Superior Performance from a Unique HF Vertical

Unconventional no-radial, wire loop vertical is lower-noise, has directional (azimuth) gain and is simple to build.

By John Portune W6NBC

How would you like a no-radial, small-footprint, ground-mounted vertical that outperforms other verticals of the same size? This one surprisingly is horizontally-polarized for lower noise, has 5-7 dBi of directional (azimuth) gain and has the same low-angle radiation of a conventional vertical. Difficult, you say; read on.

Figure 1: Loop vertical installed at my radio club's site. Loop wires (yellow), guys (black) highlighted for clarity.

Ground-mounted HF vertical antennas are popular with hams for low-angle radiation, smaller size and simplicity. They are, however, often rejected for picking up more noise than horizontal antennas, and for having no directional gain unless used in phased arrays – they're omni-directional.

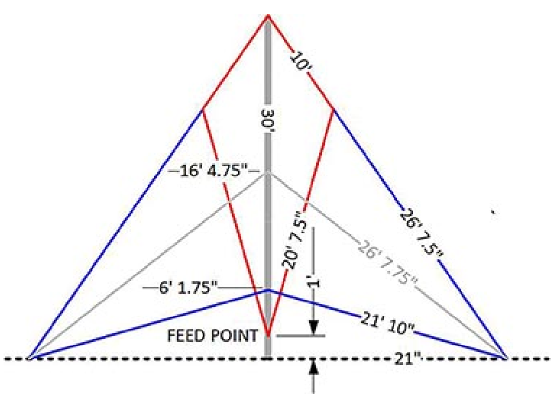

Figure 2: Dimensions of the kite-shaped wire-loop vertical (red) with a full set of guys (blue). Optional extra guys (gray)

Figures 1&2 show an unconventional super-easy solution to the major weaknesses of a vertical. It's a kite-shaped closed loop operating as a no-radial vertical. It's quickly made from just ordinary wire and a basic push-up mast and it efficiently works all bands 20-6m. It also works 40m/80m with reduced but very useful performance.

The same design concept can be applied to other heights as well. For example, A 50 ft. version would be efficient on 40m. I still have a 48 in. working scale model on 2m. For HF, it is a good alternative to a much-larger beam on a tower, particularly where

CC&R's apply or at a small urban QTH like mine. It is equally at home for portable operation or field day.

Bill of Materials

1	30+ ft. push-up telescoping fiberglass or metal mast
	Mast and guy hardware and optional decoration
200 ft.	Guy cable, galvanized steel or non-metallic line
75 ft.	12-14 AWG solid/stranded, bare/insulated wire,
1	Base-mounted antenna tuner (see article)
1	1:1 current choke balun (see article)

Design Concepts

Speaking first to polarization, respected ham radio author, L. B. Cebik, W4RNL (SK), wrote. "Most human-made noise [QRM] is vertically polarised and of *ground wave propagation*. Hence, [conventional] ground-mounted verticals are more susceptible [to noise]. A horizontal antenna generally shows an immediate 3 dB reduction." RF noise begins as both vertically and horizontal polarized ground waves. The horizontally-polarized wave is, however, quickly attenuated by the ground.

Basic physics dictates that a conventional vertical, with only a single vertical radiating element, cannot be horizontally polarized. A closed loop connected at the top and bottom can be. It may be either vertically or horizontally polarized, depending on how it is fed. Familiar examples are the cubical-quad and the Hentenna, a 6m closed loop developed originally in Japan. A quad uses a square loop, the Hentenna, a narrower rectangular loop.

Easier to Build

A vertical closed loop does not, however, need to be square or rectangular. This one is kite shaped which give it two additional advantages. One, it is easier to construct. It uses only the antenna wire, guy lines and a mast – the epitome of simplicity. Figures 1&2. There are no quad spreaders, no booms and no cross arms. The top antenna wires share 10 ft. of two of the guys. The bottom wires are also supported by the guys. Metal guys with egg insulators are best for a permanent installation, non-metallic guys are best for portable operation.

[NOTE to QST: The guy lines are tied down at diagonally-opposing corners of a 30 ft. by 30 ft. square to stay within the overall dimensions of the antenna design competition. The height is also 30 ft.]

Elevated Radiation

I noted the second benefit to a kite shape while modeling loops with EZNEC. All the parts of most antennas do not radiate equally. A familiar example is the radiation from a basic dipole, which does not come equally from the entire length but more from the center. The ends contribute little. Here the kite shape radiates more from the top than a conventional no-radial vertical. Greater radiation height reduces ground losses and improves gain.

Figures 3&4 shows the EZNEC elevation radiation patterns and gains of the loop on 20m, 15m, 10m and 6m (over average soil). A conventional no-radial ½ wavelength vertical dipole, with the same base height, has an elevation gain of roughly 0.22 dBi at a wave angle of 19 degrees. The data here was taken with the loop on a fiberglass mast using non-metallic guys. A metallic mast and guys are much the same. I verified this with EZNEC.

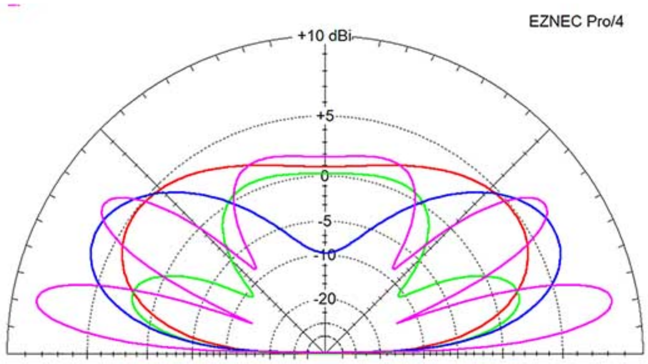

Figure 3: Elevation radiation patterns and gains on 20m: red, 15m: blue, 10m: green, 6m: violet

Band	dBi gain	Angle
20m	4.88	38
17m	6.15	32
15m	6.58	29
12m	4.62	23
10m	2.21	12
6m	9.71	10

Figure 4: Azimuth and Elevation gains and wave angles

Feeding the Antenna

A further unconventional aspect of the loop is that it operates entirely in non-resonant mode. That is, it does not show a low SWR or a 50 Ohm feed impedance on any ham band. This is due to its natural resonant frequency of roughly 16.8 MHz. A familiar antenna that also generally operates in the non-resonant mode is the popular 43 ft. vertical with radials. It is naturally resonant at 22.9 MHz. Like this loop, the non-resonant length has advantages.

Using an antenna in non-resonant mode illustrate a very basic antenna principle. The physical structure of an antenna does not need to be naturally resonant in the band of operation. If it is, the only benefit is that it is generally easier to match directly to the feed line. However, if properly matched to the feed line, any piece of metal, no matter what its shape, has no choice but to radiate the power delivered to it. Yes, a little will be lost in the ohmic resistance of the radiating elements and the radiation pattern may not be ideal, but an irregular shape MUST radiate the power when properly matched.

To drive home the basic concept of non-resonant mode, consider a common dipole cut to length by the familiar formula (L=468/f). This specific length does present a fairly-close match to coax. Suppose instead, that it is then made much too long or short, thereby putting it in non-resonant mode, and matched with a tuner? Will it still radiate as effectively?

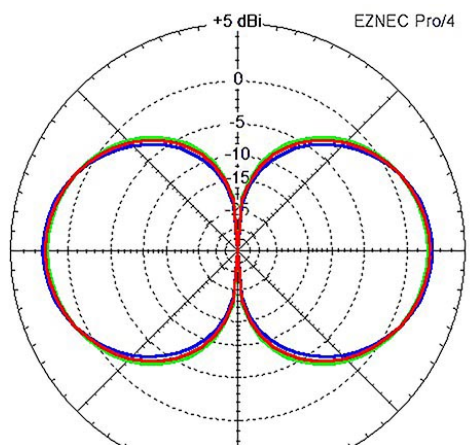

Figure 3: Radiation patters and gains of a 40m dipole matched with a tuner and operated on 5 MHz (green), 7 Mhz (red) and 9 MHz (blue).

To make the answer easy to see, notice Figure 5. It shows the radiation patterns and gains of a dipole cut to length for 40m. Then it is operated in non-resonant mode at 5 MHz and 9 MHz using a tuner. The superimposed gains and radiation patterns demonstrate that the physical configuration of the conductors determines how an antenna radiates, not the natural resonant frequency.

Some hams, though, are leery, believing that tuners “eat power.” Not so. Respected antenna authors have repeatedly pointed out that the inductive and the capacitive elements of a tuner do not dissipate power. Only the resistance part of the impedance of an antenna or turner can consume power. Yes, there are losses in a tuner, just as there is loss in loading coils and the conductors of an antenna. But if a tuner is proper designed, and not operated at its extreme limits, the losses are small.

Therefore, as this loop operates entirely in non-resonant mode, **do not attempt to feed it directly with coax.** Some form of matchbox at the base of the loop is not an option. Attempting to use a tuner in your shack and to run coax directly to the antenna is a totally unacceptable. Especially is this true if you try to use an auto-tuner in your rig. Don’t; you will likely damage the rig. Neither is a 4:1 or 9:1 balun a substitute for a matching network at the base of the loop. Either method will introduce high SWR and high losses.

You can, however, eliminate the tuner if you use the loop on only one band. In this case, cut the length of the loop to make it a full wavelength on that band. It will now operate in resonant mode and be easily matched directly to coax with a simple L-match.

For all-band usee, most external base-mounted tuners are useable with this design. It can be a commercially-built remote auto tuner, a manual tuner enclosed in a weather-tight box, or a purpose-built relay-switched match box. For convenient automatic operation, I normally use an MFJ-993BRT 300W remote auto tuner. With a quick push of a button, I am on any HF ham band or 6m. There are several other suitable similar units on the market, such as the LDG RT-100 and the RT-600 remote auto tuners. My Icom AH-4 and my older Alinco EDX-2 also work well.

It is also important to isolate the tuner from ground. That is, the tuner must “float.” Use 1:1 choke, current balun right before the tuner. A handful of common snap-on ferrite split-bead chokes will also be acceptable.

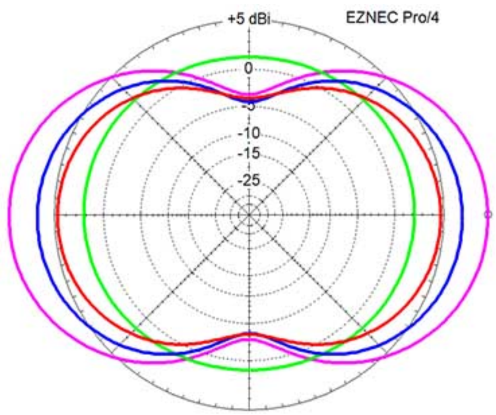

Figure 6: Azimuth patterns and gains. 20m: red, 15m: blue, 10m: green, 6m: violet

Directional Gain

Speaking now to the gain of this loop, a conventional vertical is omni-directional. This kite-loop has 5-6 dBi gain in the familiar bidirectional donut-shaped pattern, Figure 6 is the azimuth pattern. At most mast heights and loop lengths one or more bands may not exhibit gain. Note here for a 30 ft. mast on 10m that the azimuth pattern is omni-directional. The affected bands vary with mast height and loop length.

As with a horizontal wire dipole, you may wish to orientate the loop to favor one direction. Alternately you can make the gain electrically steerable by mounting a second loop, rotated by 90 degrees, on the other two guys. Then a remote or manual switch box will then let you switch the loops, either singly, in series or parallel, or in-phase or reverse-phased.

The Mast

Most heavy-duty push-up masts are suitable. Surplus camouflage poles or even a tree can also be used. My choice is an MFJ 1906HD 38 ft. heavy-duty push-up telescopic fiberglass mast. The wire and guy dimensions in Figure 2 are for this mast. A suitable steel mast is the Channel Master CM1850 40 ft. telescopic push-up mast. For a metal mast, the top of the loop and the feed point must be insulated. The loop will ignore a metal mast electrically.

For highly-portable situations, a lighter-duty fiberglass mast, perhaps a wind-sock pole, or even a large fishing pole, fitted with lighter wire and guys are both possible. For the MFJ fiberglass mast, I created a set of 3D printed parts for the guy rings and feed hardware. The files are free for download at w6nbc.com/kite or QST in-depth.

Erecting a push up mast is straight forward. Begin by attaching the guys and antenna wires to the collapsed mast, laying them out straight in the appropriate directions. A stake driven into the ground and a bungee cord, or a commercial mast anchor, should be used to secure the bottom of the mast. Then, elevate the collapsed mast and secure it with the bottom set of guys.

Figure 7: My antenna monkeys at a radio club event.

Next solicit assistants to keep the antenna wires and guy cables straight and to steady the mast with gentle tension on the guys as the mast sections go up. Figure 7 shows my construction crew at a recent radio club event.

Standing on a ladder, push up and secure the higher sections. Start with the top (smallest diameter) section and work downward. A common 6 ft. step ladder is usually sufficient. Figure 8 shows a ham buddy doing lifting duty at the same outing. A 10 ft. straight ladder, leaned against the guyed bottom section of the mast, may be needed for a metal mast.

Figure 8: Dayle Good KK6HNS pushing up mast sections while helpers gently hold the top guys..

On-the-air experience has shown me that this unconventional little, no-radial, all band, kite-shaped, horizontally-polarized vertical is an excellent alternative to a much-larger tower-mounted beam at my antenna-restricted QTH. It has nearly the gain of a small beam and definitely excels conventional verticals.

It is also well suited for field day and portable situations. The collapsed mast, antenna wire, cables and hardware travel well in my RV. If you make one, “keep me in the loop” (hi, hi) with pictures and results.

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