The Hourglass Loop Antenna

Build this simple VHF/UHF bidirectional antenna from readily available materials.

John Stanley, K4ERO

This horizontally polarized antenna is an extension of the horizontal loop antenna featured in *The ARRL Antenna Book*.[1] It provides useful gain with very simple construction. The hourglass form factor yields an antenna that is tall but with a tiny footprint and that doesn't look like any other type of antenna, which might make it stealthier in some applications. You could probably use it to support a banner or as a plant trellis, festooned with artificial plants.

How the Loop Works

The loop consists of a 2-wavelength-long wire formed into the shape of an hourglass, as shown in Figure 1. The wires cross in the center but do not touch. Currents travel around the perimeter of the loop and are maximum in the horizontal top wire, the horizontal bottom wire, and at the crossing point. The 50 Ω feed is in the center of the bottom wire.

The voltages are maximum at points about halfway up the sides of each triangle where the currents are minimum. The vertical currents cancel each other while the horizontal currents add in phase. Thus, the loop produces a strong horizontally polarized signal at right angles to the plane of the loop. The crossed wires in the center force the top and bottom wire currents to be in phase, thus producing gain. The horizontal component of the currents at the crossing point is also in phase with each other and adds to the signal.

This antenna can be viewed as two delta loops stacked one on top of the other, with the bottom one inverted and fed in the center of a side instead of at a corner. The top delta is fed from the bottom one. Choosing the correct height-to-width dimensions makes the feed-point impedance 50 Ω.[2]

Gain and Directionality

Compared to the 1-wavelength horizontal loop, which also has a 50 Ω feed-point impedance when the vertical sides are twice the horizontal sides, this antenna has an additional 2.5 dB of gain. Thus, the bidirectional gain is very close to 7 dBi, or about 5 dB more than a dipole. This is as much as a two-element Yagi has while being much easier to build and adjust (see Figure 2). The pattern in azimuth is the same as a dipole or a single-wave loop — that is, the 3 dB points are located at 45° off either side of the main beams. The antenna gets all of its gain by narrowing the vertical pattern, which costs nothing, as signals on these bands arrive at low angles, except for on satellite. The wide azimuthal beam makes aiming less critical and avoids missing some signals that are off the main heading.

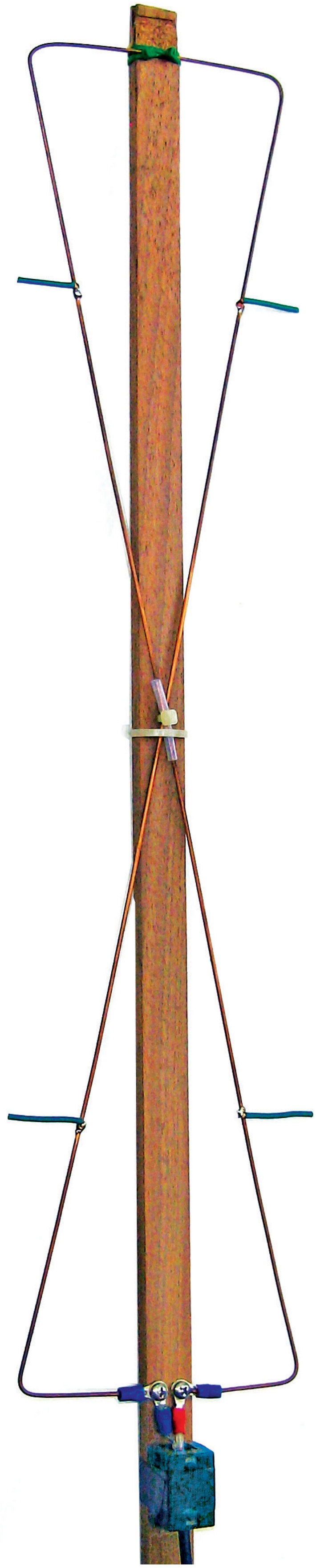

Figure 1 — A 432.2 MHz hourglass made from #14 AWG solid bare copper wire. Note the tuning flags and the clamp-on ferrite around the coaxial feed line and taped to the mast.

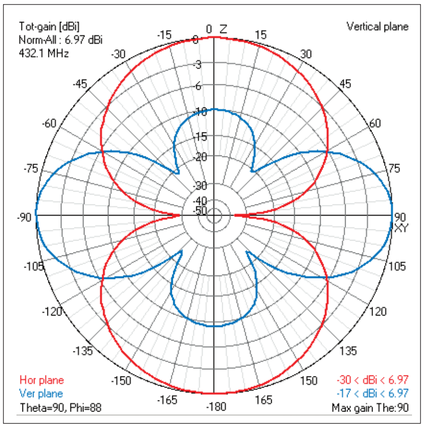

Figure 2 — Vertical (blue) and azimuthal (red) radiation patterns for the hourglass antenna.

As described here, the antenna is bidirectional. It can be made unidirectional by adding a 5% longer second loop behind it, as in a quad antenna, or by placing it in front of a flat conductive screen. Either option will add about 3 dB more gain by eliminating the signal off the back. It will also narrow the beam off the front somewhat. The feed-point impedance will change a bit, but this is not too difficult to compensate for.[3] An omnidirectional version of this antenna could also be made by using any of the methods described for the 6-meter omnidirectional antenna previously published in *QST*.[4]

Figure 3 — From left to right, hourglass antennas for 222, 432, and 144 MHz. Only the 432 MHz antenna is made from bare wire.

Construction

For the bidirectional configuration shown, the antenna requires nothing more than building a simple insulated support frame, measuring the wire to length, and stringing it on the frame (see Figure 3). Since the voltage points are not close to the support frame, wood or PVC can be used without changing the resonant frequency. To observe this, watch an SWR meter while touching the wires at the voltage points, which are between the center crossing point and the top and bottom horizontal sections (note the position of the tuning "flags" on the 432 MHz version). This will change the SWR, but there is little or no effect from touching at the support points. To avoid RF burns, do this test with a very low-power frequency source, such as an impedance meter.

If the dimensions are correct, the antenna impedance should match 50 Ω to better than 1.2 to 1 SWR. If the frequency is not correct, lengthen the wire to lower it or shorten the wire to raise it. Install the crimp lugs on only one end of the loop until you get it right. The use of a single ferrite bead on the feed line is good practice, although two computer models and tests show that even without it, the loop is remarkably free from the effect of feed-line radiation caused by common-mode currents.

The antenna is very forgiving except for having a narrow SWR bandwidth. Once you get it to resonate at the desired frequency, you can be sure that the gain and pattern are as expected. No further adjustments are needed. The bandwidth of this antenna will be about 2% of the center frequency at the 2:1 SWR points (3 MHz at 144 MHz and 9 MHz at 432 MHz). Of course, if you have loss in your feed line, it will broaden the measured SWR bandwidth somewhat. This is a relatively

Table 1
Dimensions for Hourglass Antennas

Resonant Frequency (MHz)	Wire Length (cm)	Loop Height (cm)	Loop Width (cm)
144.2	430*	175	37
222.1	279*	114.5	23
432.1	142**	59	12

*#16 AWG insulated
**#14 AWG bare

narrow-band antenna, but the activity on these bands using horizontal polarization covers only a few hundred kilohertz, so it is sufficient.

Tuning

These antennas are somewhat sensitive to nearby objects, so do the tuning with the antenna mounted in its final position where possible. Otherwise, put it clear of any nearby objects when tuning.

Dimensions for 144, 222, and 432 MHz versions of the hourglass are included in Table 1. The 144 and 222 MHz dimensions are based on use of #16 AWG stranded wire with PVC insulation such as that sold at home improvement stores. The 432 MHz antenna uses #14 AWG bare copper obtained from stripping house wire. Straighten and work-harden the wire by stretching. With the solid wire, no cross arms are needed. For thicker or thinner wire or wire with different insulation, the wire lengths may have to be changed by a few percentage points to move the resonant point back to the desired frequency. Where the wires cross, tape them to the vertical mast so they are held firmly, otherwise wind will cause the SWR to flutter. Of course, they are not connected because of the insulation. For the bare wire version, I added insulation at the crossing point. Varying the wire separation by a few millimeters where they cross provides a fine tuning adjustment to the resonant frequency.

> *“Varying the flags’ location, orientation, and length provides an easily adjustable fine tuning.”*

Tuning is also done by changing the total wire length. With the solid wire version, I used an alternate fine-tuning method by attaching movable 3-centimeter-long stranded PVC-covered wire “flags” at the high voltage points (see Figure 1). Make the flags by stripping a bit of insulation from one end and wrapping the exposed strands around the solid wire. Varying the flags’ location, orientation, and length provides an easily adjustable fine tuning. Once the desired resonance is obtained, the flags are then soldered in place. The dimensions of the 432 MHz antenna are chosen to give a resonance of about 450 MHz without the flags. The flags pull the frequency down to 432 MHz when adjusted outward, as shown in Figure 1, and all the way down to 420 MHz when they are oriented inward. After moving the flags, check the SWR at your frequency.

Other Frequencies

The frequencies listed in Table 1 are those popular for DX work where SSB and CW and horizontal polarization are used. Of course, you could scale the design to any other frequency. Six- and ten-meter versions could also be built but would be quite tall, with a very small footprint. The hourglass could be laid on its side for FM work with vertical polarization, however, the advantage of the wide azimuthal pattern and narrow vertical pattern would be lost. I suppose this would be called a “lazy hourglass antenna.”

One could also make one of these for 80, 60, or 40 meters by laying it on its back an eighth wave over the ground for NVIS work. This would be a “very lazy hourglass antenna,” and would require a rather long but narrow strip of land. For work out to a few hundred miles, it would have up to 5 dB gain over a dipole, especially in directions at right angles to its long dimension.

Notes

[1] *The ARRL Antenna Book, 23rd Edition*, pp. 9 – 38. ARRL Item no. 0444, available from your ARRL dealer, or from the ARRL Store. Telephone toll-free in the US 888-277-5289, or 860-594-0355, fax 860-594-0303; **www.arrl.org/shop/; pubsales@arrl.org**.

[2] J. Stanley, K4ERO, “Some Additional Geometries for Loop Antennas,” *QEX*, July/Aug. 2018, pp. 31 – 36.

[3] Experimenters wishing to build a unidirectional or omnidirectional version of this antenna can contact the author for further information.

[4] J. Stanley, K4ERO, “An Omnidirectional 6-Meter Horizontally Polarized Antenna,” *QST*, Apr. 2017, pp. 38 – 42.

Photos by the author.

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