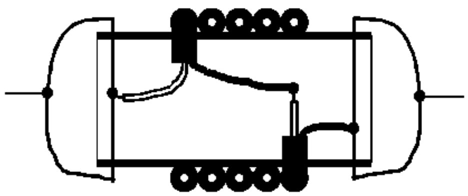
Trapped Verticals (and Radials) by Dennis Gregory-WU6X

I've been doing research on building traps for wire antennas for the past few months with the possibility of building a trapped "radial" for my old Hy-Gain 18-AVQ, 5-band HF trapped vertical (80, 40, 20, 15 and 10). The instructions for the vertical note that at least one (1) tuned radial for each band is a must. Multiple radials make this antenna a bit challenging to setup quickly, both due to the space requirement, insulated tie-down issues, and time required to setup the 5 to 10 radials if used portable (e.g. for Field Day).

If you think about it, a trapped vertical is a ¼ wave, or one-half of the typical ½ wave dipole, the tuned radials completeing the other half. So, the idea of using half of a trapped dipole as a single radial element for the vertical made perfect sense. I found several good "how-to" articles on trapped dipoles and other sites that calculate trap parameters. I finally settled on instructions by NU3E found at: http://degood.org/coaxtrap/.



What is a trap? In an antenna, a trap (sometimes called a choke) is a high-impedance element that effectively stops RF from going past the trap (at the resonant frequency) as you move from the feed point outward. For example, the first trap along the wire is tuned for 10m. So, when transmitting on 28.300 Mhz, all following traps and wire lengths are effectively "blocked" to RF going further down the wire. If the next trap is for 15m, then RF will pass through the 10m trap (not resonant on 15m) which now becomes part of the tuned length for 15m, and so on to the end of the wire. One of the benefits of using traps is they effectively "shorten" the overall length of the antenna; a great compromise for limited space and quick setup, like for Field Day.

For example, the custom tuned radial for 40 thru 10 described here is only 20 feet long. If you consider that a ½ wave dipole for 40m is about 65 feet, the traps trim about 15 feet off the full-size dipole. Adding 80m operation extends the 1/4 wave length to about 33 feet (or 66 feet for a full size ½ wave "trap" dipole). Considering an 80m dipole is typically approximately 126 feet, you can begin to see the size advantages.

Trap Construction: The traps are made from PVC couplings and RG-58/U coax and took me less than ½ hour each to build; three are required to work 4 bands, since the 40m band takes advantage of all the wire and traps leading up to the end insulator. Note: the 40m trap is only needed to work the 80m band. The "bridle wire" at the end of each trap is 12ga. solid copper. NU3E's diagram follows:

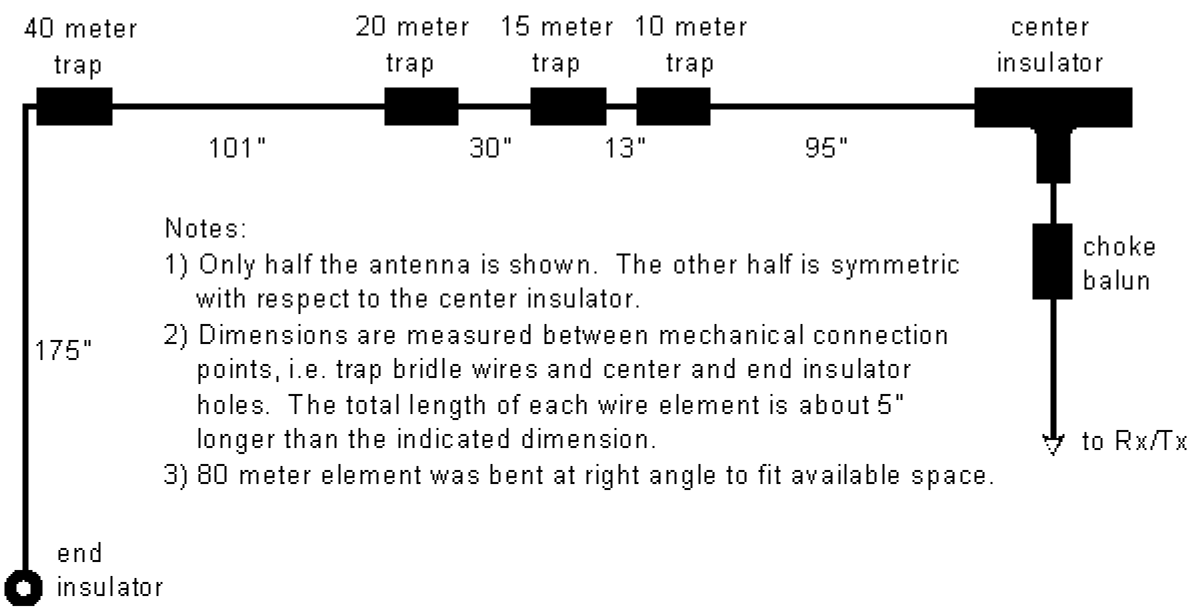
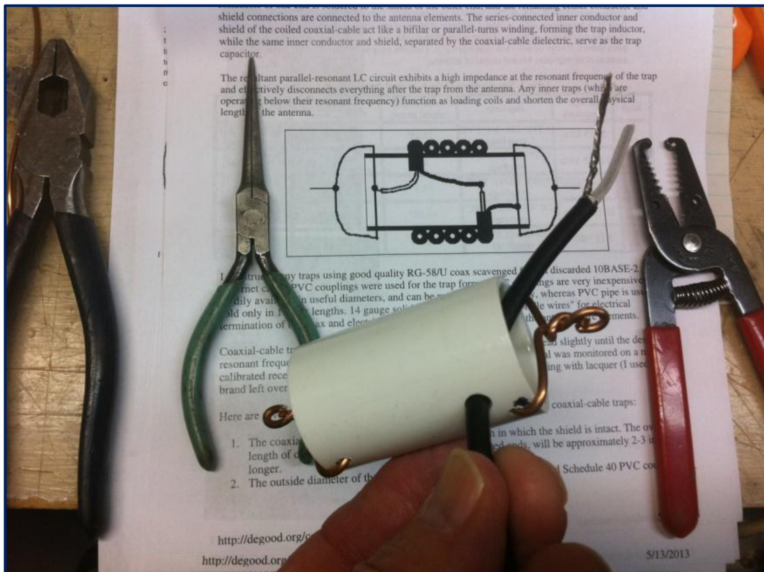


Figure 1 – Half a Dipole

High and Low "Z": Remember, that traps become a high impedance (Z) element *at their resonant frequency*, essentially acting as an insulator to effectively disconnect everything after the trap. At non-resonant frequencies, a trap presents a low-Z path to RF through the trap moving down the wire.

No 80m: Referring to the diagram, to remove 80 meters you simply omit the 40 meter trap and everything after it. This places the end insulator where the 40 meter trap should be, to get a 10/15/20/40 antenna (if constructing a full ½ wave dipole). The dimensions of the remainder of the antenna are unaffected except that the 40 meter segments might need lengthened due to removal of end loading provided by a 40 meter trap.

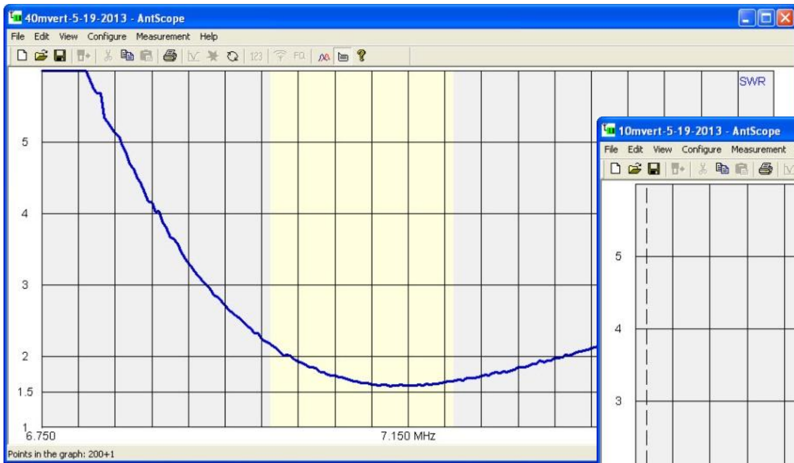


Here are a couple pix of the traps going together. Note that this trap construction technique limits power to 100w. There are other examples on the Internet that will take more power, up to 1kw.

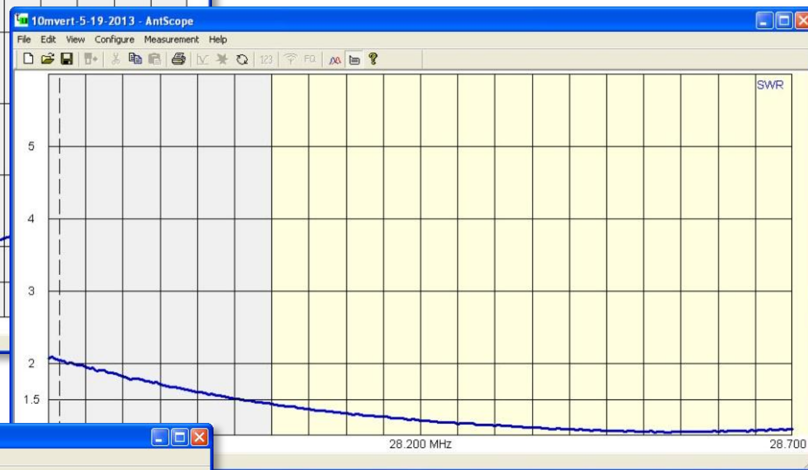
Tuning: An MFJ antenna analyzer will work to tune the traps. My traps came out so close to the design frequencies they didn't require any "tuning", which amounts to spreading the coax on the couplings. To measure a trap's resonant frequency, you simply tune for maximum impedance across the trap as read on the meter, and then view the displayed frequency. If you are close, say within 100khz of 7.1, 14. 2, 21.2, and 28.3, for example, you can compensate by lengthening or shortening the wire between the traps for the desired operating mid-point.

SWR on the Vertical (with trap radial): The following SWR graphs were made with the assistance of a RigExpert antenna analyzer. This is a top-of-the-line instrument that connects between the antenna under test and a computer. The RigExpert instantly plots SWR (vertical axis) vs. frequency (horizontal axis) in 60 seconds. This allows you to make antenna adjustments between the traps and see the result almost instantly.

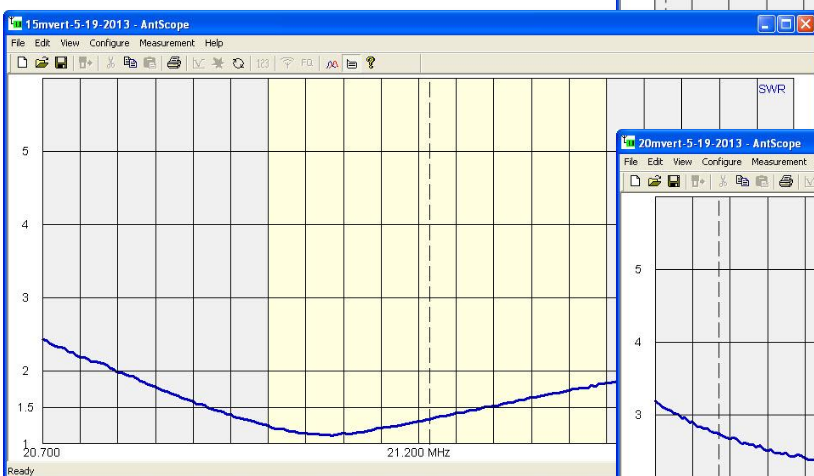
By working a bit at the tuning phase, both on the traps and antenna wire between them, you can move the center frequency up or down, also affecting the SWR. Another thing I discovered while tuning and trying different orientations for the radial is that the best SWR for my antenna is an approximate 30 degree downward angle off horizontal at the base of the antenna. If you construct this as a full ½ wave dipole or inverted-V, you might keep this in mind when securing the ends, and experiment with different angles.



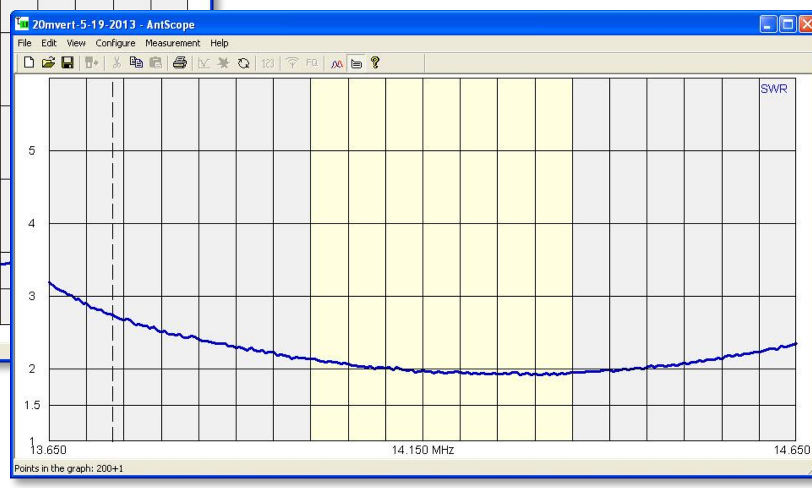
40m Sweep



10m Sweep



15m Sweep



20m Sweep

The light-shaded areas on the graphs represent the ham band from top to bottom on each. Note that the SWR for 20m is just below 2:1 and I couldn't get it lower. This indicates I need to lengthen the vertical antenna itself between the 15m and 20m traps … or I might have a "questionable" 20m trap on the vertical.

Hopefully, this may peak your interest in either putting that old trap vertical back in service, or building the whole trap dipole as a standalone antenna. I am so impressed with the performance of the traps that I may build the other half soon.

Performance: During the recent Field Day event I was able to prove the theory and design worked! I made several contacts and A/B tests between a 40/15m inverted-V antenna and the vertical. It appeared that both on the receiving station S-meter and my own, the difference between the two antennas showed an approximate 1 S-unit gain, or less, over the trapped vertical/radial combination; what you might expect when comparing vertical and wire antennas on 40m during morning hours.

I made one DX contact with La Paz Mexico with a 10-over nine report from XE2HWJ with only 100w to the vertical on 40m. Since the antenna presents close to a 50-ohm load in the middle of each band, this is also what you might expect. Another report from a portable Colorado station was again, S9 … good sigs!

Trapped radial off the back of RV: Note the base of the 5-band vertical with homemade tilt-over mechanism that lowers the antenna to the roof

My compliments and thanks to **NU3E** for his excellent website and instructions, and to the other authors noted in his article, all who have written articles for QST on trap dipole construction.

By the way, I couldn't find anything by anyone who has built a "trap radial" for use with a trap vertical … until now! Dennis –WU6X