There's still plenty of life left on the low bands. N4PC shows us how to get a simple and easy-to-build vertical antenna up by next weekend.

A Short, Two-Band Vertical For 160 and 80 Meters

BY PAUL CARR*, N4PC

I feel many in the amateur radio fraternity are missing out on enjoyable QSOS because they think they don't have the room for antennas for the low bands. I've had many requests for antennas that will work on 160 meters, and when I question the caller, it seems many can place a G5RV antenna at about 45 feet. Their comments always end with "Can you help?"

Well, there's the challenge for me—design an antenna that will work on 160 meters and will be no longer than a G5RV and no higher than 45 feet. Another thing that comes to mind when you mention a vertical is the omni-present question about a field of radials. This antenna doesn't require a single radial and it still works. Is it the perfect antenna? No, but perhaps it's optimum for your needs. Read on.

Background

I began my research by consulting *The Amateur Radio Vertical Antenna Handbook* by Capt. Paul Lee, N6PL. This is a very good reference book for those who are interested in designing vertical antennas. Chapter 4 of this book is entitled "Short Vertical Antenna Considerations." Two antennas caught my eye.

The first was the *folded unipole*. The folded unipole is basically one half of a folded dipole with the lower half being replaced by a ground plane. If this antenna is shortened and loaded by a capacity hat, the resulting antenna has a radiation resistance less than the theoretical 150 ohms for a full-size unipole antenna, but the resulting reactive component is positive. That means the reactive component can be cancelled by using a series capacitor instead of an inductor, which has more loss. Perhaps this concept could be used in the final design.

Another antenna in Chapter 4 also piqued my interest. It is called the Type UG, which was developed by John H. Mullaney and Associates. It was devised to improve the feed-point impedance and bandwidth characteristics of some of the low-frequency "inverted L" or "T" configurations. One diagram showed three vertical wires top-loaded with a horizontal wire. The dimensions were about what I was looking for, so it was time for the second phase of my research—the computer analysis.

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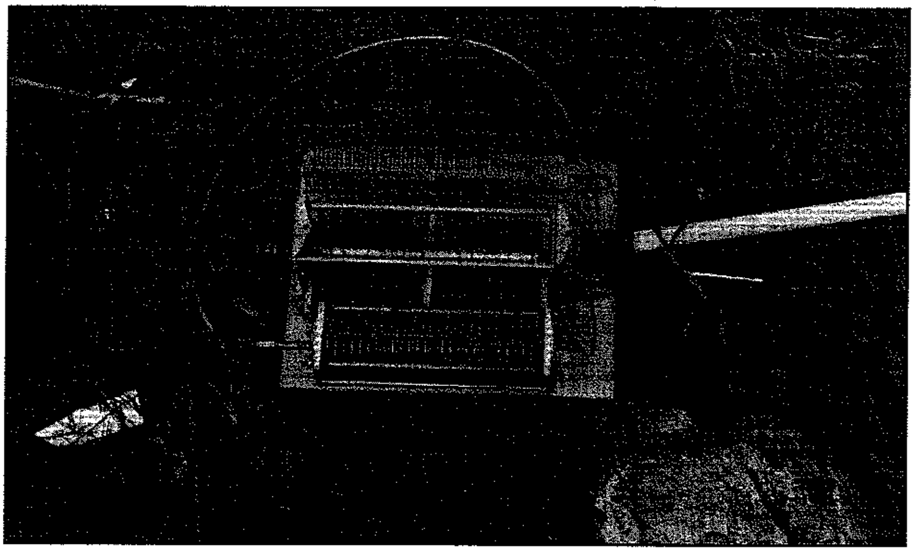


The coil, capacitor, and relay are mounted on an aluminum plate. The tuning unit sits off the ground on a few bricks to keep moisture out.

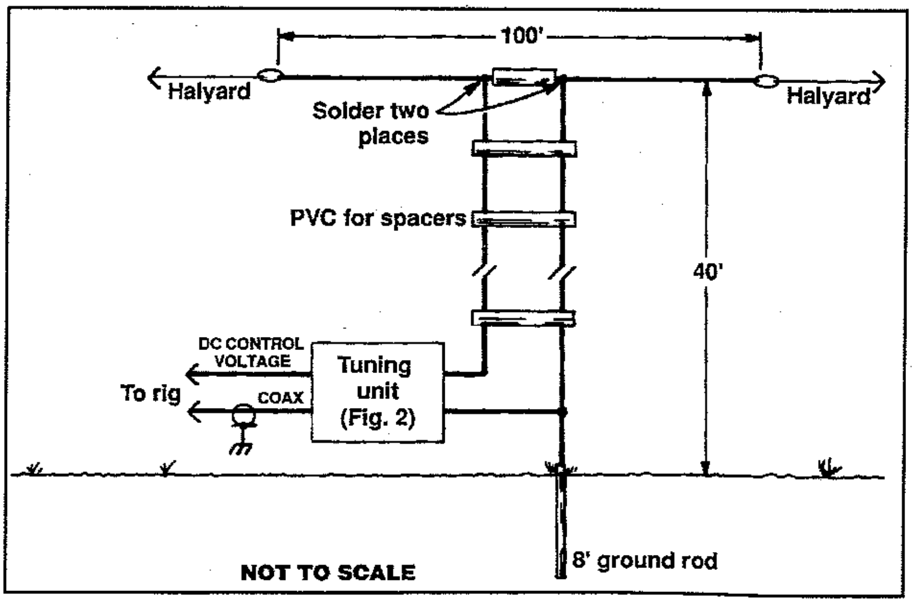


Fig. 1– Details of the 160 and 80 meter vertical antenna as described in the text.

The Computer Design Phase

As a starting point for my computer analysis I chose a "TEE" configuration using two vertical wires and a horizontal wire to act as a "capacity hat," with an initial vertical height of 45 feet and a horizontal length of 100 feet. The predicted impedance for this arrangement was 182 + J1321 for 1.85 MHz and 80 + J586 for 3.8 MHz. After a few iterations I arrived at my final choice for length and height. With a vertical height of 40 feet and a horizontal length of 100 feet, the predicted impedance for 1.85 MHz was 52 + J817 and for 3.8 MHz it was 52 + J546. This would provide a convenient way to match the antenna on both bands. A series capacitor could be used to cancel the reactive component on 3.8 MHz, and an additional capacitor could be switched in parallel to compensate for the reactance on 1.85 MHz. Now it was time to measure the wire and "smell the solder smoke."

Construction and Installation

I cut a single piece of #14 gauge wire for the horizontal capacity hat and two pieces of the same type wire for the vertical elements. I chose 1/2 inch PVC water pipe for use as spacers to maintain uniform distance between the vertical wires. I cut the first piece of PVC to a length of 12 inches, routed the horizontal wire through this pipe, and centered this spacer on the capacity hat. I cut five additional sections of pipe to a length of 13 inches each. I measured 1/2 inch from the ends and drilled holes just large enough to allow the vertical wires to pass through. I soldered the vertical wires to either side of the wire routed through the center spacer. The vertical wires were then routed through these spacers, and the spacers held in place by small cable ties. An insulator was placed at each end of the horizontal capacity hat. This allows the use of halyards to pull the antenna into the air. I next installed an 8 foot ground rod where the base of the antenna was to be placed. The antenna was now ready for installation.

If you've read any of my previous antenna articles, you're aware that I'm blessed with a good selection of tall southern pines around my house. I chose three convenient trees as support for the antenna. I placed elastic shock cords at the ends of the halyards to maintain constant tension on the antenna during windy conditions. I then raised the antenna into the air and attached the end of one of the vertical wires to the ground rod. Now on to the testing phase.

Initial Testing

I used an MFJ-259 SWR analyzer and a small broadcast variable capacitor for the initial test. The idea was to place the capacitor in series with the driven element and tune the capacitor for minimum SWR. When I performed this test, I did get a very pronounced dip on both 75 and 160 meters, but it was 1.8:1 to 2:1 instead of the 1:1 I had hoped for. Why the difference? I realized that the computer analysis programs calculate the impedance of a ground-mounted vertical with respect to perfect ground, and of course my ground was far from perfect. The additional resistance I was measuring was due to ground loss. It seemed I was going to need something such as an "L" network instead of a simple series capacitor. Back to the junk box.

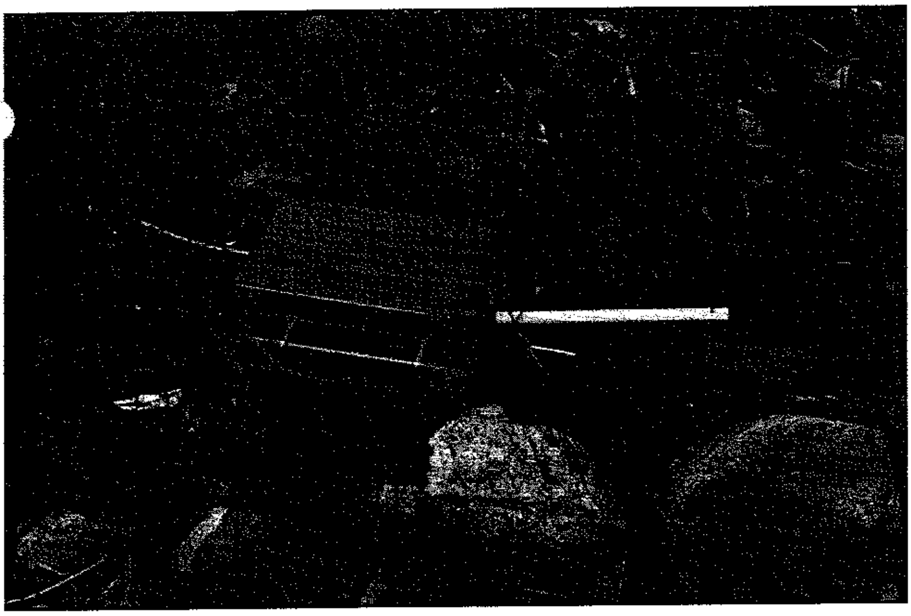
The Tuning Network

I decided to use a single, tapped inductor and two capacitors. I also found a relay with 10 amp contacts to switch the inductor tap and the capacitors. The concept of the matching network was very simple. I would use one of the capacitors and a particular tap on 75 meters and switch a different tap point and parallel capacitor for 160 meters. The relay could be wired so that when power is supplied to the relay from the shack, the tuning unit will do the necessary switching at the base of the antenna.

I chose a flat piece of aluminum on which to mount the components. Be sure to use standard high-RF-voltage techniques when mounting the components. **Remember, if you intend to use high power on this unit, considerable voltages will be developed.** Test the unit on your workbench to assure yourself that everything is working properly before installation at the antenna. If all is well, the unit is ready for mounting at the antenna. Don't forget: Some type of protection is necessary for the tuning unit. I chose a plastic refrigerator container to keep the unit dry.

Final Tuning

I moved the unit back to the base of the antenna and supported it on a couple of bricks. I con-



A plastic refrigerator container provides the weatherproofing for the tuner. To the right you can see the bottom PVC rung of the antenna.

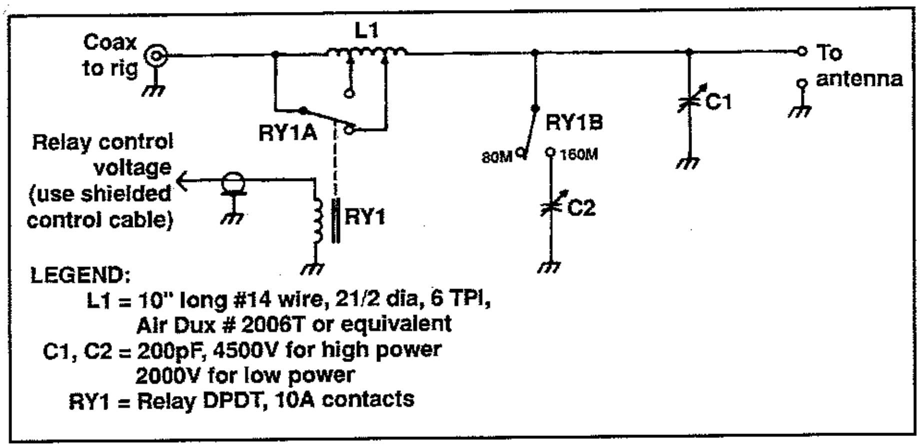


Fig. 2– Schematic diagram and parts list for the switchable antenna tuner.

nected a shielded cable from the relay control line to a 12 volt power supply in the shack and a short piece of coaxial cable to the MFJ-259. Next I tuned the unit for 75 meters. Remember, in order to reduce the SWR on a transmission line, two elements must be varied. Pick a tap point on the coil and vary the capacitor for minimum SWR. If the results are not the magic 1:1, move the coil tap about two turns and vary the capacitor again. If the SWR shows improvement, you have gone the wrong way. Continue this procedure until you have obtained the lowest SWR on your favorite part of the band.

Next switch the tuning unit to 160 meters. Without disturbing the coil tap and capacitor settings established for 75 meters, choose a trial tap point on the coil and repeat the tuning procedure for 160 meters. The tuning procedure is considerably easier to accomplish than it is to write about. On 75 meters I obtained a bandwidth of about 100 kHz, and on 160 meters the bandwidth was 60 kHz. These measurements were made with the MFJ-259 at the end of 100 feet of RG8-X coax. The measurements depend on local conditions, so your results may vary.

Results

Everyone is always excited about a new antenna, and this was the case for me. I waited until almost dark and tuned to the 75 meter DX window. My first two contacts were with stations in Germany. This is not rare DX, but I enjoyed the contacts anyway. On 160 meters I received reports that were about 10 dB stronger than I had been receiving. All this and no RF ground.

Afterthoughts

You may think it very strange to build a vertical antenna without a single radial in the ground, but one of my objectives was to determine what could be expected with such a simple installation. I'm sure the results would be greatly increased if a good RF ground were constructed using 50 to 100 radials. However, I feel that are three schools of thought: You can dream of the perfect conditions and stay off the air, you can build the antenna and add radials as time and money permit, or you can build a simple system and start having many enjoyable QSOs. The choice is yours! ■