A Relatively Simple160/80 No Tune/No Switch Dual CW Band Trap Antenna Using the Spiderbeam Mast

This project originated with my request to the Contesting Top Band forum for thoughts on a transportable and easily installed antenna for 160 that might be used for DXpeditions or made available to hams in 160-rare locations. From suggestions, plus personal preferences, I arrived at a Spiderbeam 60' fiberglass mast based vertical/L/T style enhanced with 80 m capability using a trap. Much EZNEC study ensued.

The trap is a coax type in the Low-Z mode (no effective inductance increase with a second current path through the coiled coax braid) that is resonant near 80 m at ~ 3.4 MHz.. The Low-Z choice was made because the required sloping top loading wires (2 used to kill off those useless signals going straight up) have a length that is not huge but does allow adjustment of lengths from the ground. Also the trap inductive impedance at 160 m would be so big that the L or top sections of the load wire(s) is shockingly short suggesting worse efficiency.

The radial "field" consists of 2 elevated radials in opposite directions in gull wing configuration. With some planning, it is possible to provide one elevated support for each of the radials nearer the mast for free using 2 of the guy ropes that also hold up the mast.

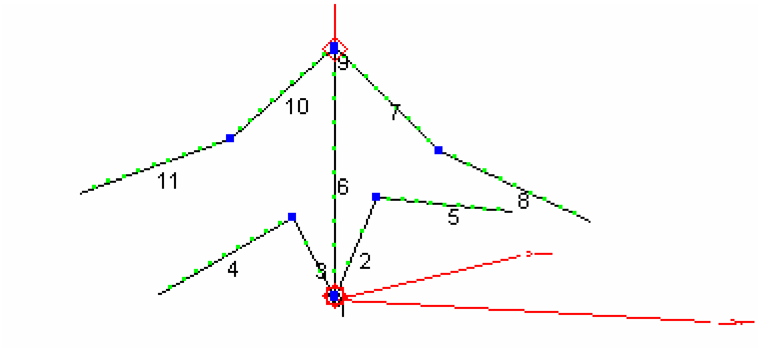
So the scheme is to first tune the antenna to 80 m by adjusting the length of the radials and then adjust the 2 top loading wire lengths together to tune for 160 since the top wires do not affect the 80 m adjustment due to trap.

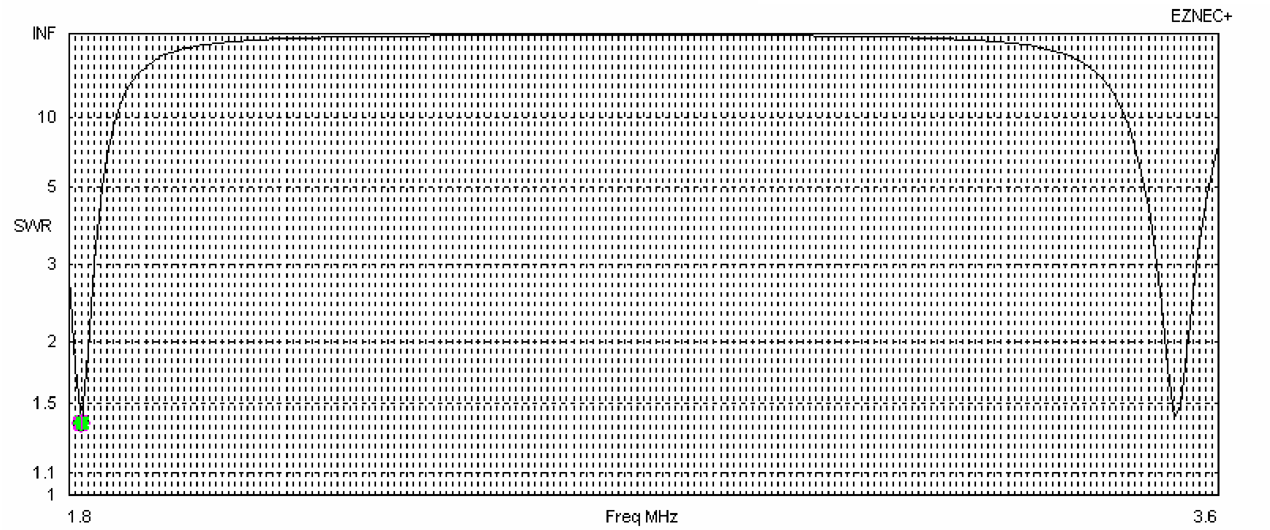
After considerable EZNEC experimentation, plus selection of trap coax of RG-58, and the usual acceptance of the notion that the 160 m antenna will be rather short with a rather low radiation resistance and narrow bandwidth, a nominal set of dimensions was arrived at that could allow for resonance (reactance X=0) in both bands. Surprisingly the final measured raw 80 m and 160 m unmatched impedances, in contradiction to EZNEC expectations, both turn out to be ~ 20 ohms (rather than the ~10 and ~40 ohms from EZNEC) at resonances1.88 and 3.54 MHz, says the MFJ, at the antenna. Of course 20 ohms at 160 m is probably rather high likely due to higher ground losses than the model.

The plan was to match the 160 m band using a "hairpin" match – that is an inductance shunted across the input. This is simple, requires no high V/I capacitor, but suffers from the need to pretty carefully tune the length of the top wires (shorten from resonance) in order to get the needed mildly capacitive reactance in the unmatched antenna.

Runs of EZNEC including the trap and hairpin match suggested the seemingly miraculous possibility that a single value of the hairpin coil would work (fairly well) for both bands leading to no required coil changes or other switches for a band change. Perhaps not so miraculous when you realize that 80 m shouldn't really need a coil and the impedance of the coil is doubled on 80 where no coil is effectively just a large reactance.

Here is an EZNEC model (my NONAKI160_2elradTestv2_80convTrap160better4half2TcutHt.EZ) illustrating the general geometry and a SWR intriguing possibility when a hairpin matching inductance is included.





Still much past work with EZNEC results being translated into real antennas has taught that the model is just a general guide (especially for wires near the ground) yet it is very useful when predicting the changes in impedance from small changes in lengths. Pruning, aided by the ever popular MJF, will be necessary and nothing is guaranteed.

Armed with this information, all pre-trimmed wires were cut long, the trap was placed on the top segment of the mast and the mast telescoped up to full height with the recommended two sets of guys (dacron rope).

Problem #1 arose. The trap, mounted on a small aluminum tube, weighs just 6 oz. But after playing with different guying heights, and even 3 sets of guys, it was determined that the trap is just too heavy to be placed at the top since much bending of the upper sections of the mast results. Back to EZNEC to see what is possible if the trap is placed at the next to top mast segment (which tapers to 1/6"), about 5' lower. Modest length reduction appears to be possible to allow this use. So the trap was remounted at the ~ 55' level but with the top mast segment still in place – now virtually no worrisome bending (from gravity alone) with the 2 sets of guys!

Step one is then to tune for 80 m use by adjusting the radial lengths, using EZNEC as a guide and checking with the MFJ. This works great and a decent impedance match appears with no additional components. Daylight was running out so the 160 m was left for the next day but leaving an operational 80 m antenna. This was tested on the air vs. DX in the evening with good results with 500 watts.

Next it is time for the 160 m tuning. For this, only the top load wire lengths are available for adjustment (with no effect on 80 m) since the radial lengths have already been established. After the adjustment a raw impedance ~ 20 can be found in the frequency range of interest.

Then we add the hairpin matching coil and adjust the tap and top wire lengths to get a decent SWR as seen by the MFJ at the antenna input – and the bonus of a still decent match to 80 m is also realized. Life is good.

Now Problem #2. So now the feed coax is connected and it is back to shack to verify the impedance at the far end of the cable for on air testing. 80 m is fairly good but the SWR (and impedance) for 160 m bears no relation to that seen at the antenna- no resonance even remotely close to 1.8 MHz is found This is not good.

The muddled initial response was to investigate the integrity of the MFJ and cables (all okay) but which led to the information that the longer the cable, the worse the SWR difference from the antenna. So finally it dawns on the beleaguered experimenter that there may be high levels of common mode currents (on the outside of the feed coax braid) since no balun or choke is being used. After a well deserved forehead slap it becomes obvious that this 160 m antenna is really a seriously off center fed (OCF) device and these are famous for needing a good choke.

All available spare cable was then coiled up (25' of premium Radio Shack RG-58 and 50' of RG-8) near the antenna input and the in-shack test repeated. Eureka! Still it is not perfect and there is a modest but inconvenient frequency offset in the SWR minimum at the ends of the cable run. This offset is enough that you need to adjust the lengths and the coil tap while looking at the SWR in the shack, which is a bit of a pain although the changes are fairly predictable. (A better choke may avoid this.)

After some minor further adjustments the antenna went final. Probably additional improvements in match are possible but this ceased to be fun or required. The antenna has now been tested on the air both with real DX and using the RBN (comparing with old antenna results). It seems to be pretty good on both bands but probably short of performance of my prior 160 antenna which was similar with about the same height but with an aluminum mast and three sloping top load wires and longer radials (but no trap). In a few days on 160, 3D2R, ZL, HC, CO, RI1A, 6Y, FM, and P4 have been worked. During the ARRL CW DX test of 2013 21 countries were worked on 160 with a fairly focused effort while 30 countries were worked on 80 with rather limited effort.

The final details of the antenna are trap with C~260pF and L~8uH using 107" of RG-58 in a ~4.75" diameter coil of ~7 turns. Note again that this is the Low-Z connection of a coaxial trap. The "coil form" consists of 4 pairs of flat plastic pieces held with cable ties. The use of the aluminum rod, cleverly selected to fit over the smallest segment of the fiberglass mast was actually not used for that purpose but it does provide a connection point for the top wires for which solid #18 copperclad steel was used. This choice of wire was based on economy, strength, weight and lack of insulation for fold-back tuning. The trap can be seen near the top of the mast in the second photo.

The final dimensions (which aside from the vertical part are about 5% short EZNEC predictions) are: Vertical wire, ~55', top loading wires (sloping down at ~ 45 degrees) ~60', radials ~ 75' total sloping up from the base at ~ 45 degrees to ~ 17' to the first support and then nearly horizontal for the rest out to the second support. The hairpin coil is tapped at about 6 turns with ~ ½" spacing on a 4" diameter light weight form giving ~ 3 uH inductance. In the YMMV category, at the antenna with matching in its final configuration (coil tap optimized for 160) there is a minimum SWR of 2 at 3.53 MHz and SWR of 1.8 at 1.86 MHz - while in the shack (where the final tuning was done) it is SWR of 1.6 at 3.53 MHz and SWR of 1.0 at 1.83 MHz with a SWR<2 BW of +/- 20 kHz. Note that the apparent residual common mode current frequency offset (antenna vs. shack) is still quite noticeable for 160 so if you were to put in a good choke, retuning would be necessary.

Note that the “beverage” coil form could also serve as a rain gauge unless drain holes are used. The less that elegant temporary 2 element choke is shown below.

Finally you will note that the smallest and top segment of the fiberglass mast was left on although it is not used. There was a modest structural reason but it also avoids having the mast used as a prey-observation platform.

A note on the use of the Spiderbeam 60’ mast: If the sole use of the upper segment of the mast is to support a vertical wire that runs down the rest of the mast, that may be okay. However if you want to support wires, especially wires other than the lowest weight, that angle off the mast, be prepared for significant bending. As a practical matter, for many applications, the upper segment is probably of minimal value and the mast could better be described as 55’. Under this 55’ use, the recommended two guy collars seem to be adequate for support. All the work described here was carried out by one person for telescoping the mast. However, in this case the bottom segment of the mast was strapped to a fairly strong 2”X6” board in concrete making the task fairly easy. No attempt was made to first extend the mast on the ground and the walk it up. While I don’t doubt one person can walk it up, there is the ugly question of what next.