A Compact 20-Meter Vertical Dipole for Stealth and Portable Applications

This antenna earned an Honorable Mention in the 2018 *QST* Antenna Design Competition.

Steve Appleyard, G3PND

While thinking about the design of a new antenna for a 30 × 50 foot plot of land, I wanted the antenna to be easily erected/dismantled for both stealth and portable operation. I subsequently decided on a free-standing half-wave 20-meter vertical due to it having a reasonable antenna length and no need for a counter-poise. However, as a 20-meter vertical dipole is about 33 feet high, this would still be outside my design parameters. There-fore, I decided to design a shortened loaded vertical dipole by making the bottom section an almost complete helically wound inductance, and the top section a self-supporting conductor with an appropriate amount of inductive loading.

Parts List

- 10 foot × 1¼ inch PVC pipe
- 9-foot length of wood to insert in the PVC pipe to give it additional rigidity [A 1⁵⁄₁₆-inch-diameter wood dowel, available in 6-, 8-, and 10-foot lengths from a hardware store, perfectly fit the inside diameter of 1¼-inch PVC pipe — *Ed.*]
- 6-inch length of wood with a ½-inch hole drilled vertically through it
- 6-foot length of ½-inch diameter copper pipe
- ½-inch hose clamp
- 15 A terminal blocks, three-way (Bussman TB300-03 or equivalent) and one-way (Cinch 1-142 or equivalent), as shown in Figure 2
- Masking tape, double-sided tape, self-amalgamating tape, and electrical tape
- 50 feet of copper wire; #12 AWG stranded insulated wire was used in the proto-type, but smaller diameter wire has been used in subsequent antennas
- Appropriate length of coaxial cable, terminated with a PL-259 connector

Design

As I wanted to keep the total antenna length about 16 feet, I chose the main two elements to be a 10-foot-long, 1¼-inch-diameter PVC tube and a 6-foot-long, ½-inch-diameter copper pipe. Using antenna design software for this project was beyond my capa-bility, so I decided on a trial-and-error process, taking advantage of help from Norfolk Coast Amateur Radio Society (NCARS) volunteers — in particular, Bruce, G4KZT, and Phil, G4PQP.

I began by erecting a full-size tuned 20-meter horizontal wire dipole with the center 7 feet above the ground. I then replaced the left-hand section of the dipole with my experimental bottom vertical section. After several iterations, I arrived at a dipole resonant at 14.128 MHz. Next, I replaced the right-hand dipole section with my first attempt at the top section. I adjusted the coil until I again achieved reso-nance. This gave me the basic pieces necessary for the vertical dipole.

Assembling the Compact Vertical Dipole

Originally, I was unable to achieve a low SWR at resonance. However, after much experimentation, I found that I needed to increase the winding separation closer to the feed point and then progressively reduce it down to the final 1-centimeter spacing. The coil winding details are shown in Figure 2 [For those without a metric ruler, 1 centimeter = 0.4 inches. — *Ed*.]. The main issue is the high voltage at the bottom of the lower helical winding, as maximum voltage occurs at the ends of a half-wave dipole. The risk of arcing was minimized by fitting a 30 A terminal block at the wire end to provide the rounded edges of the terminal barrel.

Using the materials in the “Parts List” sidebar, I began assembly following these steps:

1 Stick a 6 foot × 5 inch strip of masking tape along the length of the 10-foot PVC pipe from the end you designate to be the top of the dipole.

2 Mark the masking tape with each turn of antenna wire as shown in Figure 2, starting from the top of the antenna.

3 Stick double-sided tape alongside the masking tape to keep the antenna wire from slipping.

4 Insert the reinforcing wood into the tube, ensuring a 12-inch clearance from the top.

5 Fix the three-way terminal block with the center contact removed, as shown in Figure 2, using two wood screws.

6 After taping the wire to the pipe so that 4 inches extends from the end (this end will connect to the copper tube), start winding the antenna wire from the top end of the PVC pipe so that each turn coincides with the markings on the masking tape. Wind it as far as the terminal block and terminate it into the block. Tape the winding every 6 – 8 inches with electrical tape to keep it secure.

7 Terminate the remainder of the antenna wire into the other half of the terminal block and start winding the lower section of the antenna (see Figure 2). Tape the wire at the last turn and then tape a 16-inch straight section along the length of the tube.

8 Fit the 6-inch wooden insert into the top end of the tube and secure with a small wood screw through the plastic tube (see Figure 3).

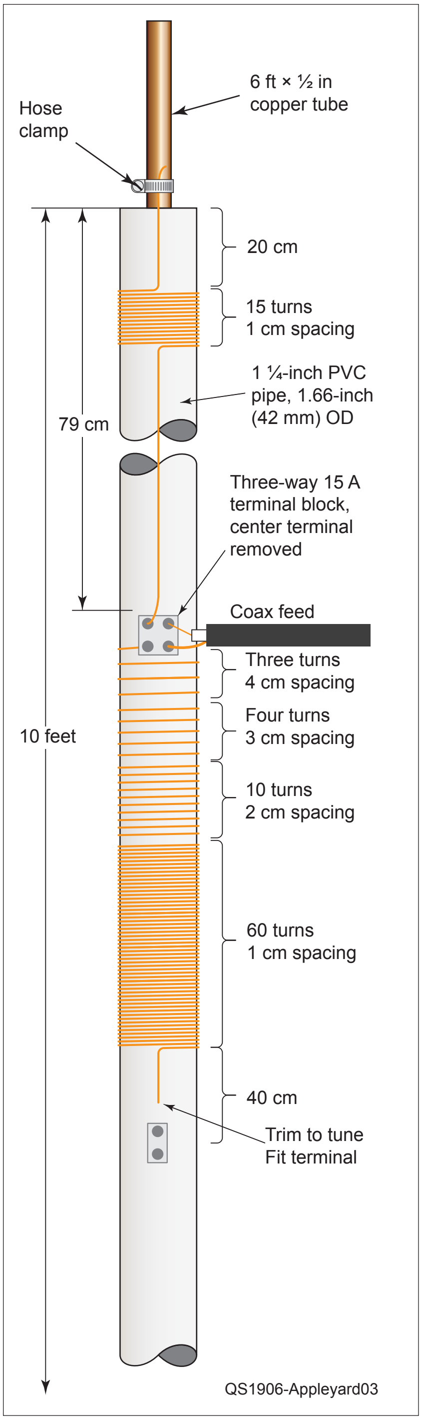

Figure 2 — Details of the dual coil assembly.

9 Insert 6 inches of the copper pipe into the pre-drilled wooden insert and fit the hose clamp with the tail of the previously stripped back wire under it (see Figure 4).

10 Attach the coaxial cable to the terminal block with the shield connected to the bottom section of the antenna. Make one turn of the coaxial cable around the tube at the center of the terminal block and tape to hold.

Tuning the Antenna

Mount the antenna, using an umbrella base, at least 10 feet from nearby objects. The coaxial feeder should be brought away perpendicular to the antenna for at least 3 feet before it can drop vertically. As the feed is unbalanced, a 1:1 choke balun was used to suppress any common-mode current during testing. Subsequently, I have not bothered with the balun as the common-mode current doesn’t appear to cause any problems, at least up to 100 W.

▶**Figure 3** — Drilled wooden insert installed in PVC pipe.

▼**Figure 4** — The copper pipe installed.

The antenna is tuned by trimming the bottom straight-wire section. The length is longer than required, so the antenna will be resonant below 14 MHz. It should not be necessary to trim more than 8 inches off this tail — it is important that at least 8 inches remain. If resonance is still below 14 MHz when 8 inches has been trimmed off, remove a turn from the bottom of the coil. At resonance, the SWR should be below 1.2. If it is not, then a small adjustment can be made to the top section by releasing the hose clamp and dropping the copper tube by a small amount. Strip back ½ inch of insulation from the bottom of the antenna and fit a single-way 15 A terminal block.

Once tuning is complete, replace or cover the temporary electrical tape with self-amalgamating tape. This should also be put liberally around the terminal blocks and the hose clamp. The open top of the copper tube should also be made waterproof.

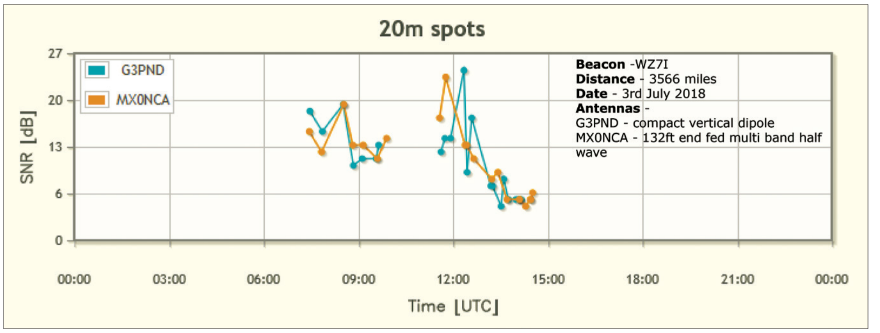

Figure 5 — An antenna comparison conducted on July 3, 2018.

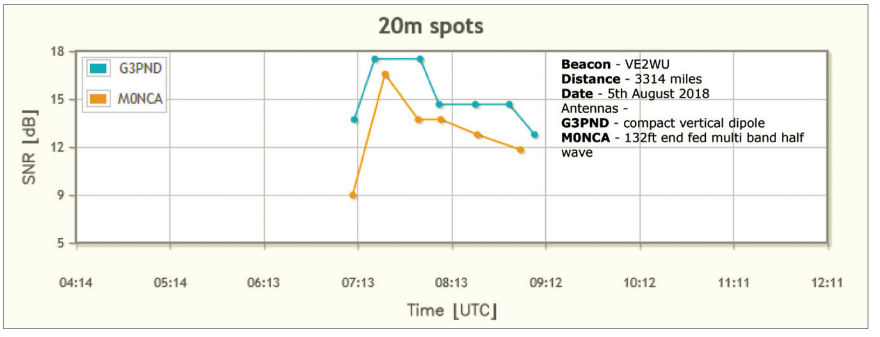

Figure 6 — An antenna comparison on August 5, 2018.

The final result is an antenna with an SWR of less than 1.2:1 at 14.128 MHz, and less than 2:1 across the full 20-meter band. Several antennas have subsequently been constructed with almost identical results. I have tested the antenna up to a maximum of 400 W, measuring the temperature at various points. There was no noticeable temperature rise.

Warning — High voltages exist at the two ends of the antenna. If there is any risk of a person touching the copper tube, a non-conductive plastic pipe can be placed over it. A larger diameter, non-conductive tube can also be fitted over the bottom section of the dipole (see the lead photo). These tubes will only have a minimal effect on the SWR of the antenna.

On-Air Testing

I am a great advocate of using the Reverse Beacon Network (RBN) to compare antennas.[1] I currently have a 20-meter horizontal dipole with its center at 20 feet and a 130-foot multi-band end-fed antenna. Both antennas perform well given the conditions at the time. Tests on the compact vertical dipole were carried out from June 30 – August 5, 2018. In the tests, I used my call G3PND for the compact vertical and the NCARS calls MXØNCA and MØNCA for my existing antennas.

Given its small size, the compact vertical dipole performed amazingly well. For the most part, it matched the performance of the dipole and end-fed antennas and, on occasion, it was the best of the three. Figures 5 and 6 show a couple of the days during the testing period using the RBN Spot Analysis tool. The results from all the beacons that responded to the test transmissions are retained by the Reverse Beacon Network and can be accessed at **www.reversebeacon.net**. To do this, click **MAIN** on the opening page, then **DX SPOTS**, and fill in the date, the region, and the call signs to compare (e.g. G3PND, MXØNCA).

This antenna lends itself to further experimentation, such as determination of the optimum height above ground and versions for other HF bands.

[1]S. Appleyard, G3PND, "Using the Reverse Beacon Network to Test Antennas," *RadCom*, Jun. 2018, pp. 26 – 30.

Photos by the author.

Steve Appleyard, G3PND, was first licensed in 1961 while studying electronic engineering in college. He went on to work on the development of communication and navigation systems with the Marconi International Marine Company. In later years, he became the CEO of a number of electrical engineering companies. Now retired, he is secretary of the Norfolk Coast Amateur Radio Society. Steve edited the book *International Antennas*, published in 2017 jointly by ARRL and the Radio Society of Great Britain (RSGB), and he wrote the first chapter, "Using the Reverse Beacon Network to Test Antennas." He is co-author of *Getting Started in EME*, also published by the RSGB. You can contact Steve at **sfappleyard@btinternet.com**.

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