Antenna of the Month:
Portable All-Band Vertical

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Having an all-band antenna that's lightweight, easy to set up and easy to use is handy for all kinds of portable operations such as POTA and Field Day. After a request from my blind ham friend Earl KG7UKW, I put together something that he can take to the field with minimal hassle. It's based on a non-resonant vertical wire and a modest number of ground radials with a matching transformer to improve the average SWR. This one uses one of the "magic" vertical lengths of 25 feet which actually resonates around 9 MHz. Avoiding resonance on any ham band is an old trick that helps avoid extreme feed point impedances which are hard to match.

Figure 1. Base of the antenna showing the mast, radial connections, and matchbox.

Construction

To keep things simple and lightweight, I used 20 gauge insulated wire for both the vertical and radials, and a 32-foot telescoping fiberglass pole from *Sotabeams* [Ref. 1], which we extend to about 25 feet. Other types will also work such as the ones made by *Jacktite*. The pole can be supported at the base by almost anything. In an open area, a 3-foot construction stake works great. Heavy Velcro straps tie the mast in place. Radials are connected together via screws and wingnuts at a copper ring at the base but almost any connection method will do. I chose to use eight radials 25 feet long as a compromise. More is better of course but it becomes a matter of convenience and diminishing returns after a point. The radials simply lie on the ground. Finally, the matchbox is strapped to the base and connected between the vertical and radials (Fig. 1).

Matchbox Design

Feed point impedance of this antenna is literally all over the map as you sweep through the HF bands. The map I'm referring to is the *Smith Chart*, a handy way of displaying complex impedance and much more. It's about the only way to make sense of what's happening and to determine if your matching technique is likely to be successful. In general, we find that the impedance is higher than 50 ohms and also wildly reactive. Also, it's bad enough that the built-in tuner in most transceivers will not succeed. A 4-to-1 impedance stepdown transformer is a reasonable choice, bringing things into range of most tuners on most bands. This same solution was applied in last month's antenna, the off-center fed dipole, which had many of the same issues.

Since this antenna is only intended for use up to 100 W, small ferrite cores were used in the matchbox. A 4:1 transformer is bifilar wound with magnet wire on a 1.4 inch type 61 core which exhibits low loss. A common-mode choke is also required to avoid having the outside of the coax become another radial. I used a 1.2 inch type 31 core wrapped with 12 turns of RG316 Teflon coax. This yields at least 4000 ohms of choking impedance from 7 to 30 MHz, an excellent result. Binding posts provide wire connections. A weatherproof plastic box gives us some peace of mind when it rains. Figures 2 and 3 shows the schematic and a photo of the innards. I ran 100 W continuous through this matchbox into the actual antenna on all bands and there was no significant heating.

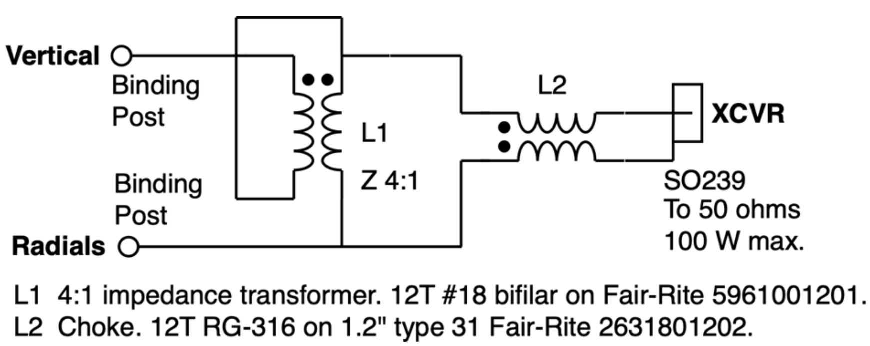

Figure 2. Matchbox schematic.

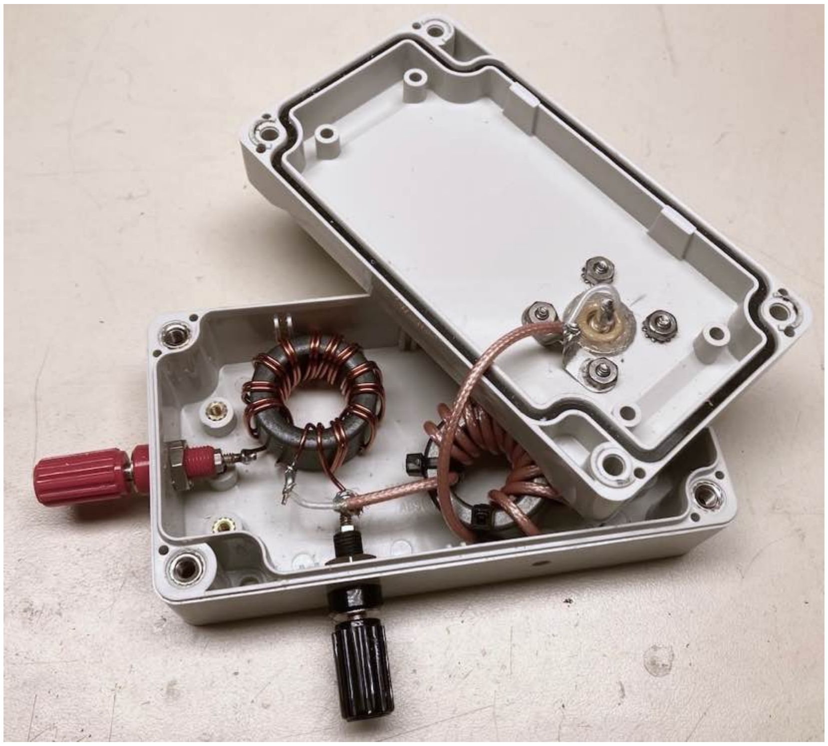

Figure 3. Matchbox internal construction. The box is 5 x 2.5 x 1.6 inches.

Performance

Everybody wants to know if the SWR is perfect everywhere because they mistakenly think that's what makes an antenna "good." But a dummy load has perfect SWR and radiates nothing! What matters most are radiation pattern and efficiency. SWR only has to be within range for your antenna tuner.

One way to estimate efficiency of a vertical is to measure the feedpoint resistance at its fundamental resonance. I did that with my VNA, and found that it was 38.1 ohms at 8.67 MHz. An ideal 1/4-wave vertical over perfect ground would be about 35 ohms, and that represents ideal *radiation resistance*—the place your input power goes to do the work of turning RF current into radiated fields. Since mine measured higher than that we have some loss, in this case 0.7 dB, and it's mainly due to an imperfect radial system which allows some current to flow in the lossy Earth. It turns out that's because this antenna exhibits relatively high impedance at its feedpoint, its dependence upon the ground system is relaxed compared to a resonant vertical.

There is also quite a bit of loss in the coax due to the high SWR. I used 40 feet of RG58 and *SimNEC* [Ref. 2] tells me that the worst-case loss between 7 and 50 MHz is about 2.4 dB. Using RG8 reduces that to about 1 dB. Actually, this loss can work somewhat in our favor since it masks the most extreme SWR excursions that might cause our antenna tuner to fail in finding a match. Still, do not be surprised if your tuner fails to match on one or more bands. I found that 17 m was the worst. Table 1 lists the SWR at the matchbox connector and at the end of the coax.

Table 1. SWR at matchbox and at the end of 40 ft of RG58.

Band	At Matchbox	At End of Coax
40 m	7.2	5.2
30 m	4.6	3.7
20 m	7.7	4.5
17 m	13.4	5.5
15 m	9.8	4.7
12 m	3.9	2.7
10 m	2.8	2.1
6 m	3.5	2.2

Radiation pattern is of course omnidirectional and mostly at a low takeoff angle. Figure 5 shows the elevation patterns which gain higher-angle lobes on the higher frequencies. This is typical of a vertical that is too long for those bands.

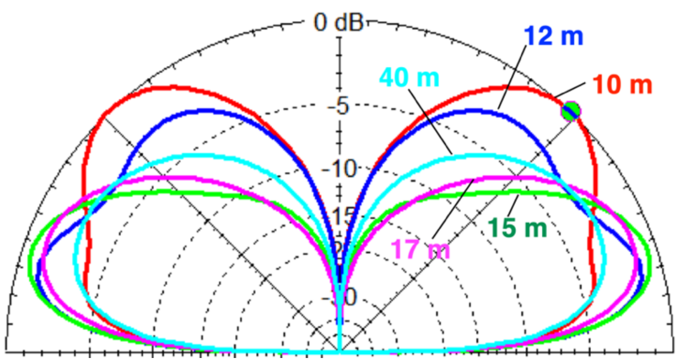

Figure 4. Elevation patterns. 40 through 15 m are typical single-lobe, low-angle. Higher bands start to have lobes at higher angles. Outer ring is 1.7 dBi.

Conclusion

Every antenna is a compromise and those that try to cover a vast range of frequencies are often doomed to poor performance over at least part of their range. In this case, we did ok for such a simple, lightweight kit with no fiddly adjustments. It offers decent efficiency and probably will yield a usable match on all bands from 40 through 6 m. I gave it a try mid-morning running 100 W on CW for all bands and the reverse beacon [Ref. 3] detected me from Hawaii to central America and into Europe, as well as all over North America. Also I got a report from Earl: He managed to set his up for the first time in 10 minutes, and that's without eyes! Not bad. And it fits in your backpack.

References

1. **Sotabeams** compact 32-foot travel mast. https://www.sotabeams.co.uk/compact-light-weight-10-m-32-ft-travel-mast/

2. **SimNEC** is a free Smith Chart simulator, very useful for all kinds of RF circuit analysis. https://www.ae6ty.com/smith_charts/

3. Reverse Beacon Network. https://reversebeacon.net/main.php