

# A 20 and 40 Meter Vertical on 'Autopilot'



*An old “Hints & Kinks” item results in an excellent Field Day antenna.*

Dan Richardson, K6MHE

With its size, ease of installation, and reliable performance, the 40 meter quarter wavelength vertical antenna is a very popular HF antenna. What's more, with proper matching, it also performs very well on the 20 meter band. Being a half-wavelength on that band, the antenna provides an efficient low-angle radiation pattern, with roughly a dB of gain over the shorter standard quarter-wave vertical.

This article describes a dual-band vertical antenna system for 20 and 40 meters that I built for portable Field Day use. It uses a somewhat innovative tuning method that, after the initial setup adjustments are made, permits operation on either band with no further tuning required—and it works great!

I discovered this scheme while perusing some past issues of *QST*. I had a very nice telescoping 35 foot marine vertical whip that I wanted to use for an upcoming Field Day

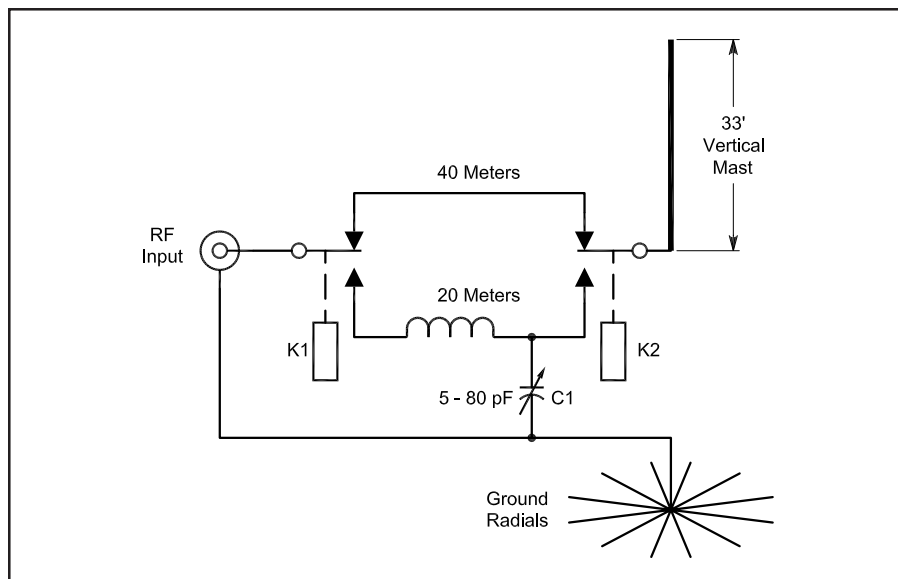


Figure 1—Using remote relays (K1, K2) for dual-band operation. One DPDT relay could be substituted for the two relays.



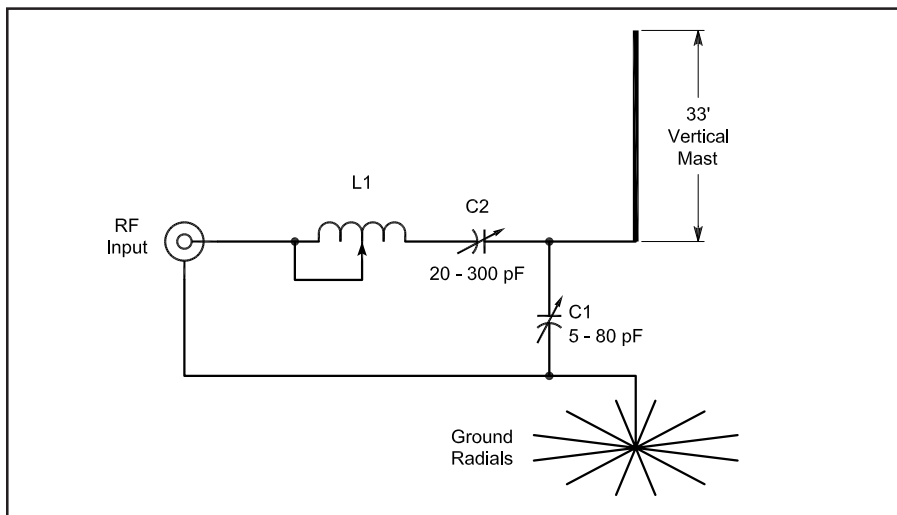


Figure 2—The modified L-network for dual-band operation—without relays.

and, while looking for some ideas, I came across this novel method for dual band operation. It was described by Wes Hayward, W7ZOI, in an old *Hints & Kinks* column.<sup>1</sup>

Typically, a quarter-wave vertical is fed by directly connecting the coaxial feed line to the base of the antenna. As the base impedance is low (typically 40-70  $\Omega$ , depending upon the ground/radial system utilized) this technique provides an acceptable SWR and works well. However, the base impedance of a half-wave (20 meters, in this case) vertical is much higher (around 1100  $\Omega$ ); therefore a matching network is required to successfully feed the antenna with coaxial transmission line. Prior to discovering this method, I had only seen this type of dual-band operation performed using remote relays (K1, K2) in conjunction with an L network (L1, C1), as shown in Figure 1.

This innovative approach involves placing an additional capacitor in series with the inductor of an L network so that, when properly adjusted, a conventional 40 meter,  $\frac{1}{4}$  wavelength, vertical will operate on both the 40 and 20 meter bands with an acceptable SWR with no need for switching schemes or any additional adjustments.

### How it Works

W7ZOI's modified network, shown in Figure 2, is easily understood when compared side-by-side with the simple L network of Figure 1. L1 and C2 form a series resonant circuit that behaves—on

40 meters—as a short circuit. The result is the same as having the relay contacts in the 40 meter position, as shown in Figure 1. The shunt capacitor (C1) reactance on 40 meters is roughly ten times that of the antenna's base (feed-point) impedance and therefore has a negligible effect on matching. The net result is the antenna's low base impedance essentially remains unchanged to the coaxial transmission line on 40 meters.

Twenty meter operation is accomplished by adjusting L1 and C2 so that the net inductive reactance is the same as it would be in the basic L network. The value of C1 remains the same in both networks.

So, we end up with a matching system that does double duty. The modified L network is adjusted so that L1 and C2 provide the proper amount of inductive

reactance such that, when used with C1, matches the high base (feed point) impedance of the antenna on 20 meters. And, simultaneously, it maintains the series resonance that is required for matching the antenna's low base impedance on 40 meters. A pretty neat idea!

### Construction

I built the entire network solely from junk-box parts. As is usually the case when building a project like this, my treasure trove did not contain capacitors of the exact values recommended by W7ZOI. I substituted a 100 pF capacitor for C1 and a 500 pF capacitor for C2. Originally, I was concerned that, by using larger values than those recommended, particularly for C2, the minimum capacitance values might be too large for proper tuning; however, this turned out not to be the case. The inductor was made from a section of coil stock (2 inch diameter; 14 gauge wire; 10 t at 8 tpi). All components were mounted on a  $\frac{1}{8}$  inch thick plastic panel, which, in turn, was installed in a watertight housing that had seen previous life as part of a shipboard antenna system. The completed network is shown in Figures 3 and 4.

If you choose to build this project take care to use capacitors that have a sufficiently high voltage rating. Mine are rated at 4.5 kV and should easily handle 500 W or more. [Vacuum capacitors would be ideal for this application, but they are expensive.—Ed.]

### Tuning

As I stated earlier, my antenna's height is about 35 feet; therefore, its resonant frequency falls below the 40 meter band. This caused me no problems when tuning; however, I did have problems trying to adjust the network with an antenna height that was slightly less than  $\frac{1}{4}$  wavelength. I will discuss this in a moment.

Tuning was done empirically. Using an MFJ-259B antenna analyzer, the tap on the inductor was set near maximum inductance and capacitor C2 was adjusted for the best indicated SWR on 40 meters. Next, the analyzer's frequency was changed to the 20 meter band and C1 was adjusted for the best SWR, but the match obtained was not good. I next moved the tap on the coil in the direction of less inductance and C1 and C2 were adjusted again for their respec-

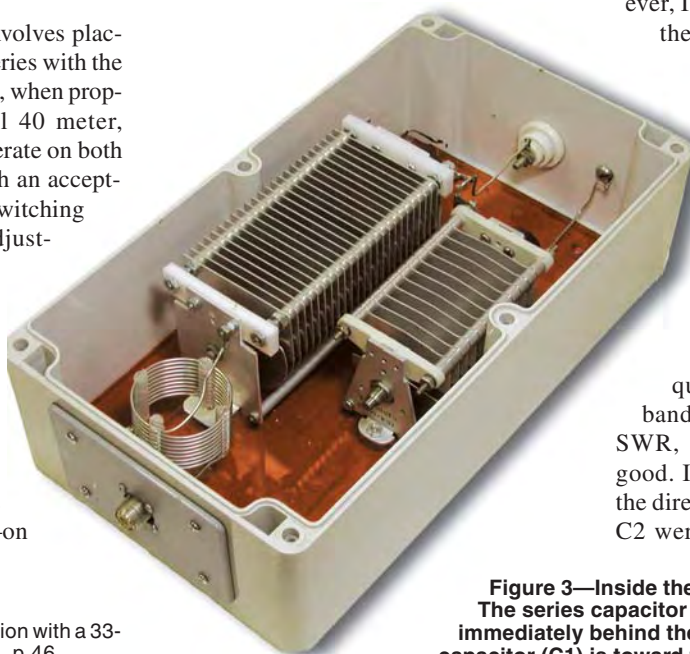


Figure 3—Inside the dual-band modified L-network. The series capacitor (C2) is at the top left, immediately behind the inductor (L1). The shunt capacitor (C1) is toward the right.

<sup>1</sup>W. Hayward, "Dual-Band Operation with a 33-Foot Vertical," *QST*, Jun 1977, p 46.

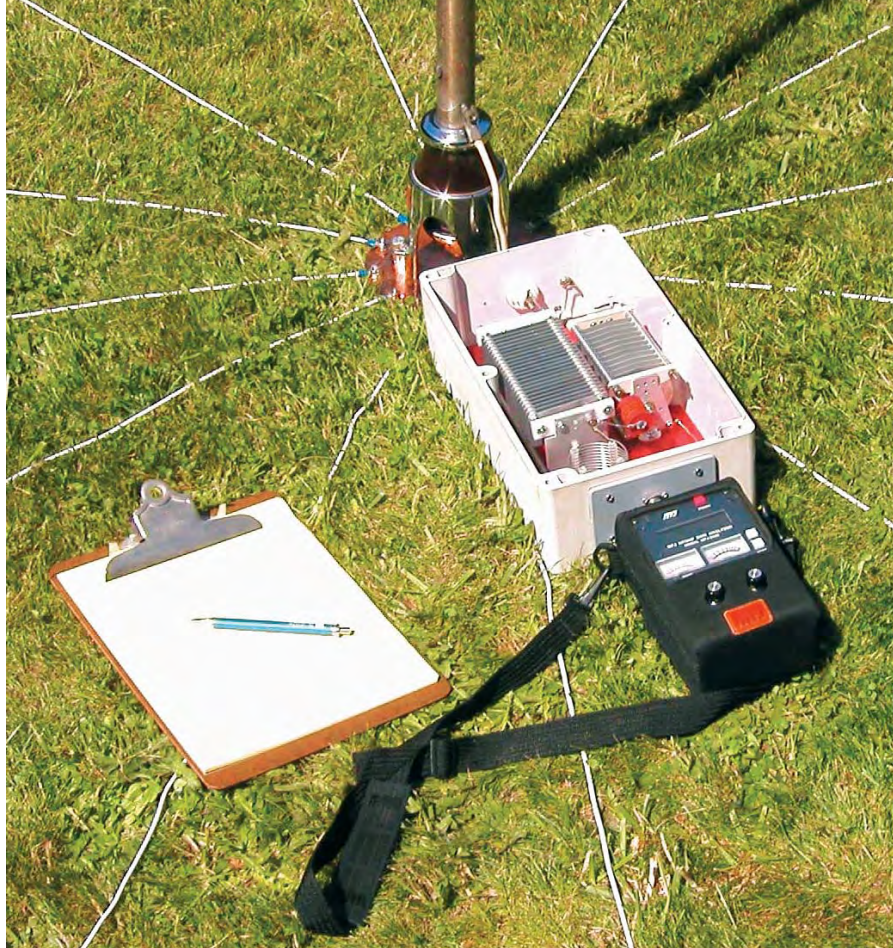


Figure 4—Tuning the network with an SWR analyzer. See text for tuning suggestions.

tive bands. This process was repeated until satisfactory SWR readings were obtained. (My requirement was to have the SWR fall below 2:1 on both bands. Many solid-state rigs start reducing their power or, worse yet, shut down at an SWR of 2:1.) The resulting SWR curves are shown in Figures 5(A) and (B). I should point out that this system was tuned using a marginal radial system (only twelve radials) and the SWR curves are therefore rather broad. Those curves would be more pro-

nounced had the antenna been adjusted utilizing a more efficient ground system.

My telescoping mast comprises six sections that, when extended, reaches about 35 feet. As a matter of interest, I tried tuning the antenna with one of the sections retracted, resulting in an overall antenna height of about 30 feet, which is, of course, self-resonant above the 40 meter band (about 7.8 MHz). Using the shorter length antenna, I could achieve a good match on one band or the other but not on

both simultaneously. It turned out that the additional inductance required to obtain a good match on 40 meters with the shorter antenna height resulted in having too much net inductive reactance in the L1/C2 series combination for a satisfactory match on 20 meters. Conversely, reducing the amount of inductance that provided a good match on 20 meters did not afford enough inductance for an acceptable match on the lower frequency. Hence, for this system to work properly, the antenna height should be no shorter than  $\frac{1}{4}$  wavelength for the lowest frequency of operation. I found no detrimental consequences, however, when it was slightly longer.

## Conclusion

After the initial adjustments, the network performed flawlessly. Alternating back and forth between 20 and 40 meter operation required nothing more than changing the frequency/band selection on the radio, with no concern whatsoever about the antenna system.

I am surprised I haven't seen this technique in wider use. Given that more than 25 years has passed since it was first published, I felt it worthwhile to present it again for those who may not be aware of this practical and versatile design.

I wish to thank to Wes Hayward, W7ZOI, for his review and suggestions in the preparation of this article.

*First licensed in 1955, Dan Richardson, K6MHE, enjoys experimenting with antennas. Dan was an electronic technician in the US Coast Guard during the 1950s and '60s; he then joined the family foundry business, retiring about 10 years ago. After he had moved to rural Northern California, Dan's devotion to antennas flourished, and he's published several articles in leading amateur journals. Dan can be reached at PO Box 2644, Fort Bragg, CA 95437 or [k6mhe@arrl.net](mailto:k6mhe@arrl.net).*

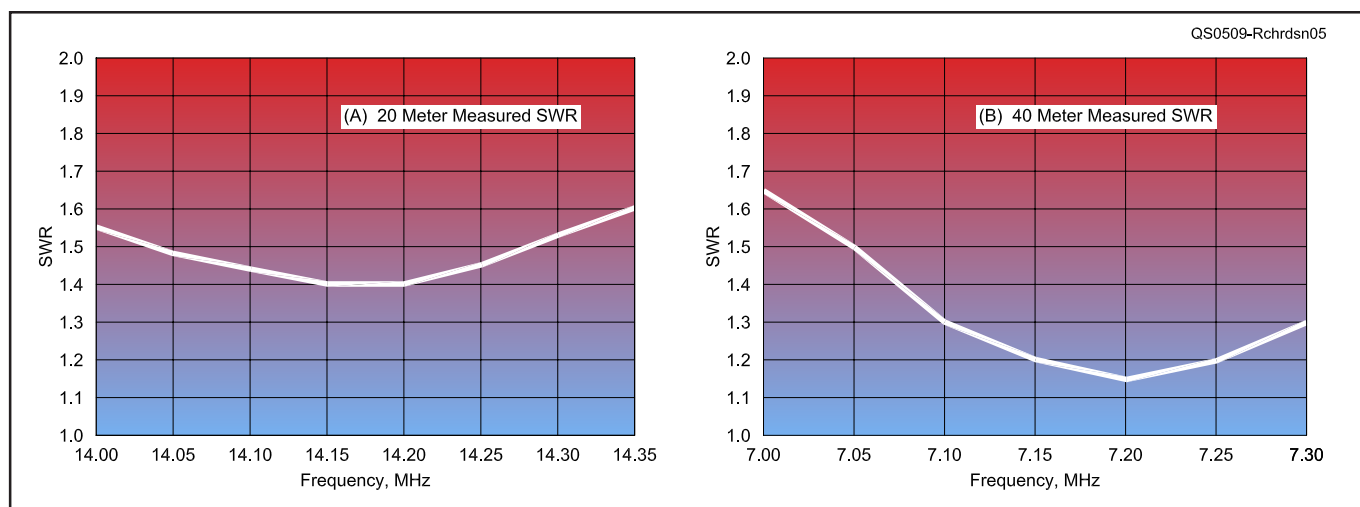


Figure 5—The SWR at 20 meters (A) and 40 meters (B).