The Hen-Delta 6m Antenna

Improving the popular 6m Hentenna. Easier to build – Easier to tune – Better performance when ground mounted – Made from ½ in. copper and PVC pipe.

By John Portune W6NBC and Jim Bailey W6OEK

This design improves on a popular 6m classic, the Hentenna, developed for the magic band in Japan in the 1970's. As a re-design of this familiar tall skeleton slot, seen widely on the internet, it incorporates significant improvements noticed during the design of a related antenna, the HF kite-shaped slot antenna, QST, July 2019.

Figure 1: My ground-mounted prototype

Changes to the Hentenna

It became obvious with the kite antenna, a near relative of the Hentenna, that a rectangular shape is not optimum. The reason is basic physics – radiation cancellation present in varying degrees in all antennas. It led to the top being made wider than the bottom. The result is a higher center of RF radiation for less loss and better performance when the antenna is ground mounted. Llow mounting can be a real asset with neighbors and HOA's. Figure 1 shows the prototype.

Structurally, by using rigid copper water pipe, only a half-height support arm and a base clamp are required – no guys. It will free stand in a buried ground-mount tube, on an under-car-wheel mount for temporary operation, or clamped to the top of a mast. The large copper conductors yield high efficiency.

Elevated Radiation

The reason the radiation moves upward in an inverted delta compared to a rectangle, is the proximity of the lower conductors. At the bottom, the adjacent conductors behave more like a non-radiating open-wire transmission line. Out of phase equal amplitude currents result in little radiation, just as in an open wire line. The EM wave from this antenna, therefore, radiate mostly from the top, horizontally polarized. Also, being tall and narrow, like a classic vertical, the radiation angle is low.

If you would like to confirm these findings, e-mail W6NBC for an EZNEC model file: jportune@aol.com. With it, perform an [FF PLOT] and then look at [CURRENT PHASE] in [VIEW ANTENNA]. There you can see the radiation cancellation and the polarization. For a more-complete explanation, see chapter 15 of the Amazon/Kindle e-book: *Slot Antennas for Ham Radio*.

Performance

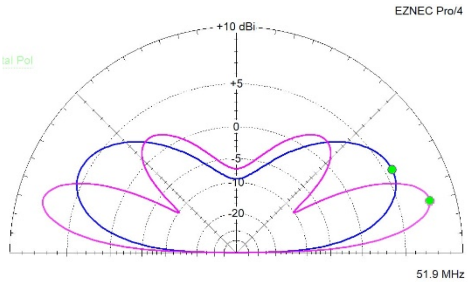

Figure 2: Elevation radiation patterns with gains at 1 ft (blue) and 10 ft. (violet)

Figures 2 and 3 show the comparative radiation patterns at ground level (blue) and at 10 ft over average soil (violet).

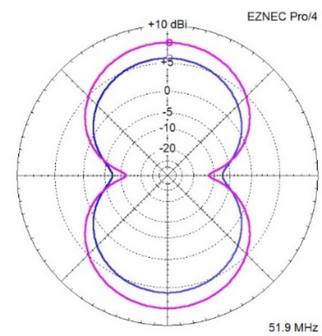

Figure 3: Azimuth (horizontal) radiation patterns with gains at 1 ft (blue) and 10 ft. (violet)

Figure 3 shows a further benefit, azimuth gain (6dBi when ground mounted). Conventional verticals normally need to be in a phased multi-antenna array to give azimuth gain. The gain here is comparable to a small beam on a modest tower, with an antenna that is far less visible to the neighbors.

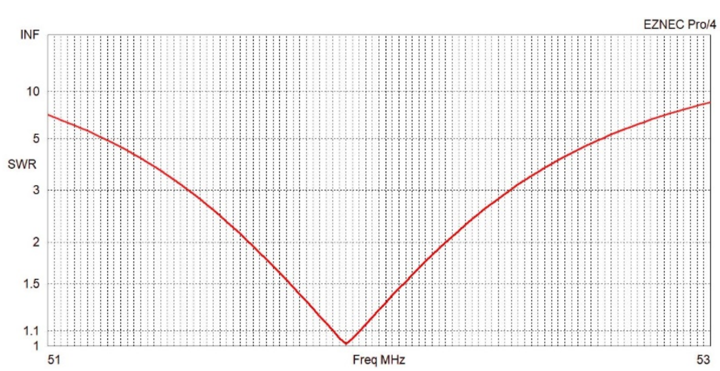

Figure 4: SWR curve

Figure 4 shows the 3 dB bandwidth, roughly 1 MHz.

Construction

Figure 5 gives dimensions and materials. Note the movable fixtures near the bottom (black). These are the adjustments for frequency and SWR. The coax connects to the ends of the SWR fixture (more detail below and in Figure 8).

Begin by bending 12 in. of one end of two 10 ft. lengths of Type M common ½ in. rigid copper water pipe to the small angle shown in Figure 5 & 6. Avoid type L or K pipe – unnecessarily heavy. To make the bends, flatten the pipes halfway with the tip of a large Vice Grip style pliers. The half-flattened spot will then bend neatly over the edge of a workbench, Figure 6. Next, trim the total length of the side sections to 112 in, including the bent ends.


Figure 6: Bend at half flattened spot in pipe

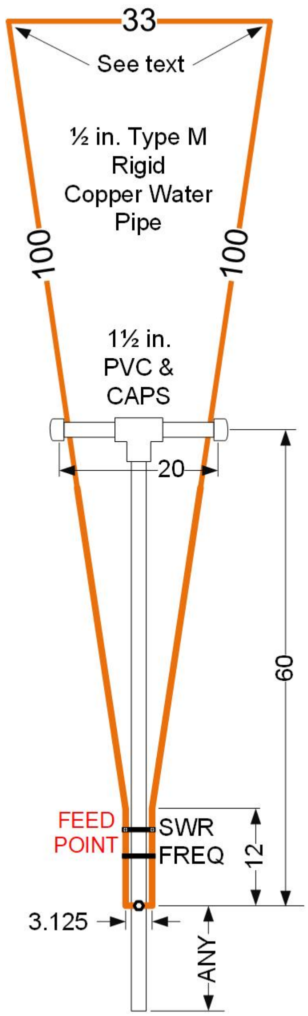

Figure 5: Essential dimensions and materials.

For the odd-angle corners at the top, completely flatten 1 in. of the ends of the side and top pipes and drill holes for ¼-20 stainless bolts, washers and nuts.

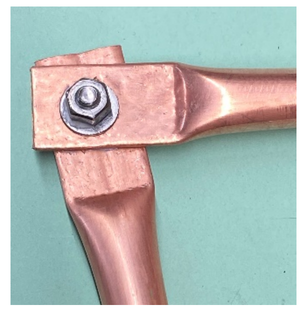
Figure 2: Flattened and bolted top corners

Mast snd Support Arms

For the mast, cut a length of 1½ in. white Schedule 40 or gray Schecule 80 PVC pipe suitable for your preferred method of mounting – mast or ground mount, and two 10 in. lengths of the PVC pipe for the cross arms. Next make a slot across the center of one end of each cross arm, 2¼ in. deep by 5/8 in. wide. Cement together the mast, the T coupling and the support arms, being sure that the slots point upward.

Cut a short 2¼ in. pipe stub to go between the elbows at the bottom of the delta. Drill a ¼ in. hole through the middle of the stub for attaching the antenna to the PVC mast. Finally, assemble all the copper pieces on a flat surface with the bent pipe ends parallel to the mast. Bolt on the top section and solder the bottom short stub and antenna pipes

Insert the antenna into the slots in the PVC cross arms, adjusting the height of the PVC cross arm from the bottom for a proper fit, Figure 5. Cement on 1½ in. pipe caps to the cross arm ends to complete the support. The cross arms will be roughly 60 in. from the bottom. Drill a ¼ in. hole through the PVC pipe at the bottom to match the center hole in the pipe stub. Bolt the antenna to the mast with a 3 in. stainless bolt, nut and washer.

Adjustment Fixtures

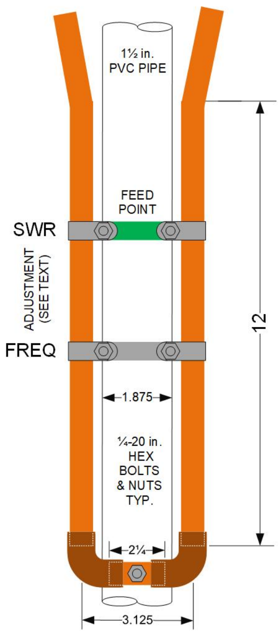

Figure 8: lower sections with feedpoint (SWR) and frequency adjustment.

The moveable bars for adjusting frequency and SWR attach to the side pipes by modified ½ in. stainless wire clamps They are available at most electronics parts stores and on the internet. Figures 8 & 9 show the details.

These are the clamps that I used:

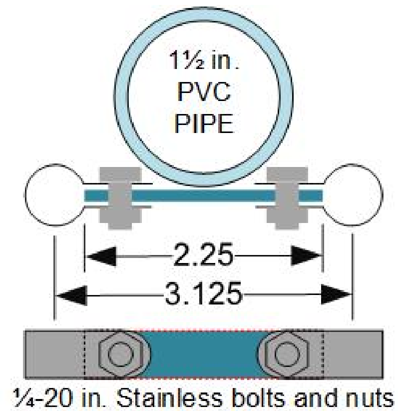

Figure 9: Moveable adjustment bars for frequency and SWR.

https://smile.amazon.com/Cable-Lokman-Stainless-Rubber-Cushioned/dp/B01N074XSY/ref=sr_1_3?dchild=1&keywords=1%2F2+in.+stainless+wire+clamps&qid=1604016706&sr=8-3

Remove and discard the neoprene cushoning. Partially bend open the clamp and them flatten both ends. Re-form the clamp around ½ in. copper pipe, bending the ends into the shape shown in Figure 10. Electricians pliers and heavy-duty needle nosed pliers work well for bending.The end holes in the clamp should line up as shown.


Figure 10: Re-shaped stainless cable clamps for ends of adjustment bars.

Cut two 2½ in. x 1/8 in. x ½ in. flat bars to connect the clamps. For the SWR (feedpoint) bar, make it of an insulating material, e.g. plastic. Use aluminum or copper for the frequency bar. Flattened ¼ in. aluminum or copper tubing is also suitable for the frequency bar. Drill ¼ in. holes, ½ in. from both ends for ¼-20 in. bolts and nuts.

Feedline and Balun

Prepare a pigtail of RG-58 or Mini RG-8 with a connector on one end. Separate and fan out roughly 3 in. of the braid (shield) and the center conductor into separate wires. Add heat-shrink tubing for weather proofing and ring terminals for ¼ in. lugs. For the run into to the shack, use larger low-loss coax. Small diameter coax has high loss at VHF.

Also provide a 1:1 current choke balun at the antenna. It can be a commercially-made unit, several ferrite sleeves, toroids or clamp-on choke beads, or 6 turns of the coax pigtail wrapped around the PVC mast, secured with holes in the mast and/or zip ties.

Tuning and Matching

With the antenna in a ground mount or temporarily mounted on a non-metallic support at least 5 ft. above ground, adjust the tuning and matching (SWR) with an antenna analyzer, portable VNA or a transceiver and an SWR bridge. Adjust the match first for a low SWR, paying little attention initially to the resonant frequency. Once set, the SWR will change little when you next adjust the frequency. To set the frequency, move both bars as a pair, maintaining the separation. Minor re-adjustment will likely be required with the antenna in its final location.

Good performance when ground-mounted for low neighbor/HOA visibility, ,azimuth gain comparable to a small beam, plus horizontal polarization make this small vertical a good choice for the magic band, as a permanent installation or for portable/field day operation.

My sincere appreciation to W6OEK Jim Bailey for his help on this antenna. His keen insight twice destroyed my initial engineering, but the final result is now clean and easy.