A scaled-up and improved 6-meter version of the popular 2-meter copper-pipe slot-cube antenna.

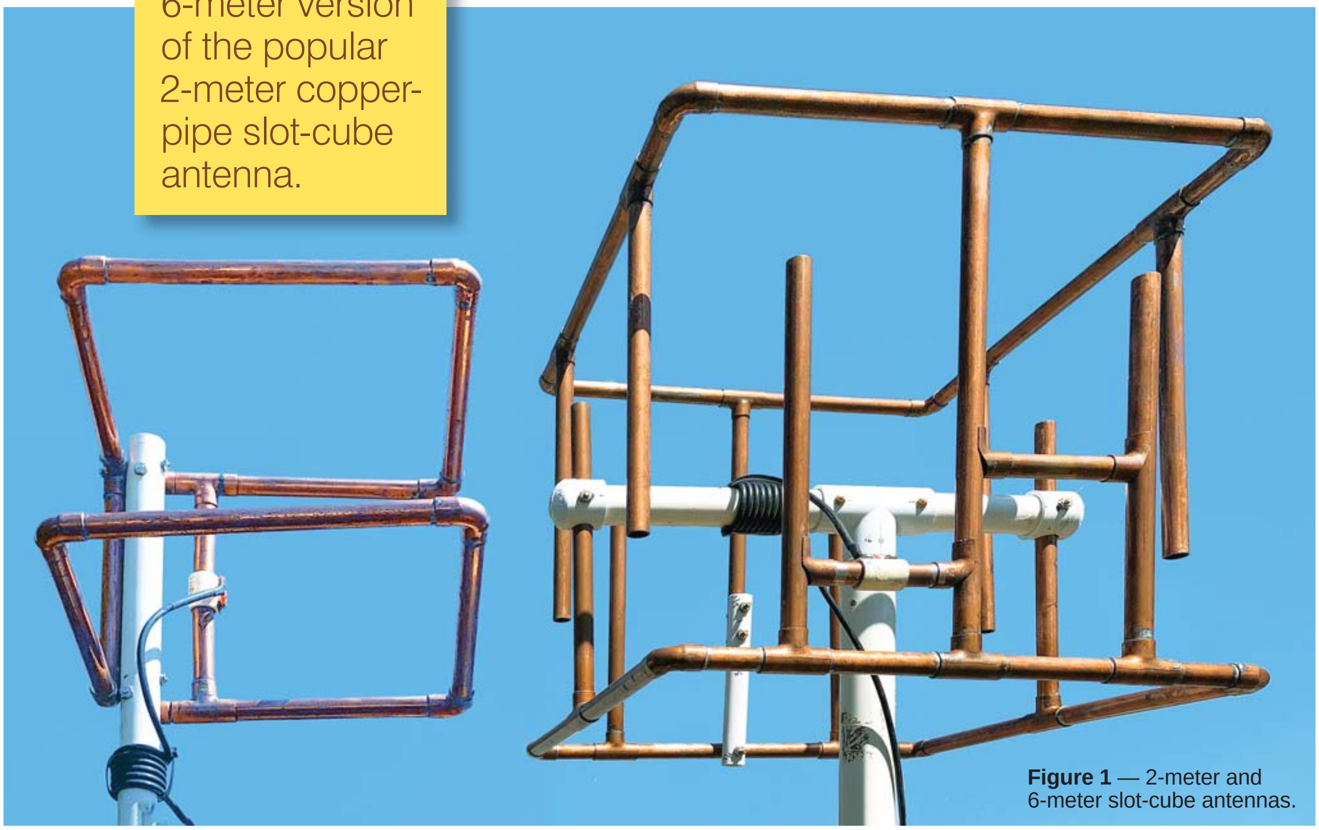

Figure 1 — 2-meter and 6-meter slot-cube antennas.

Slot-Cube Antenna for 6 Meters

John Portune, W6NBC

In the January 2019 issue of *QST*, I introduced the slot-cube, a remarkably small 2-meter base station antenna, with similar gain to a J-pole, and, like the popular homebrew version, soldered together from ½-inch copper water pipe. In response, I've received a flood of emails and photos from around the world, and many have wanted to know if the design can be scaled up to 6 meters. Figure 1 shows my 16-inch 6-meter slot-cube antenna, only 60% bigger than its popular 2-meter cousin.

Hamspeak

Skeleton slot

An antenna consisting of a full-wave rectangular loop higher than it is wide. It is fed via a transmission line split to connect to the center of each vertical side. It acts as two horizontally stacked bent dipoles in phase and was used as the driven element structure of a VHF stacked Yagi array popular in the 1950s.

How Slot Cubes Work

Slot cubes are folded skeleton slot antennas with widened, folded dipoles bent into a cube to reduce size. The Japanese "Hentenna," found widely on the internet, is a straight version of the *skeleton slot*. To adapt the 2-meter design to 6 meters, one needs to reduce the size even more. Simply scaling up the 2-meter slot cube in the same copper pipe makes for a heavy and large antenna on 6 meters.

Therefore, I folded the slot one more time, adding open-ended vertical elements with caps (for rain) to stagger the slot. The slot now wanders up and down as it folds around the cube. Figure 2 shows the evolution and size reduction, compared to its larger parents of a straight skeleton slot and a single-folded slot-cube, all on the same frequency.

Performance

Figure 3 compares the free space elevation radiation patterns of a normal 14-foot-tall, 6-meter **J**-pole (blue) made from ½-inch copper pipe and the 16-inch double-folded slot cube (red). Both are almost perfectly omnidirectional in azimuth.

As seen, the slot cube has a nearly isotropic pattern, meaning it puts a signal in all directions. This requires that the gain towards the horizon is about ½ to ⅓ of an S-unit less than the **J**-pole, which has nulls vertically like any vertical dipole.

Efficiencies are above 95% for both antennas due to the large-diameter copper conductors. Like all size-reduced antennas, the slot cube is narrow in SWR bandwidth. The **J**-pole bandwidth is roughly 3 MHz at 2:1 SWR, whereas the slot cube is roughly 300 kHz. This means the slot cube must be carefully tuned to your operating frequency. Provision for that is provided in this improved design.

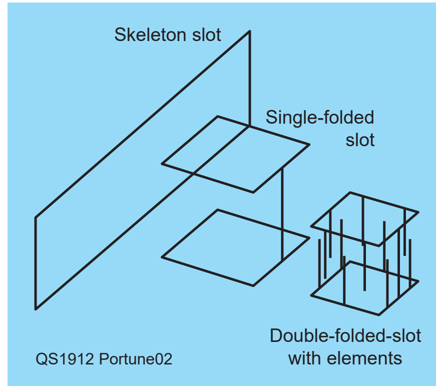

Figure 2 — Evolution of 6-meter skeleton slot with relative sizes to scale, all on 6 meters. From left to right: unfolded, folded, and folded and staggered.

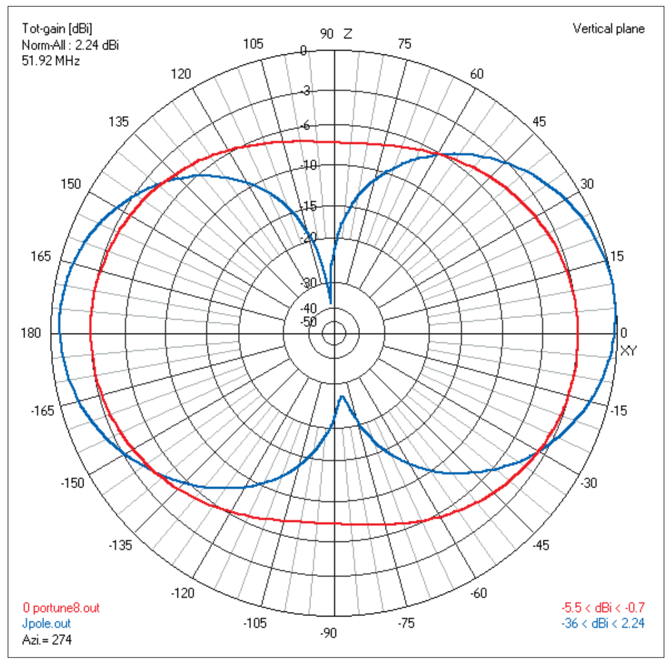

Figure 3 — *4NEC2* copper pipe 6-meter **J**-pole (blue) and slot-cube (red) free space elevation radiation patterns.

Materials List

The dimensions are cut lengths of the pipe sections, not overall antenna dimensions. They do not include the length added by the elbows and **T**s. Assemble the antenna with these pipe lengths and the tuning will be correct.

(8) 2¼-inch lengths of ½-inch rigid copper water pipe

(2) 3¾-inch lengths of ½-inch rigid copper water pipe

(8) 7-inch lengths of ½-inch rigid copper water pipe

(3) 8¼-inch lengths of ½-inch rigid copper water pipe

(11) 10½-inch lengths of ½-inch rigid copper water pipe

(1) 14.625-inch lengths of ½-inch rigid copper water pipe

All of the above can be cut from two 10-foot lengths of copper pipe.

(8) ½-inch short-radius (standard type) copper pipe elbows

(15) ½-inch short-radius (standard type) copper pipe **T**s

You must use standard radius parts (not extended radius), for correct dimensions.

(8) ½-inch copper pipe caps for open-ended pipe sections

(1) CPVC pipe coupling (not a PVC coupling, which won't fit the tubes)

(2) crimp terminals for #6 stud, to be installed on coax

(8) 10-24 × 2 inch stainless-steel screws and nuts

(2) 6-32 × ⅜ inch stainless-steel screws

(2) 6-32 stainless-steel flat washers

(1) RG-8X or RG-58 for feed and balun

(1) 5½ inch × 1 inch PVC pipe

(1) 9 inch × 1 inch PVC pipe

(1) 1-inch PVC **T**

(2) 1-inch PVC caps for mounting (see "Mounting" section)

(1) 7 inch × ½ inch PVC pipe, for brace

Figure 4 is the physical layout of the antenna, including the locations of the copper-pipe sections listed.

Construction

The cube has two distinct halves (red and blue, see Figure 4) connected by a single vertical pipe (green). Solder together each antenna half separately. Four common bricks laid on a flat concrete surface work well during soldering. Square up everything before beginning. Misadjustments are, however, easy to correct by reheating individual joints after the cube is fully assembled. At first, do not solder either end of the connecting section (green). You may wish to change its length during tuning. The antenna will function normally when only partially soldered, and final soldering can be done after tuning. The 7-inch black piece is the PVC brace.

Improved Tuning

The tuning and SWR adjustments are easier here than on the 2-meter version. I added movable pipe sections at both ends of the slot (see Figure 5). I made the movable pipe ends by cutting a copper T in half longitudinally through the center of the side arm. I further cut off the corners at a 45-degree angle. Then, I filed out any internal material to allow the curved surface to slide freely along the tubing. The short cross-pipe section on the left tunes the frequency. If the overall dimensions are correct, it should be possible to tune over the 50 – 54 MHz range.

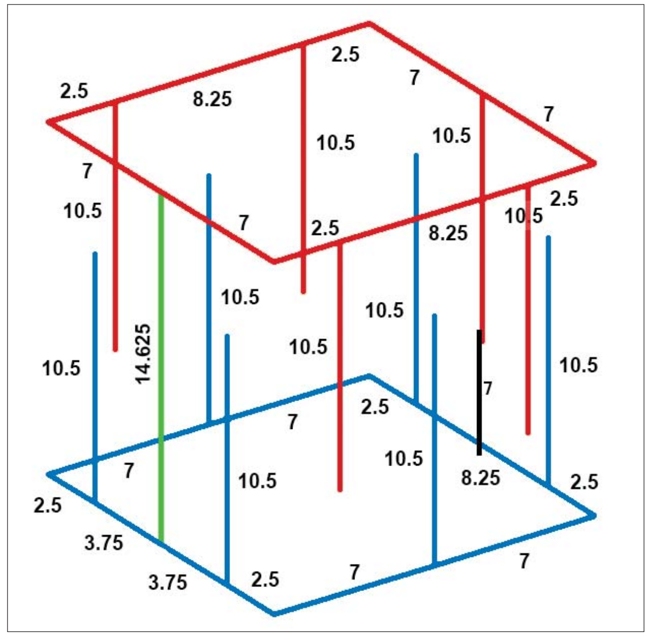

Figure 4 — Cut lengths (inches) and locations of copper pipe sections.

Figure 5 — Movable bars, tune (left), and match (right). Also, note the feed point.

Soldering Tips

The antenna may be assembled by following standard plumbing methods with sweating flux. Excess solder will not affect performance but may be unsightly. For a cleaner result, the following alternate process may be used.

1. Degrease pipe sections and fittings with acetone.
2. Carefully remove copper patina with swimming pool hydrochloric acid and rinse thoroughly.
3. Apply a coating of rosin flux thinned with acetone. Let the flux dry.
4. Assemble and add a minimum amount of solder. Unlike with plumbing work, the joints don't need to be watertight.
5. After you have tuned the cube in its working location, you may just temporarily remove any non-copper parts, reheat the joints, straighten things up, and add more solder.

The section with the CPVC coupling adjusts the SWR (the match). Adjusting the tune frequency affects the match only slightly. The feed coax attaches on this section by crimped-on ring terminals and 6-32 screws into tapped holes in the pipe ends. Weatherproof the separated coax wires with heatshrink tubing. There is roughly a ⅛-inch gap between the pipe ends inside the CPVC coupling. After tune and match adjustments at the working location of the antenna, the movable sections may be screwed, hose-clamped, or soldered in place.

Mounting

One-inch PVC is suitable for mounting (see Figure 6). The ⅝-inch holes drilled through the end caps allow the mount ends to slip over two of the open-ended pipes. The mount is centrally located in the cube and secured by 10-24 × 2 inch stainless-steel screws through the end caps and pipe. An additional small seven-inch brace of ½-inch PVC pipe provides final stabilization for the cube, as seen in Figure 7. It is attached on the opposite face of the cube from the crossover pipe by three 10-24 x 2 inch screws.

Figure 6 — Mounting assembly. Note ⅝-inch holes through the end caps and 10-24 x 2 inch screws.

The main mounting **T** is located slightly off center to allow the antenna to be mounted for either vertical or horizontal polarization. As oriented in Figures 1 and 4, the polarization is vertical, which is preferred for FM work, and will work fine for DX work (sporadic E) on all modes via the ionosphere. For local SSB contacts, horizontal polarization is preferred. Further details on patterns and mounting for horizontal polarization can be found on the "QST in Depth" web page (**www.arrl.org/qst-in-depth**).

For a mast or mounting nipple, use Schedule 40 PVC or aluminum pipe or a steel TV mast inserted into the mounting **T** secured with a 10-24 x 2 inch screw through the mast.

Lastly, a 1:1 current choke balun is required near the antenna. A handful of Mix 61 ferrite toroid cores slipped over the coax may be used, or nine turns of RG-8X or RG-58 around the PVC cross-arm or mast secured with cable ties through 3/16-inch holes. The balun prevents detuning and distortion of the radiation pattern by common-mode currents in the coax and should be present when doing adjustments, as it may affect the measured SWR.

Figure 7 — Mounting brace location.

> Following in the footsteps of the ever-popular homebrew copper pipe **J**-pole, this little antenna is a good performer and is much stealthier than most 6-meter antennas.

Photos by the author.

John Portune, W6NBC, is an ARRL member and frequent contributor to *QST*. He has been licensed for 54 years and has held an Amateur Extra-class license since 1972. John has a BS in physics and also holds FCC Commercial General Radiotelephone Operator and FCC Radiotelegraph licenses. He retired as a broadcast television engineer and technical instructor at KNBC in Burbank and then from Sony Electronics in San Jose, California. He will be pleased to correspond via email at **jportune@aol.com**, or at **www.w6nbc.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.