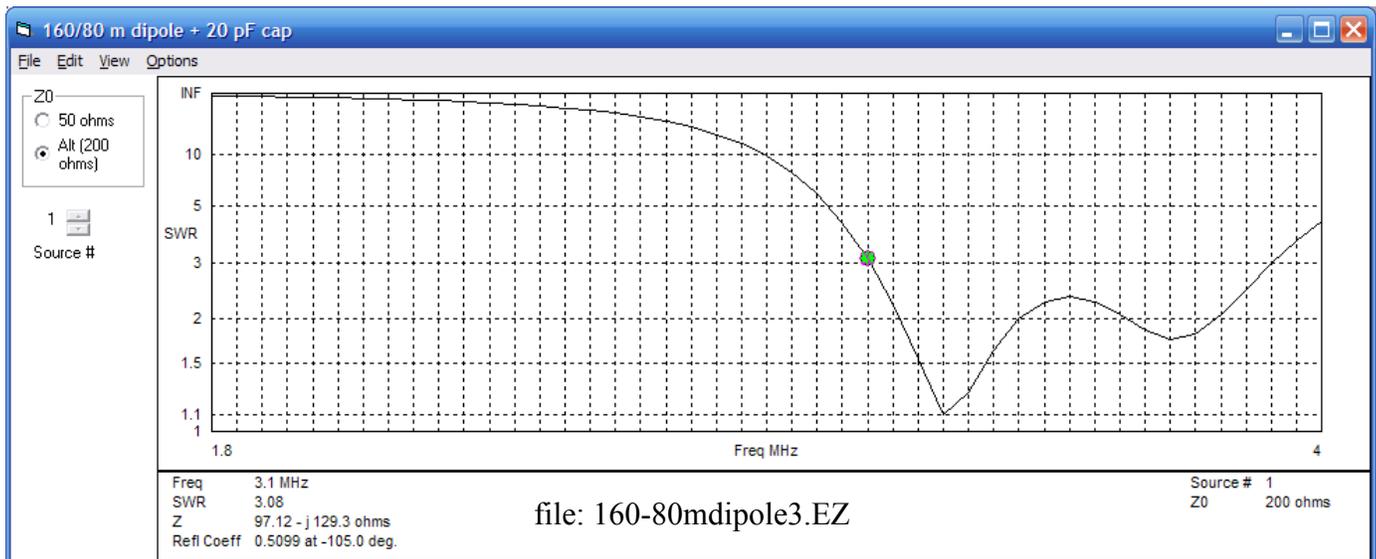


This causes the 160 meter resonance to become higher while having little effect on the 80 meter resonance. Can we keep decreasing the center capacitance and bring the resonance within the 80 meter band?

Setting the capacitor to 50 pF shifts the lower frequency higher.

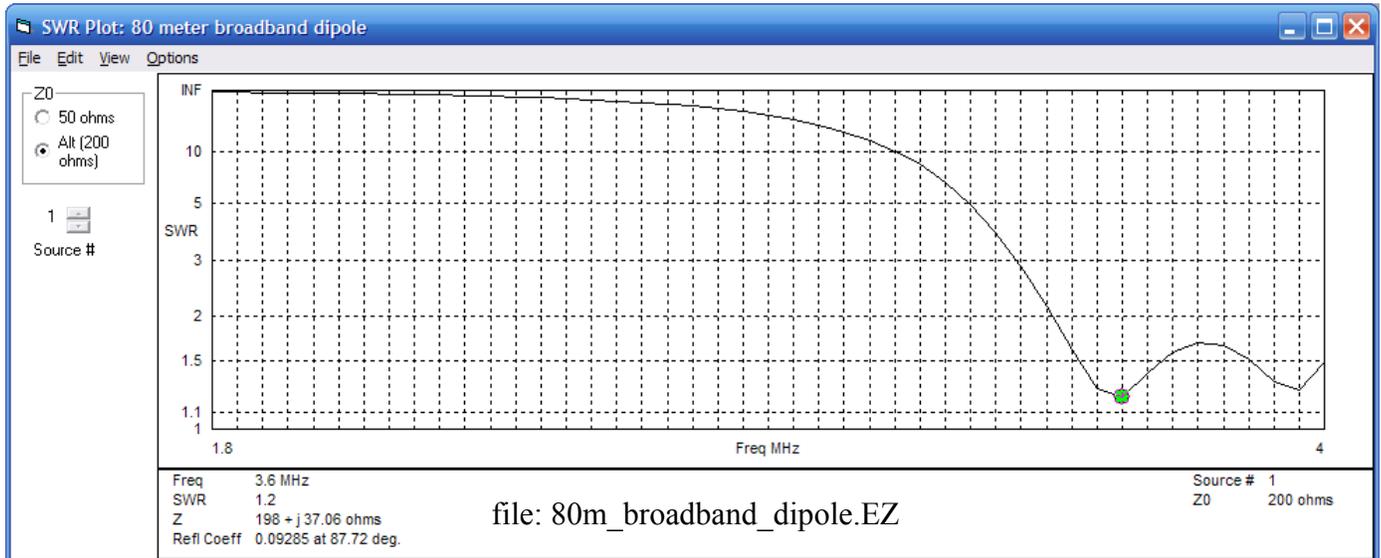


Setting the series capacitor to 20 pF shifts the lower frequency even higher – within the range of 80 meters.

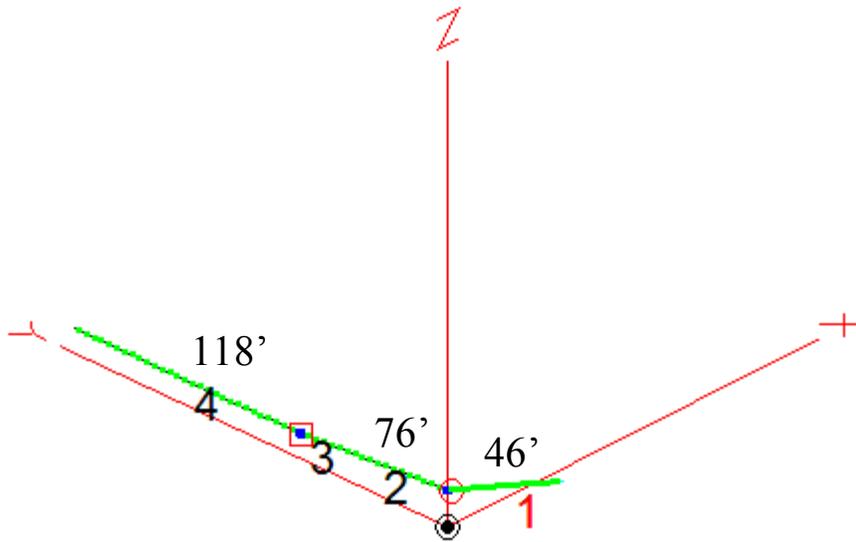


And now we have an antenna that tunes from 3.1 to 3.9 MHz with less than 3:1 SWR. The next page shows this antenna after the element lengths are shortened and the capacitor adjusted so the SWR is ideal for full coverage of the 80 meter band.

The SWR plot for an 80 meter broadband dipole is shown below.



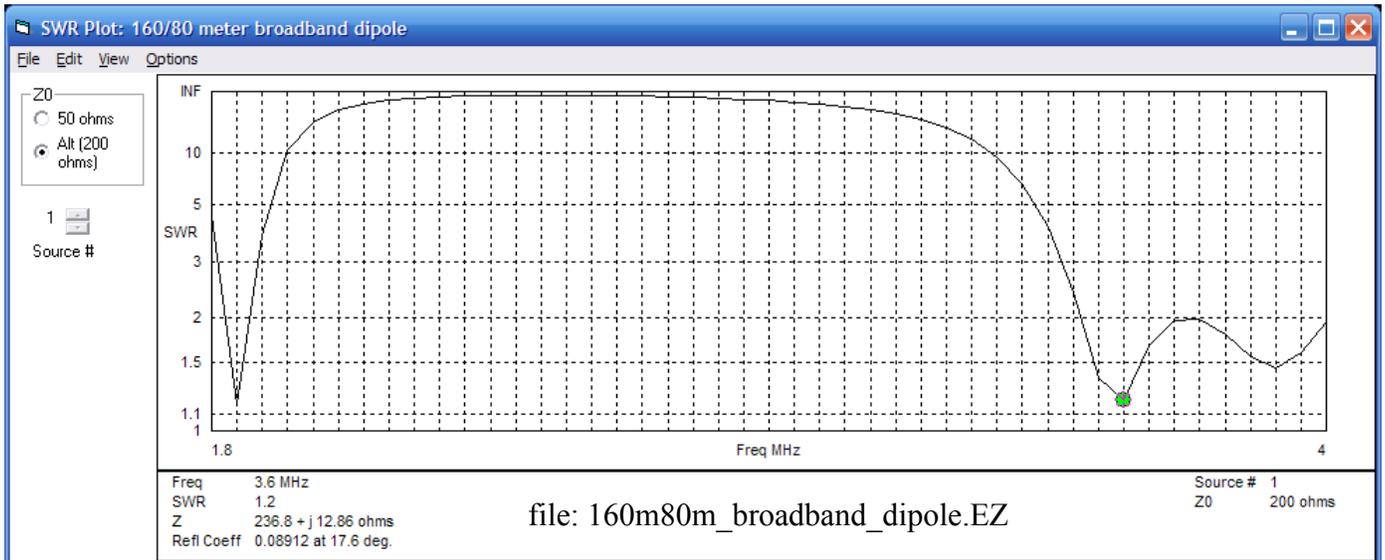
For the antenna layout below, the center capacitor is 15 pF at element 3 between elements 2 and 4 and a 4:1 balun feeds the antenna between elements 1 and 2.



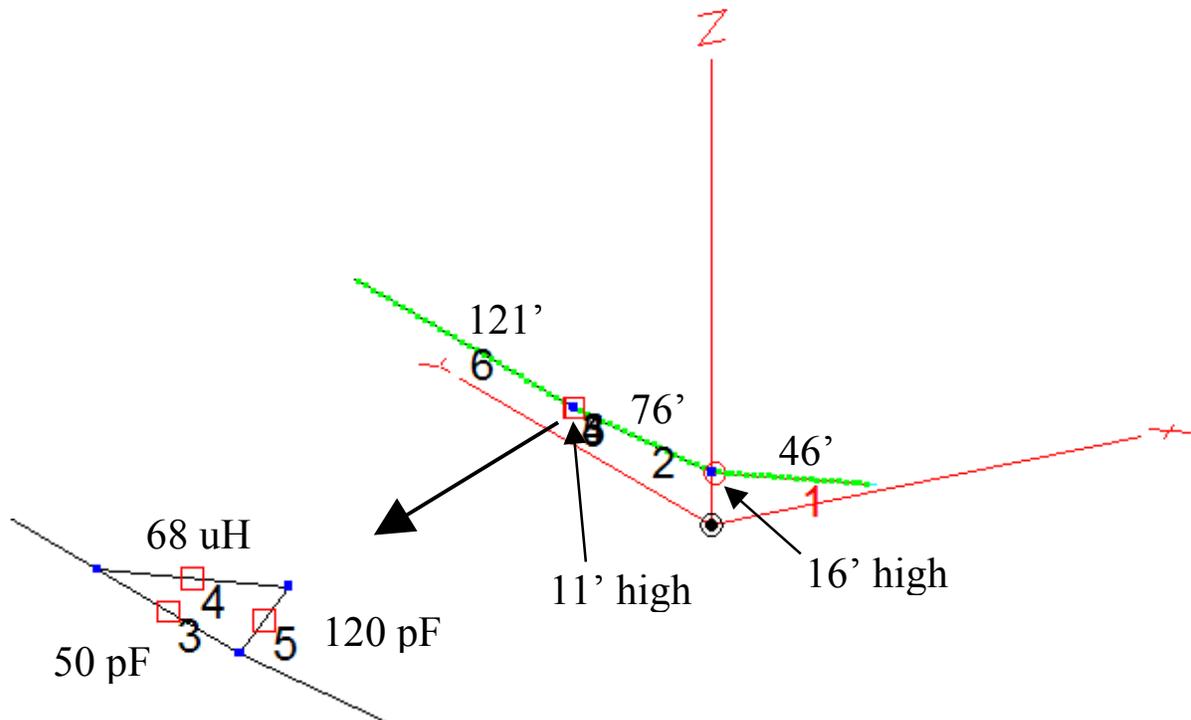
The SWR is less than 1.7 to 1 across the entire 80 meter band.

How do we get back the 160 meter resonance? By placing a series L and C across the 15 pF capacitor. When we do this, we must retune the elements slightly since they interact a little.

Below is the SWR plot for the initial 'retuned' antenna that uses a series L-C to get back the resonance on 160 meters.

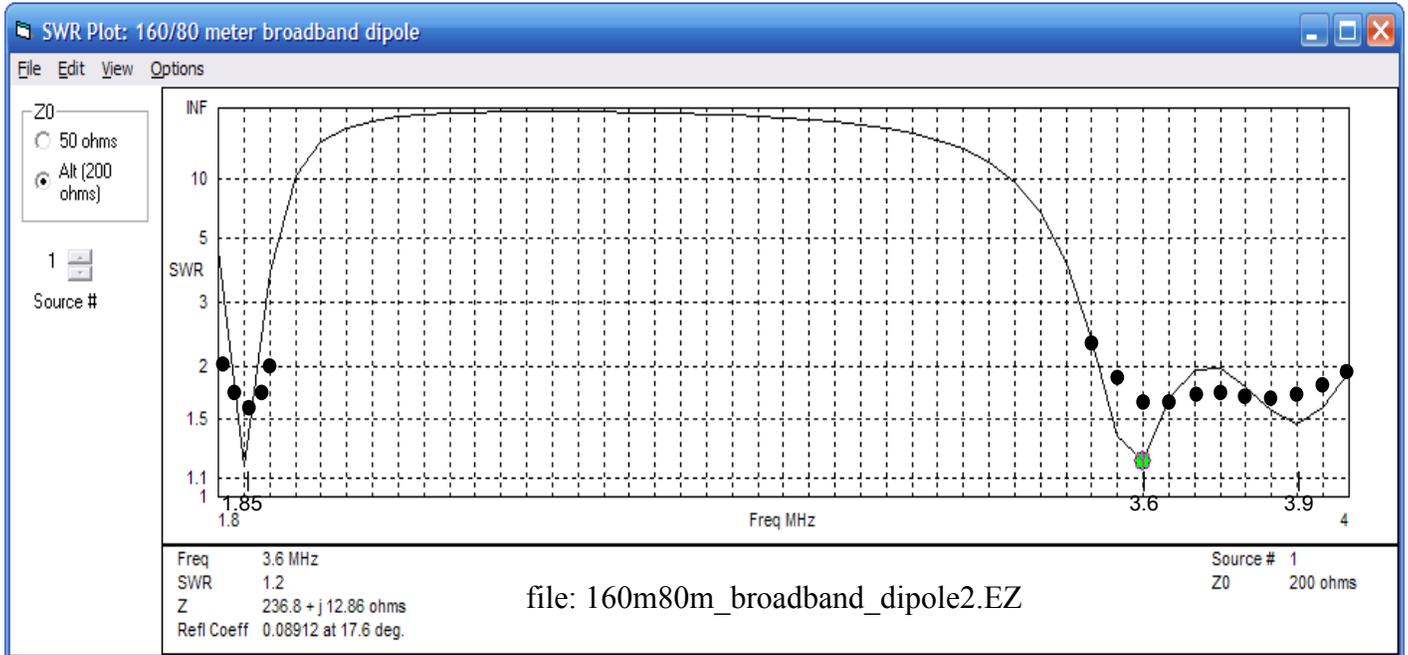


And here are the elements for the antenna for the above SWR plot.

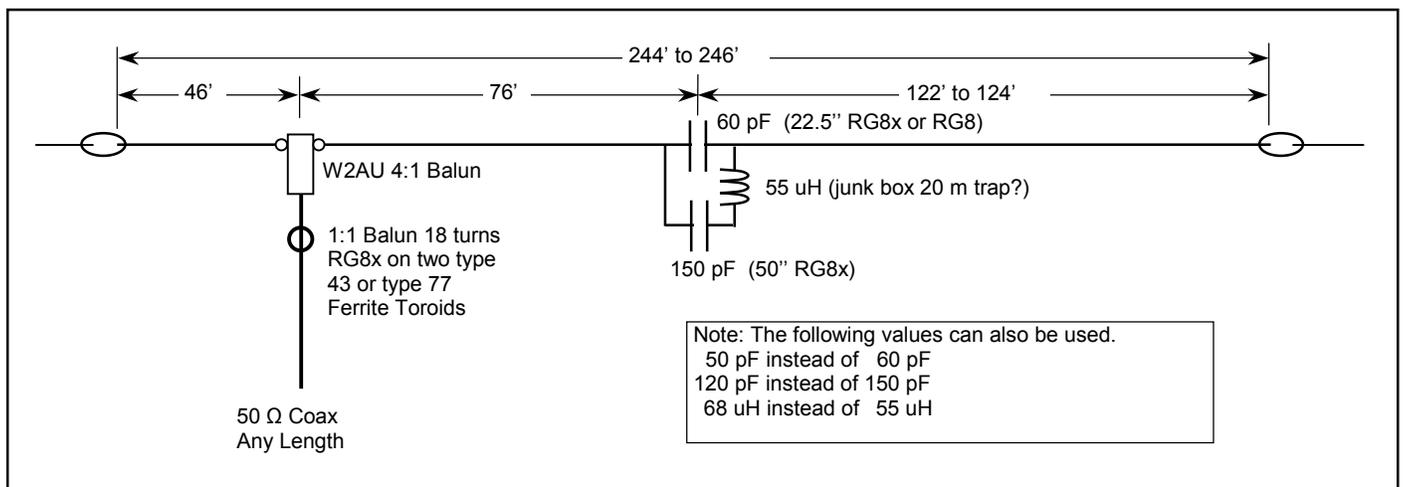


I did not have enough wire in my junk box to create a 68 uH coil. I used the MFJ 259 b meter to check inductances and found a coil in my junk box that had 55 uH inductance (shown in later slides).

I redesigned the antenna around the 55 uH inductance and obtained a nearly identical SWR plot. The antenna was constructed and the actual SWRs were measured on an ICOM 756 Pro3 rig as shown below by the black dots. It almost worked as good as EZNEC said it would – hi.



The detailed layout of the finalized 160/80 m broadband antenna is shown below:



Now I need to talk about some problems that were encountered and how they were fixed.

The first problem encountered was that no resonance was observed on 160 meters. I suspected the W2AU 4:1 balun did not have enough shunt inductance on 160 meters, so I added another 1:1 balun in series with the W2AU balun. This fixed the problem. The two baluns are shown in the photo below.



The 1:1 balun is 18 turns of RG8x on two 2.4 inch ferrite cores, type 43 or 77 material.

The second problem was that the 22.5 inches of RG8x coax arced internally when I was running high power on the lower end of 80 meters. I tried 22.5 inches of RG8 and so far it has worked. The photo below shows the 55 uH inductor and the two capacitors when they were both RG8x and before the ends were gunked up.



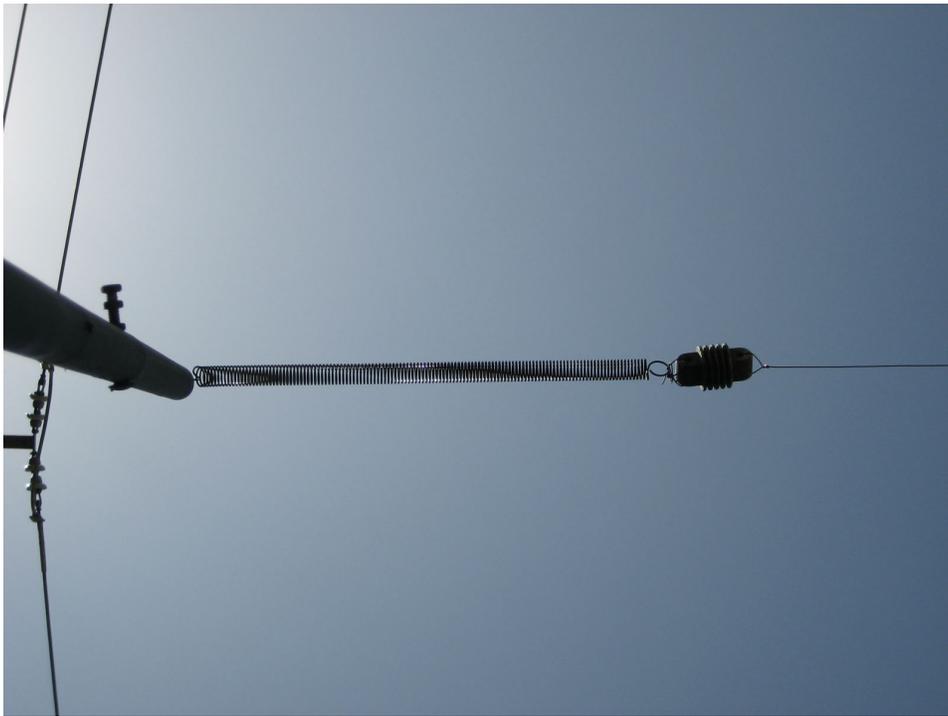
The ends of the coax capacitors need to have good voltage handling capability and be covered with rubber or silicone grease.



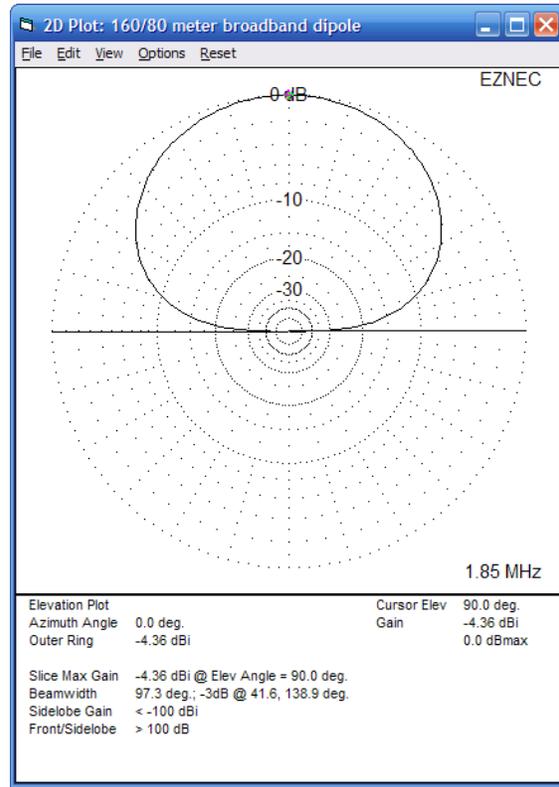
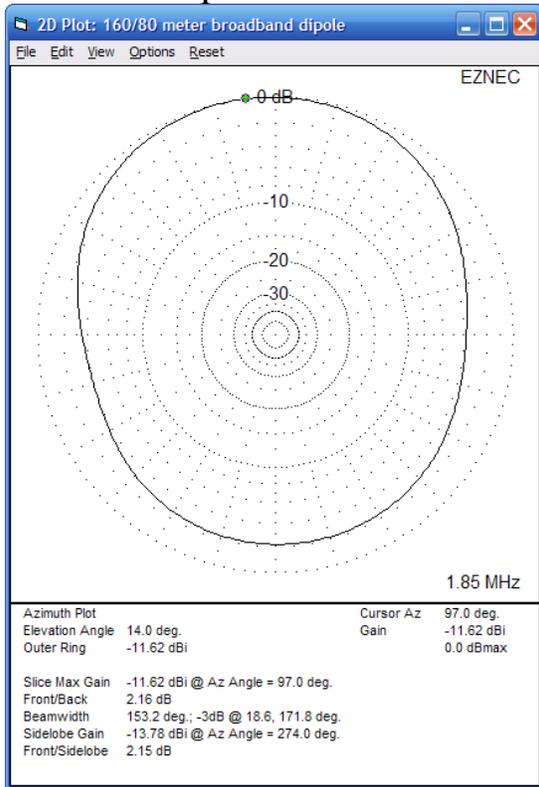
Here is the 55 μH inductor and coax capacitors “supported” with $\sim 13'$ of plastic pipe sprayed camouflage green to help hide it.



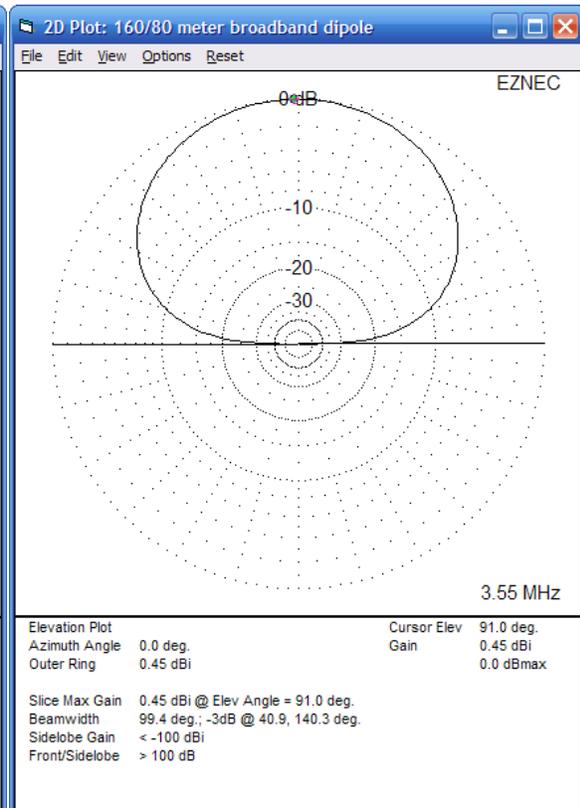
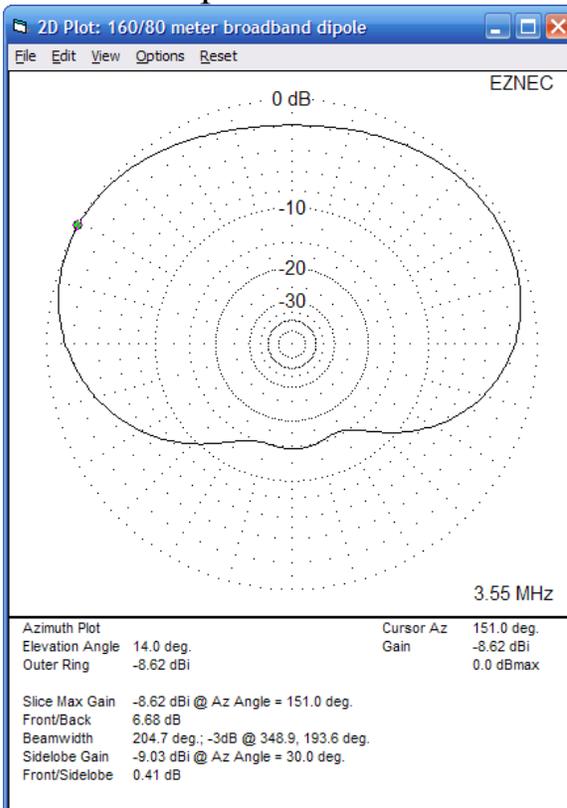
Use springs at the ends to allow movement of the tree in the wind.



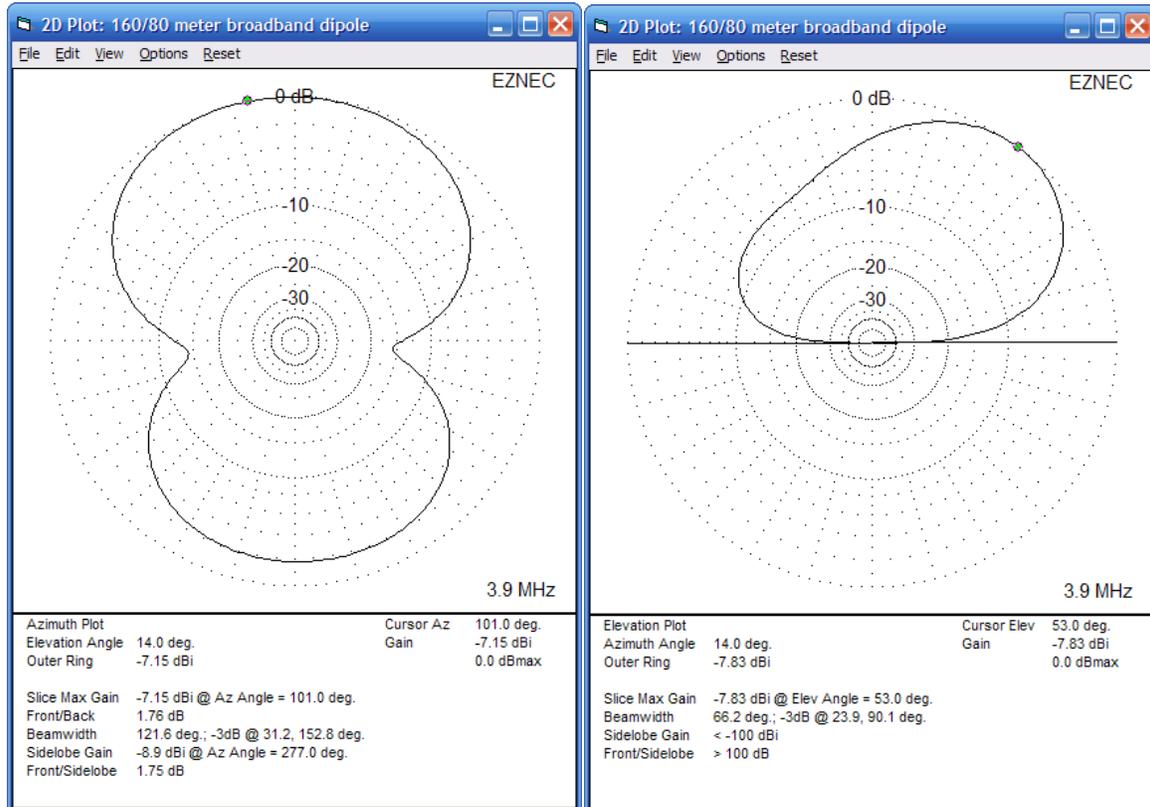
Here is the pattern of the 160/80 meter broadband dipole on 160 meters:



Here is the pattern of the 160/80 meter antenna on 3.55 MHz:



Here is the pattern of the 160/80 meter antenna on 3.90 MHz:



This antenna is tuned by the following procedure:

- 1) Put up the entire length of wire and the 4:1 balun and resonate it to the upper end of 80 meters by lengthening or shortening it.
- 2) Check to see that a good SWR can be obtained in or near 160 m.
- 3) Build the LC components with the RG8 and RG8x sections of coax cut a little longer than needed, since they will be trimmed.
- 4) Place these LC elements a few feet farther out than the mid point to improve the SWR on the upper end of 80 meters.
- 5) Trim both capacitors at the same time to the desired frequencies.

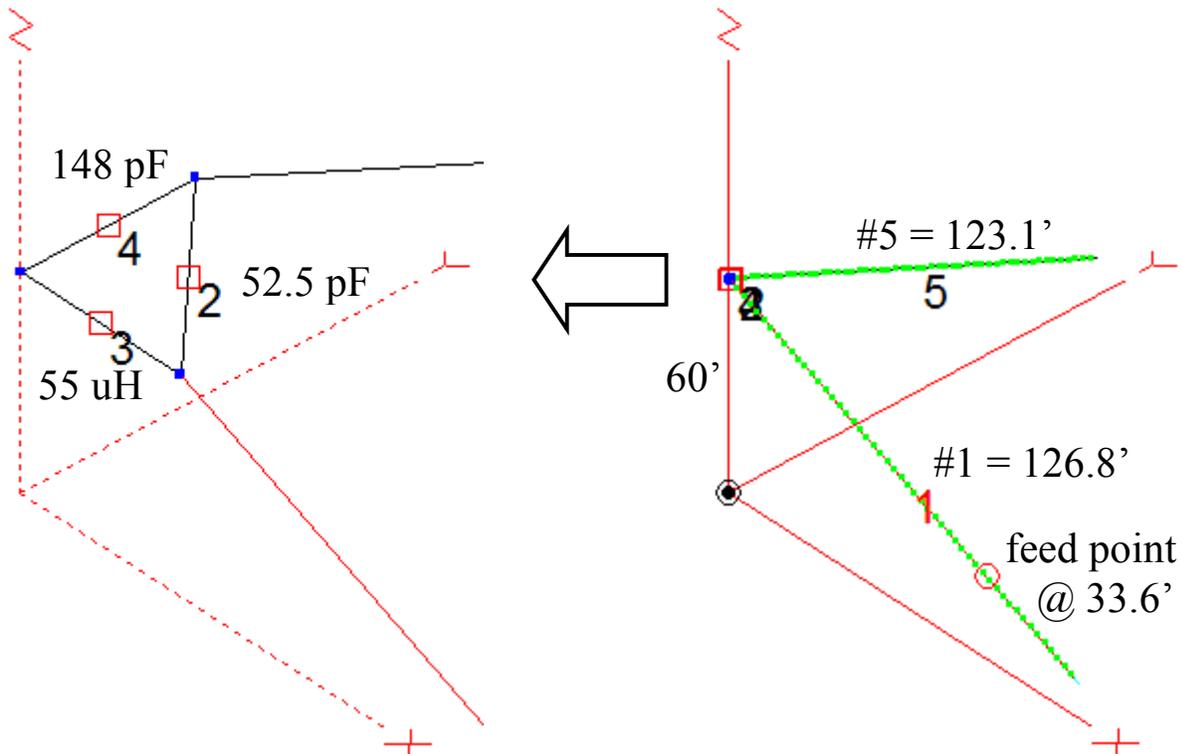
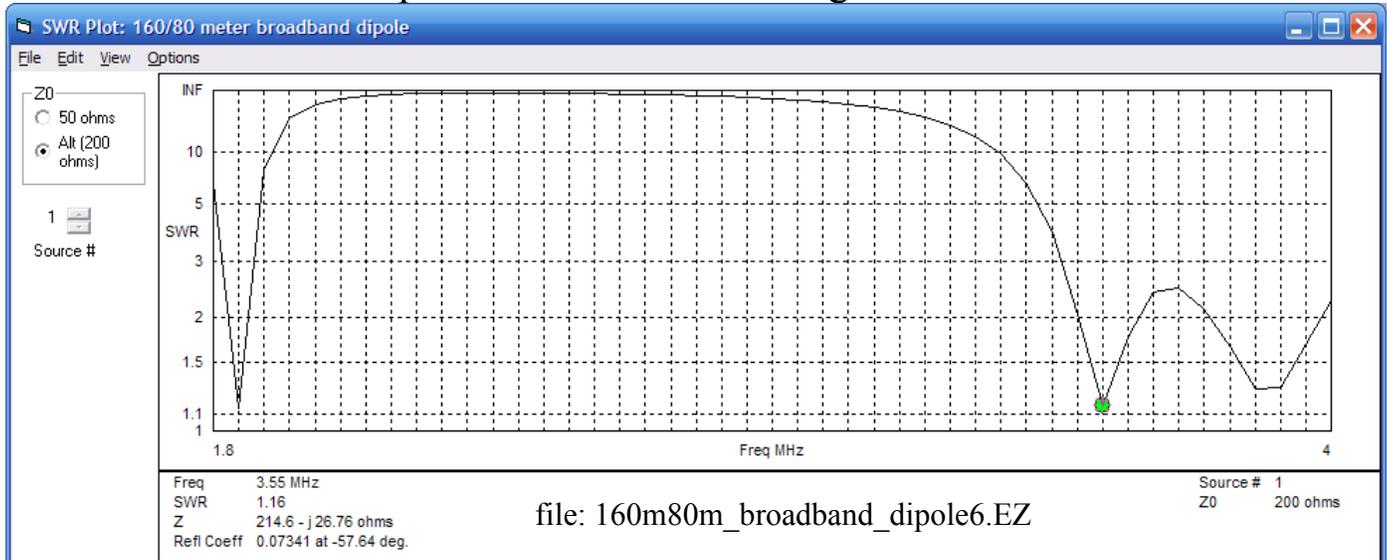
This antenna is very quiet on 80 meters during the daytime. During the hurricane net operation on 3873 kHz in the middle of the morning before hurricane Ike hit Galveston, I was able to relay in several stations the net control station in College Station was not hearing. The NCS said “I wish I had your antenna”.

Several different configurations are possible.

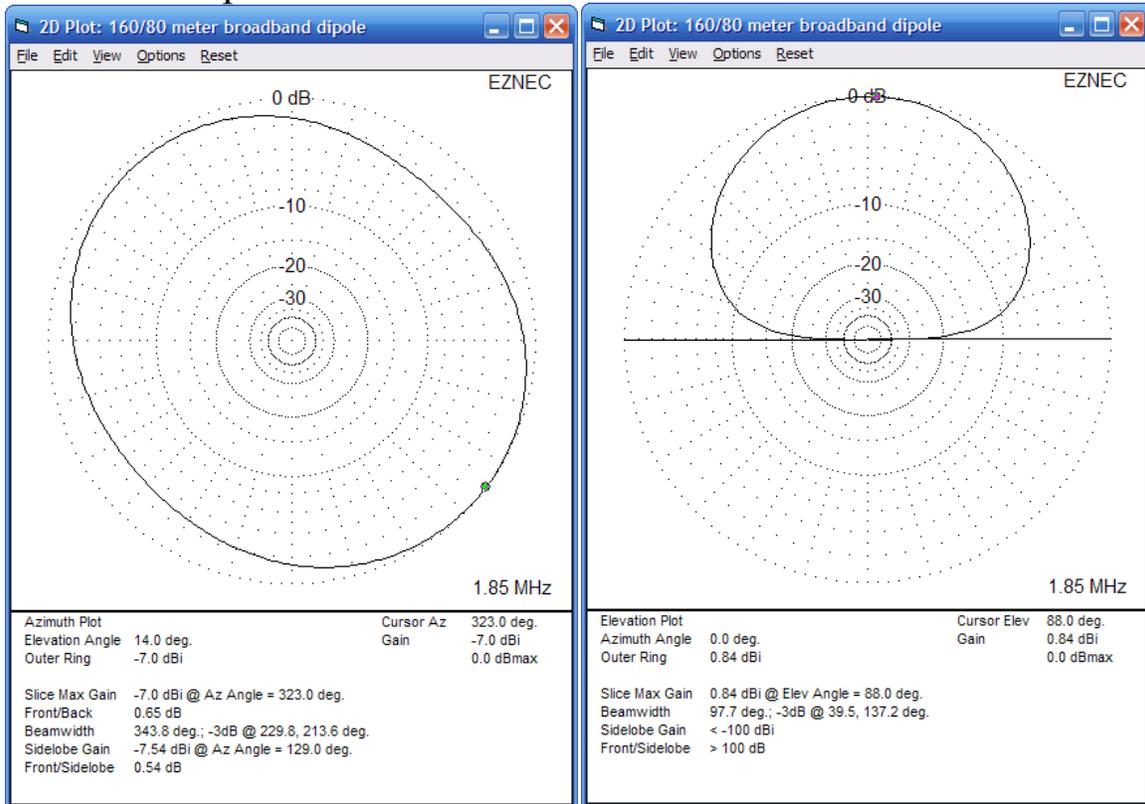
Because...

- the three frequencies are independently tunable
- the feedpoint location and feedpoint impedance are adjustable
- the 160 m feedpoint impedance can be lowered by using a corner

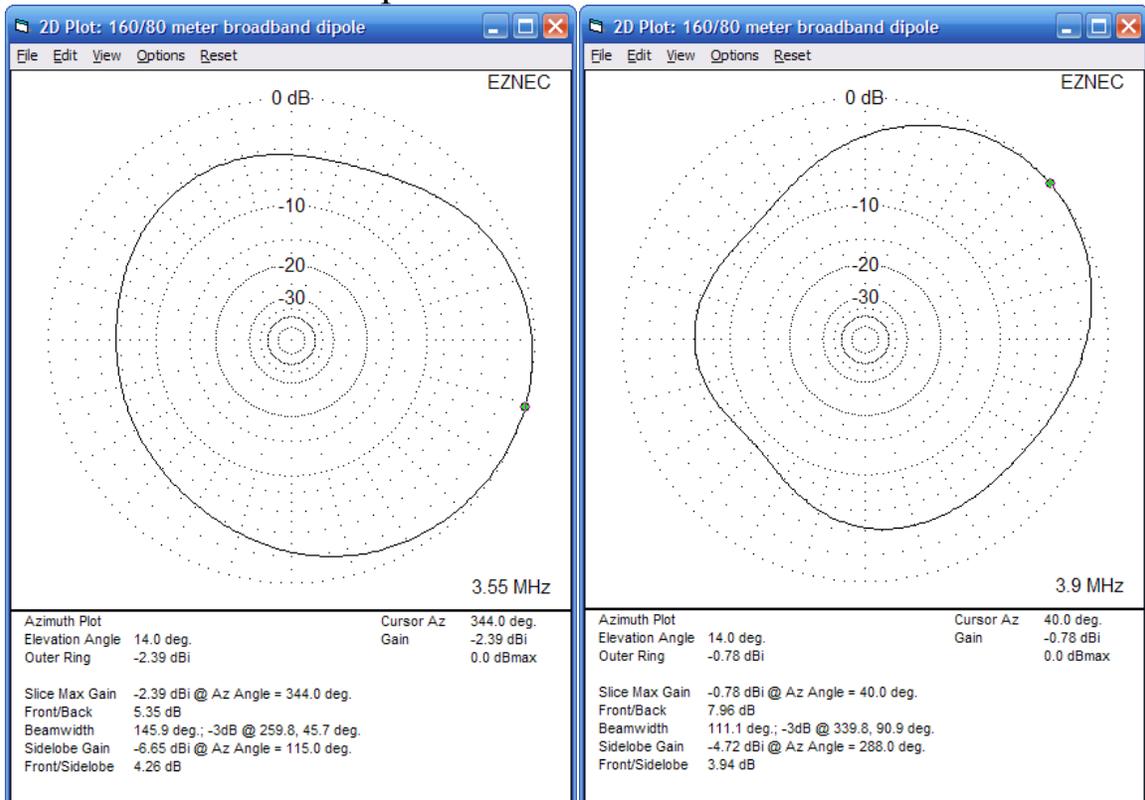
Here is an example of an installation using a 60' tower.



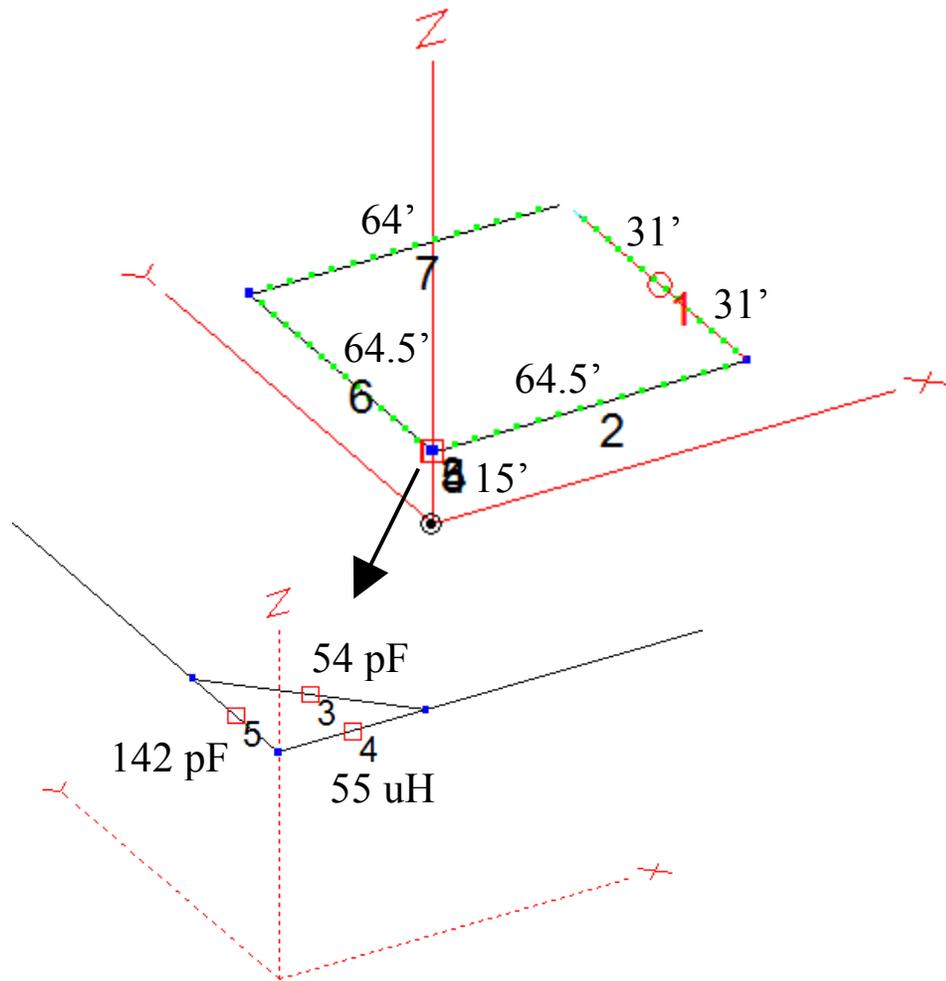
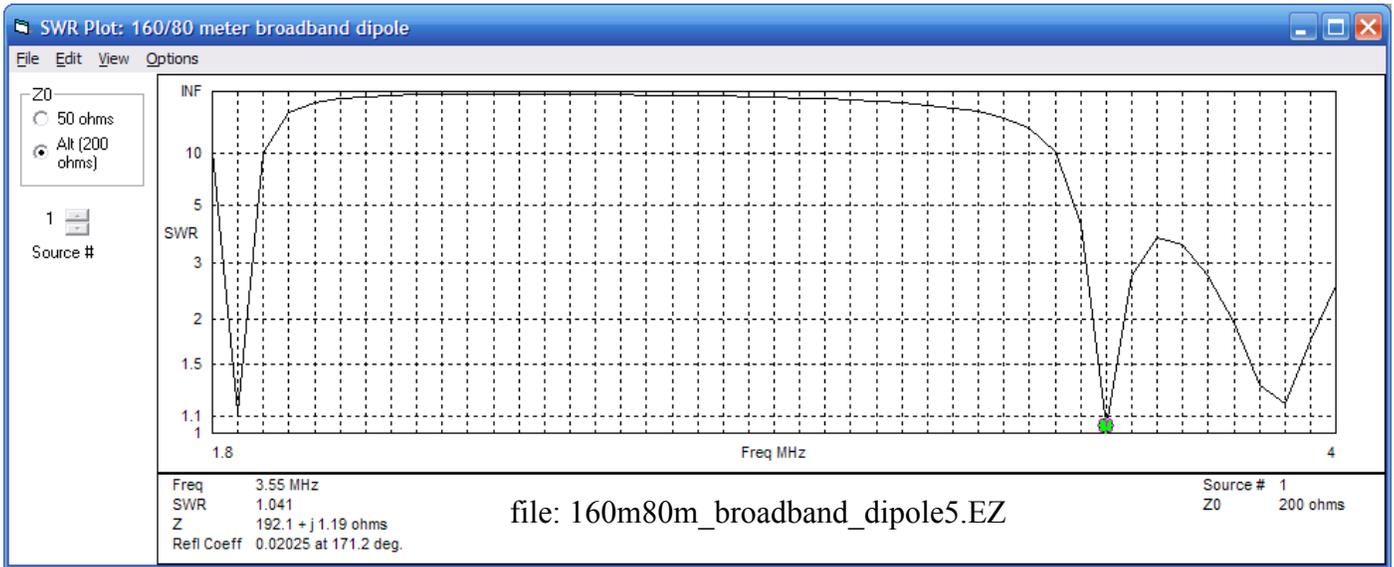
Here are the patterns of this antenna on 160 meters:



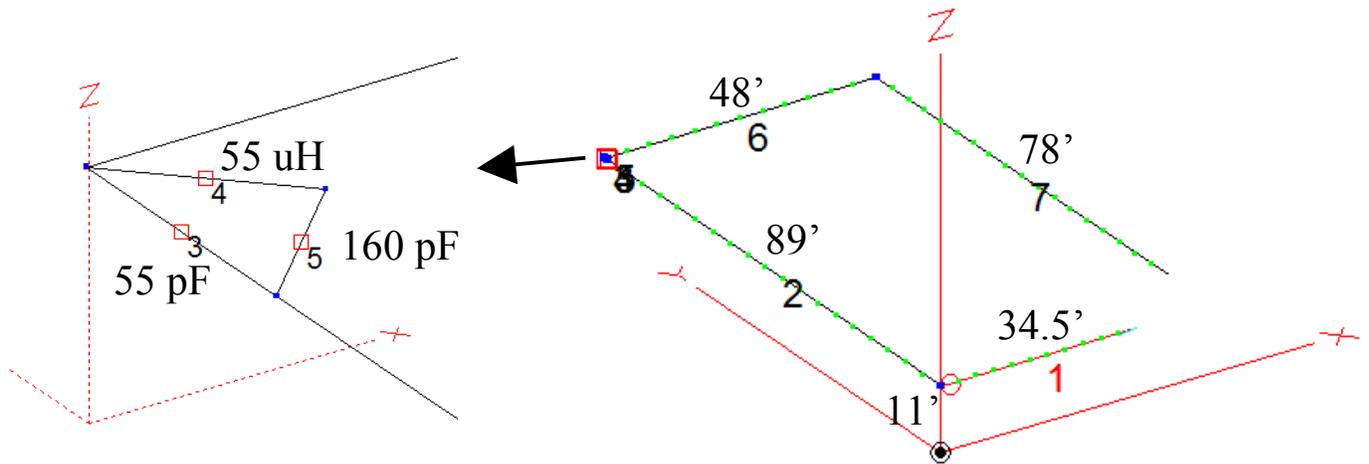
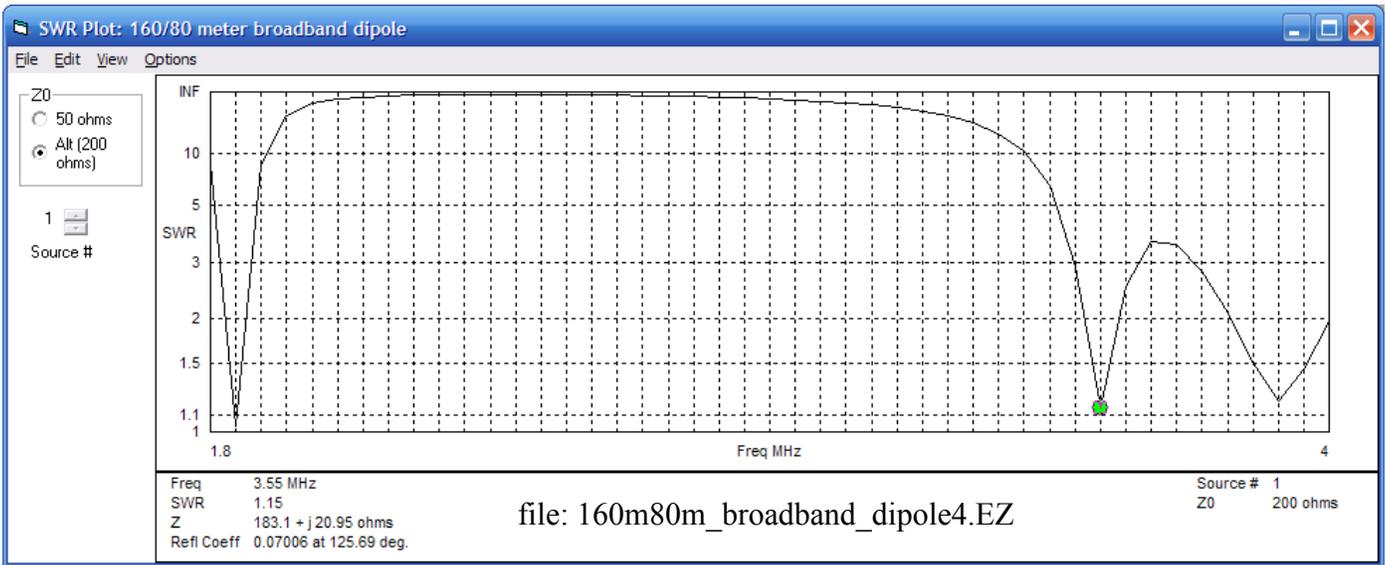
Here are the Azimuth plots of this antenna on 3.55 and 3.90 MHz:



Here is a compact square loop 65' on a side configuration.



The loop can be made rectangular to fit a narrower and longer lot.

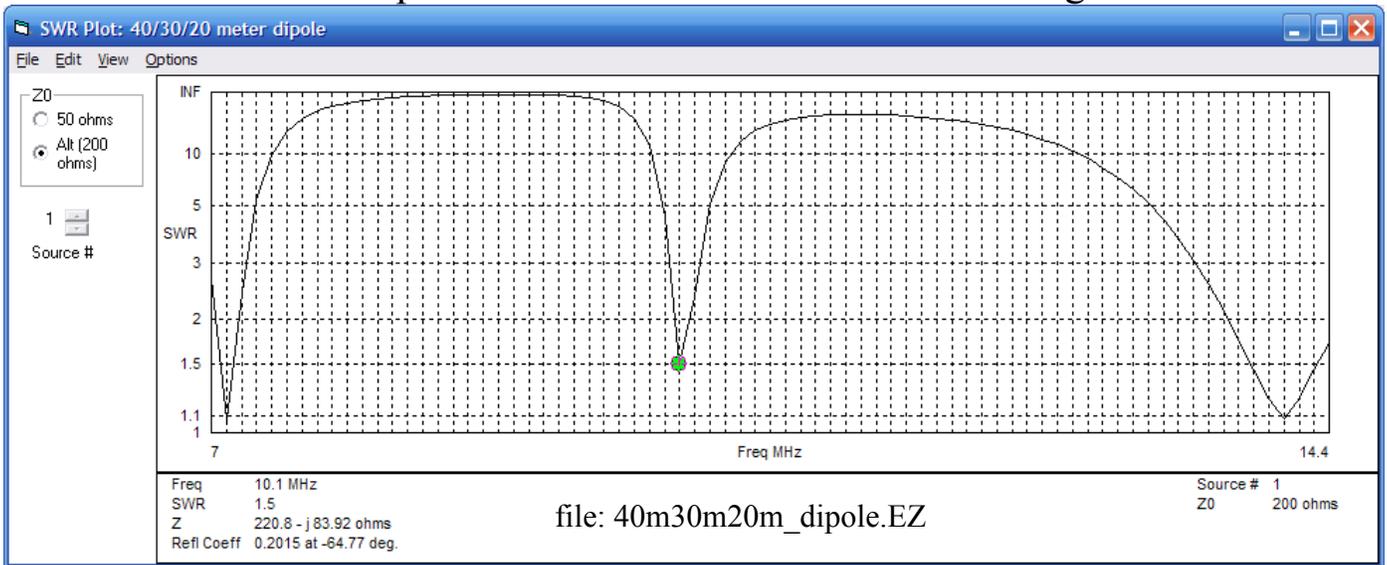


The more compact we make the antenna, the sharper is the tuning.

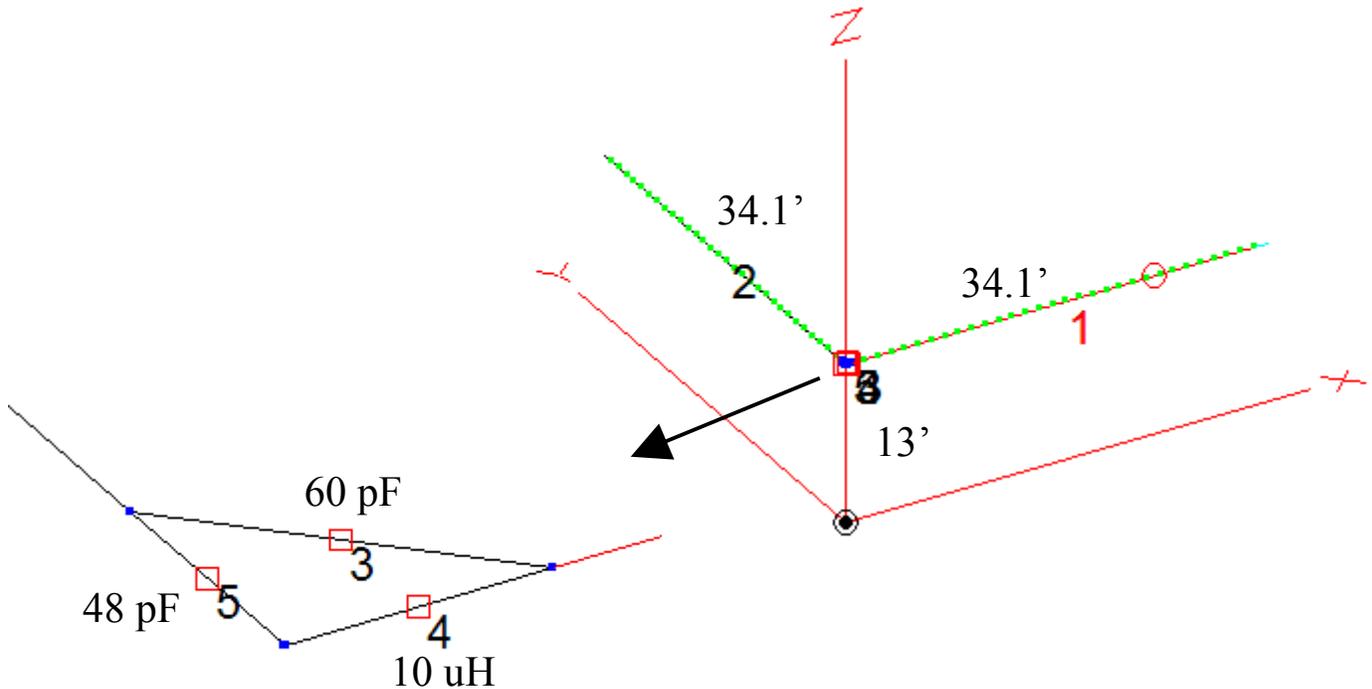
Recommended steps to tune this antenna design:

- 1) Put up the antenna with no L or C and resonate to 3.9 MHz
- 2) You should also get a good SWR indication in or near 160 m
- 3) Install the L and C elements and trim both caps up to frequency

Other bands are possible. Here is a 40/30/20 meter design:



Resonant frequencies are at 7.1, 10.1, and 14.1 MHz. The feed point is 9.35 feet off the end.



Another paper is posted at:

http://egpreston.com/K5GP_broadband_80_meter_antenna.pdf