

A Portable 2-Element Triband Yagi

Have you ever dreamed about a portable beam you could use at your summer cottage, while camping or on Field Day? Dream no longer. This portable beam can be rolled up and stashed in your car's ski boot!



Several years ago I entered the ARRL November Sweepstakes CW contest in the QRP category, operating from a portable location. It turned out to be a very frustrating experience with only 3 W of output power and dipole antennas. After the contest I decided that the next time I entered a QRP contest it had to be with gain antennas.

My philosophy has always been to try to keep life as simple as possible. In other

words, I look for the easiest way to accomplish a goal that guarantees success. Don't get me wrong: Dipoles work particularly well considering the time and effort put into making them. But adding a reflector to a dipole antenna increases the overall gain about 5 dB, depending on the spacing between the elements. This extra gain makes a significant difference, especially when you are dealing with QRP power levels. My 3-W transmitted

signal would sound like a 9.5-W powerhouse just by adding another piece of wire! And it would be inexpensive too.

With Solar Cycle 23 in full swing, having an antenna with gain on 15 and 10 meters also became a consideration. Another parameter was the sale of the family van, which meant the new antenna had to fit into the ski boot of our car. Keeping these constraints in mind, I used a computer antenna-modeling program,

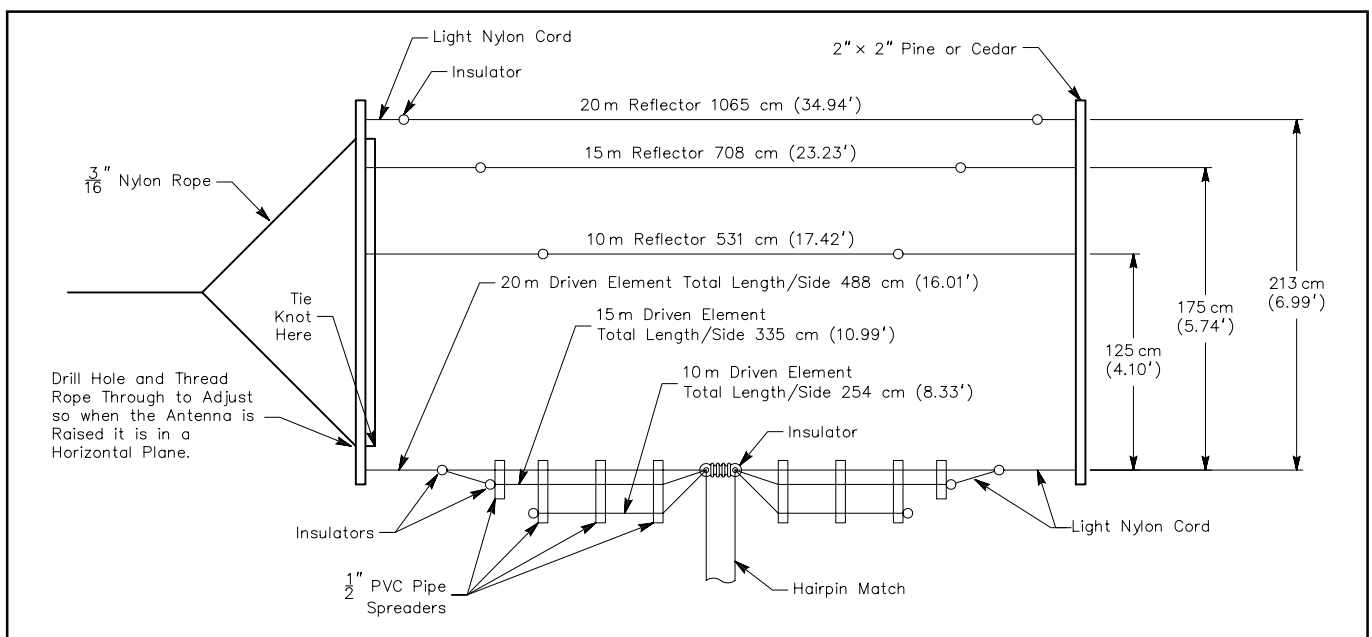


Figure 1—Dimensions for VE7CA's 2-element wire triband Yagi.

trying different design parameters to develop a triband 2-element portable Yagi using wire elements.

The basic concept comprises three individual dipole driven elements, one each for 10, 15 and for 20 meters tied to a common feed point, plus three separate reflector elements. The elements are strung

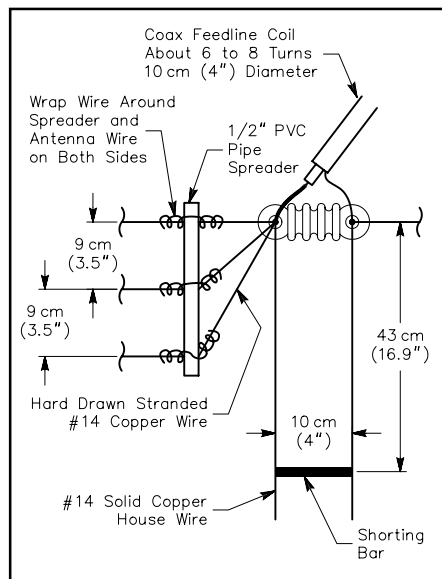


Figure 2—Close-up view of the feed point.

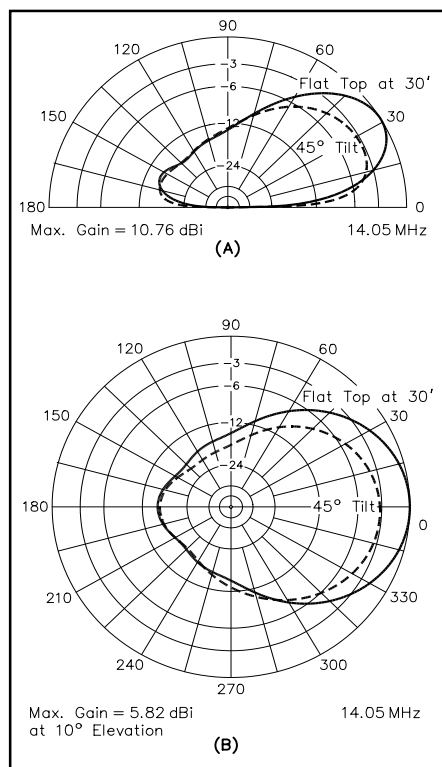


Figure 3—At A, comparison of elevation patterns for VE7CA Yagi as a horizontal flat top (solid line) and tilted 45° from vertical (dashed line). At B, comparisons of azimuth patterns for a 10° elevation angle.

between two 2.13-meter (7-foot) long, 2×2-inch wood spreaders, each just long enough to fit into the ski boot of the car. Use the lightest wood possible, such as cedar, pine or spruce to keep the total weight of the antenna as light as possible. Fiberglass poles would also work, or PVC pipe reinforced with maple doweling to ensure they don't bend. (Wood has the benefit of being easy-to-find and very affordable).

Adding a reflector element relatively close to the driven elements lowers the feed-point impedance of the driven element, so a simple hairpin match was employed to match the driven elements to a 50-Ω feed line. Figure 1 shows the layout and dimensions of the antenna.

The Hairpin Match

The matching system is very simple and foolproof. You should be able to copy the dimensions shown in Figure 2 and not need to retune the hairpin match, unless you plan to use the antenna in the top portions of the phone bands. The dimensions in Figure 2 produced a very low SWR—under 1.3:1 over the CW portions of all three bands. However, even in the lower portions of the SSB bands, the SWR doesn't rise above 2:1. SWR measurements were made at the end of a 25-meter (82-foot) length of RG-58 coax feed line.

Some may wonder why I used such a long feed line. First, when operating from a portable location it is better to be long than short. Nothing is more frustrating than finding that the coax you took along with you is too short. Further, when I change beam direction I walk the antenna around the antenna support, thus requiring a longer length than if I went directly from the antenna to the operating position.

If you are concerned about line loss you can run RG-58 down to the ground and larger-diameter RG-8 or RG-213 to the operating position. You may also find that in your particular situation a shorter length of coax will do. An 18-meter (59-foot) long piece of RG-58 has a loss of about 1 dB at 14 MHz, which is entirely acceptable considering the convenience of using coax cable.

Adjusting the Hairpin Match

If after raising the antenna the SWR is not as low as you want in the portion of the bands you plan to operate, first double-check to make sure that all the elements are cut to the correct length and that the spacings between the driven elements and reflectors are correct. Next you can adjust the hairpin match. Connect either an antenna SWR analyzer or a transmitter and SWR meter to the end of the feed line and pull the antenna up to

operating height. Determine where the lowest SWR is on 15 meters. By moving the shorting bar on the hairpin match up or down you can adjust the lowest SWR point to the middle of the portion of the 15 meter band you prefer. If your preference is near the top end of 15 meters you may have to shorten the 15-meter driven element slightly. After adjusting the 15-meter element and hairpin match, adjust the 10 and 20 driven-elements lengths separately, without changing the position of the shorting bar on the hairpin match.

The hairpin match is very rugged. You can attach the feed line to it with tape, roll it up, pack the antenna away and even with the matching wires bent out of shape it just seems to want to work.

Antenna Support

Adhering to my constraint to keep things as simple as possible, I only use one support for the antenna, typically a tree. When the antenna is raised to its operating position it is a sloping triband Yagi. To achieve this, attach a rope to each end of the 2×2's to form a V-shaped sling, as shown in the Figure 1. Attach a length of rope to one sling and pull the antenna up a tree branch, tower or whatever vertical support is available. Tie a second length of rope to the bottom sling and anchor the antenna to a stake in the ground. By putting in two or three stakes in the ground around the antenna support, you can walk the antenna around to favor a particular direction. To change direction 180°, give the feed line a pull and the array will flip over. So simple but very effective!

Local or DX

One of the features of a sloping antenna is that you can adjust the take-off (elevation) angle. For example, if you are interested in North American contacts (whether for casual QSOs or the ARRL SS contest), then sloping the antenna away sideways from the support structure at 45° with the feed point approximately 8 meters (26 feet) above the ground, will yield a 20-meter pattern similar to Figure 3A. Here, the maximum lobe is between 10° and 60° in elevation. The pattern of the antenna in a flat-top horizontal configuration at 9.1 meters (30 feet) is overlaid for comparison. You can see that the tilted beam has better low-angle performance, but at higher angles has less gain than its horizontal counterpart. Figure 3B shows an overlay of the azimuth patterns for these two configurations at a 10° takeoff angle.

If DX is your main interest, then you want to position the antenna even closer to vertical to emphasize the lower elevation angles. Figure 4 shows the pattern

on 20 meters when the antenna is tilted sideward 10° away from vertical, again compared with the other orientations in Figure 3A. The feed point is 6 meters above ground and the model assumes fresh water in the far field, which is the case at my portable location.

Remember that the radiation pattern is quite dependent on ground conductivity and dielectric constant for a vertically polarized antenna. A location close to saltwater will yield the highest gain and the lowest radiation angle. With very poor soil in the near and far field, the peak radiation angle will be higher and the gain less.

I have had the opportunity to test this out at my portable location. Using two trees as supports, I am able to pull the antenna close to horizontal with the feed point about 7 meters above the ground. In this position, with 20 meters open to Europe, I have found it difficult to work DX on CW with 3 W of output power. However, when I change the slope of the antenna so that it is nearly vertical I not only hear more DX stations, but I find it relatively easy to work DX.

I have tried this many times, since it is simple to lower one end of the antenna to change the slope and hence the radiation take-off angle. The sloping antenna always performs much better for working DX than a low horizontal antenna. Recently, I worked nine European countries during two evenings of casual operating, even though the highest end of the antenna was only about 10 meters high, limiting the slope to about 45°.

Figure 5 shows the elevation pattern on 28.05 MHz for the beam sloped 10° from vertical at 45° from vertical, with the feed point at 8 meters height, again compared with the beam as a flat top at 9.1 meters (30 feet). With a steeper vertical slope, the 10-meter elevation pattern has broken into two lobes, with the higher-angle lobe stronger than the desired low-angle lobe.

This demonstrates that it is possible to be too high above ground for a vertically polarized antenna. Lowering the antenna so that the bottom wires are about 2.5 meters (8 feet) above ground (for safety reasons) restores the 10-meter elevation pattern without unduly compromising the 20-meter pattern.

Portable It Is

A winning feature of this antenna is that it is so simple to put up, take down, transport and store away until it is needed again. When I am finished using the antenna and it's time to move on, I just lower the array and roll the wire elements onto the 2x2's. I put a plastic bag over

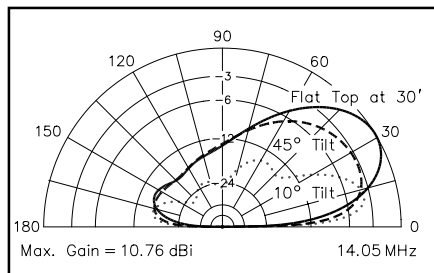


Figure 4—Comparison of elevation patterns for VE7CA Yagi as a horizontal flat top (solid line), tilted 45° from vertical (dashed line) and tilted 10° from vertical (dotted line).

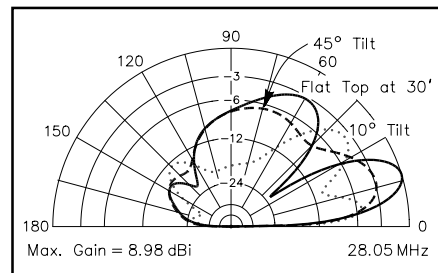


Figure 5—Same antenna configurations as shown in Figure 4, but at 28.05 MHz. On 10 meters, the flattop configuration is arguably best, but the 45° tilted configuration is not far behind.

each end of the rolled-up array and tie the bag with string so that the wires don't come off the ends of the 2x2's. I then put it in the ski boot of a car, or in the back of a family van and away we go. At home, it takes very little space to store and it is always ready to go—No bother, no fuss.

Testimonial

How well does it work? It works very well. On location I use a bow and arrow to shoot a line over a tall tree and then pull one end of the array up as far as possible. For DX I aim for a height of 20 to 30 meters if possible. For the Canada Day, Field Day and Sweepstakes contests I aim for a height of about 15 meters. This antenna helped me to achieve First Place for Canada, in the 1997 ARRL CW Sweepstakes Contest, QRP category.

The ability to quickly change direction 180° is a real bonus. Late in the 1997 ARRL SS CW contest with the antenna pointed east I tuned across KH6ND. He was the first Pacific station I had heard during the contest and obviously I needed to work him. After trying many times to break through the pileup and not succeeding, I flipped the antenna over to change the direction 180° and then worked him on my next call. Figure 6 shows the azimuth pattern at 21.05 MHz for the beam mounted with a 10° slope from vertical. There is a very slight skewing of the azimuthal pattern because the slope away from purely vertical makes the antenna geometry asymmetrical.

VE7NSR, the North Shore Amateur Radio Club, has used this antenna sloped at about 45° for the last two years on 20 and 10 meters on Field Day with good success. The title photo shows the antenna attached to a tower during Field Day.

As they say, the proof is in the pudding. If you need a 20 to 10 meter antenna with gain, this has to be one of the simplest antennas to build, and it will work every time!

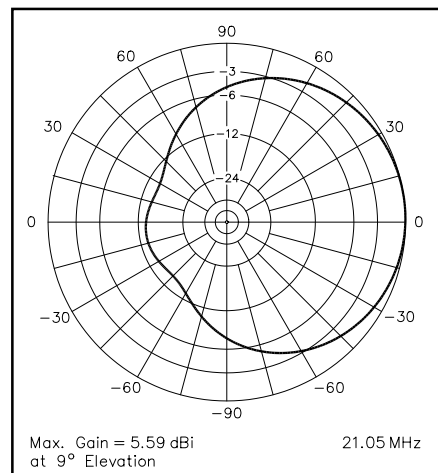


Figure 6—Azimuthal pattern for VE7CA Yagi tilted 10° from vertical on 15 meters.

Markus Hansen, VE7CA, was first licensed as VE7BGE in 1959. He has been a member of ARRL since he received his license. His main interests include DX, collecting grids on 6 meters, contesting and building his own antennas and various types of ham-radio equipment. He is also an ardent CW operator. Markus has had two previous articles published: "The Improved Telerana, with Bonus 30/40 Meter Coverage," in The ARRL Antenna Compendium Vol 4 and "Two Portable 6-Meter Antennas" in The ARRL Antenna Compendium Vol 5. You can contact Markus at 674 St Ives Cres, North Vancouver, BC V7N 2X3, Canada, or by e-mail at ve7ca@rac.ca.

You can download the EZNEC input-data files as **VE7CA-1.ZIP** from ARRLWeb (www.arrl.org/files/qst-binaries/).

QST

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