A Coat Hanger Beam to Hang Your 440 MHz FM Signal On

By Richard Fisher, KI6SN

The arrival of a digital television (DTV) converter here set the wheels in motion to build a little receiving antenna for the relatively new, non-analog, over-the-air signals beamed from stations across Southern California.

Commercially-made DTV antennas can be pretty pricey, but a piece of wood, a handful of metal coat hangers and some hardware yielded a great little beam that picks up as many as 106 non-cable digital stations here – *all free.* Ah, TV DXing. Another story, though, for another time.

The exercise brought back memories of 1960s Novice days in New England when my friend and I built a beam for 2-meter AM using a broomstick and all the metal coat hangers we could scrounge from our parents' closets. The antenna worked great and survived several Massachusetts winters.

Building the DTV beam was so much fun it begged the question: *How about making a coat hanger beam that's trail friendly for VHF or UHF?*

A lightweight 6-element 440 MHz FM beam antenna that's inexpensive and a snap to make performed nicely from the top of Mount Rubidoux in Riverside, California, on ARRL January VHF Sweepstakes weekend.
(Photographs courtesy of KI6SN)

'Direct Feed' Is A 'Must'

There are plenty of 2-meter T-FR antennas here, but only a little handi-talkie *rubber duckie* for 440 MHz FM. Element lengths at 70 cm are short and manageable. We'd just need to look around for a nice design.

The only requisite was that the antenna must allow for *direct feed* – meaning the feed line is attached directly to the driven element. Having to fiddle with tuning a gamma, beta, delta or T-match just wouldn't do. Especially with an antenna that would be disassembled, assembled, then disassembled again with each round trip to the field.

A Web search brought up many interesting 70cm beam designs, but a paper titled *Controlled Impedance 'Cheap' Antennas* < http://bit.ly/dKZZUK > by Kent Britain, WA5VJB, of Grand Prairie, Texas, emerged the winner. You may recognize 'VJB's name and call sign from his extensive writings in publications including *CQ Amateur Radio* and *Popular Communications.* The *cheap* part the paper's title was particularly attractive.

As you can see in the accompanying illustration and pictures, the 440 MHz beam features a robust six elements: A reflector (REF), four directors (D1-4) and the driven element (DE), shown in red.

Designing for the Field

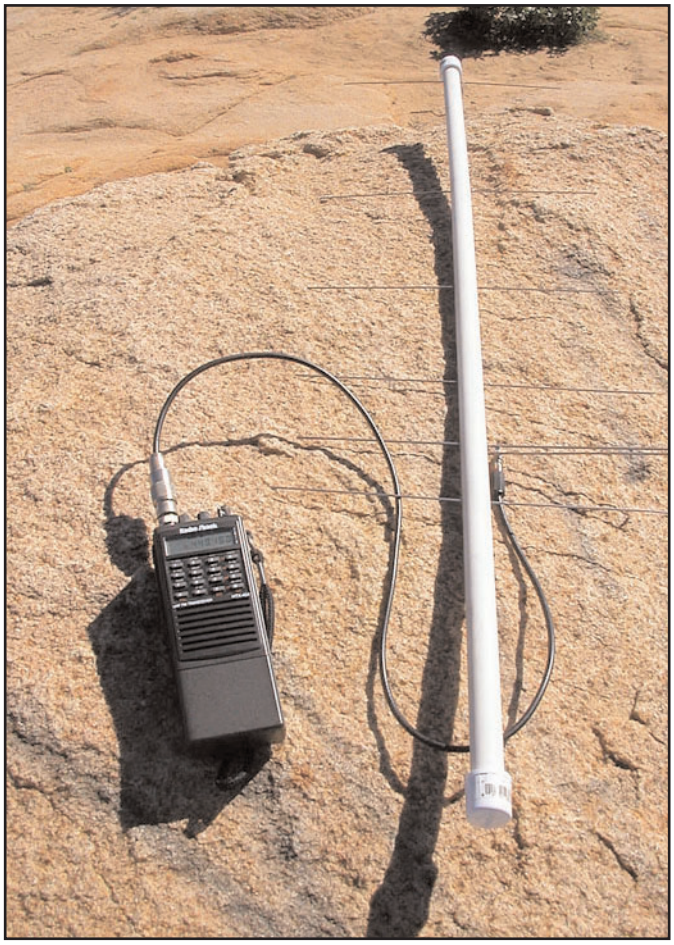
With the trail-friendly mantra in mind, a 40-inch length of lightweight half-inch diameter PVC was chosen for the boom. An RCA-style phono jack would be used at the coaxial feed point. You'll need six metal coat hangers.

With these inexpensive materials and simple hand tools, a portable antenna can be built in practically no time that's perfect for mountain topping on 70cm FM.

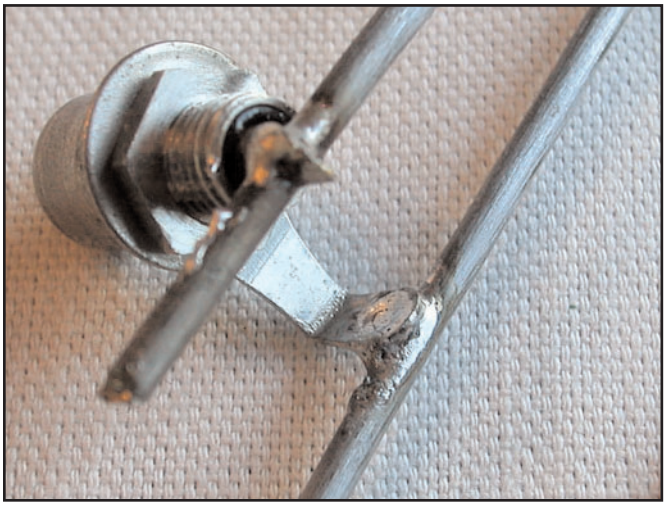
Contrary to what many people think, it is possible – *even easy* – to solder to metal coat hangers. The trick is to strip away all of the lacquer coating to expose the bare metal, and to apply enough heat to get a solid solder bond. A 40-watt iron worked beautifully at KI6SN.

Braving the Elements

To get started, cut one coat hanger to length for the reflector (REF) and others for each director (D1-4). You'll need about a 20-inch length for the driven element (DE), which will take a fancy turn, as you can see in Figure 1 in the illustration. To get the proper length, the *raw* coat hanger will need to be unbent.



A vintage Radio Shack HTX-404 70cm FM transceiver is connected to the antenna's driven element using a standard RCA plug and jack.



A close-up of the driven element of the 440 MHz beam shows how an RCA-style phono jack bridges the two sides of DE, creating the antenna's direct feed point. The short portion of the two-sided element is slid through the hole in the lug protruding from the jack's inner conductor and soldered. The jack's ground lug is soldered on the opposite side.

When your coat hanger pieces for REF, D1-4 and DE (now a straight 20-inch length) are in hand, it's time to go to work removing the lacquer coating. Coarse sandpaper and steel wool work just fine. Take special care with every piece. Making the *direct feed* point will require soldering to the driven element, and we'll end up soldering a little bit to all of the other elements as well.

With everything clean and shiny, set REF and D1-4 aside, for the moment. Grab the 20-inch-long piece prepared for DE and refer to Figure 1 in the illustration. It shows a two-sided element with a half-inch bend at the 12-inch point of the top side.

To make the bend, a half-inch diameter wooden dowel or metal rod makes the perfect *former.* Measure, say, 12-and-one-half inches along the coat hanger and place the dowel or rod across it at a right angle. Take the remaining portion of the 20-inch length and bend it to form a U-shape with two parallel sides spaced a half-inch apart. Following specifications in the illustration, trim one side to 12-inches and the other to 6.25 inches. *Voila.*

There's nothing wrong with soldering the inner and outer conductor of your coax cable to the driven element. At KI6SN, since the beam was going to be frequently broken down for toting into the field, an RCA-style phono jack was soldered into position as shown to accept an RCA phono plug at the antenna end of the coax.

The hole in the solder lug of the inner connector on the RCA jack was not quite big enough to allow it to slide one-half inch along the driven element's 6.5-inch side. A small file was used to widen its diameter. The solder lug on the outer conductor was then bent to form the bridge to the other side of the driven element. Solder both the inner and outer conductors in place on the driven element, a half-inch in from the end of the short side.

Then: 'Boom!'

With DE now complete and REF and D1-4 now trimmed and pretty, it's on to the boom. The 40-inch length for the PVC was chosen for a few reasons. First, there needed to be 10 inches of PVC behind REF to serve as a *handle* for holding and pointing the beam while operating. Second, 40 inches is a good height for a walking stick, which the boom could certainly be used as on the trail. Just add PVC end caps to protect the pipe. Third, half-inch diameter PVC is inexpensive and widely available. Your local home improvement store has miles of it.

By far the most time consuming part of the beam's construction was lining up holes along the boom for each element to pass through. Ideally, one beam element should line up 90-degrees to the PVC pipe and perfectly parallel to its neighbor element for maximum efficiency. Syncing things up along the PVC's curved surface takes a bit of *doing.* Holes out of alignment – even slightly high or low; too far forward or back – will leave you with six cockeyed elements that may get your signal nowhere.

Having a drill press, of course, would make the alignment process a snap. Unfortunately, *I don't, and it wasn't.*

It seemed the only way to get this right was to hand-draw parallel *chalk lines* the length of the PVC – first on one side and then the other, 180 degrees opposite. After several tries, and sighting down the outside of the boom like a pirate, everything looked good.

Measuring 10-inches from one end of the PVC, a drill point was marked on each chalk line as the position for the reflector (REF). Exactly 2.5-inches from the REF position, the *chalk lines* were marked for holes for the driven element (DE). Again, measuring from REF, marks were made for the first director (D1) at 5.5 inches, and so on for the D 2-4. *Remember, each element*

Snow-covered mountain peaks surround Southern California's Inland Empire valley – some of the summits home to popular VHF and UHF repeaters.

spacing is determined by measuring from the reflector. In the illustration, see the part of the chart labeled *DISTANCE FROM REF.*

Once the boom is marked, it's time to choose a drill bit for making holes that will allow the coat hanger pieces to pass through the PVC. A snug fit would be good. Drilling test holes on another piece of PVC to find the perfect hole size isn't a bad idea.

Carefully drilling at the marked spots for the elements on each side of the PVC is all that is needed to complete boom preparation. Done.

Putting It All Together

Now for the fun. Select the 13-inch-long reflector and slide it through the holes in the boom closest to the antenna *handle* portion of the PVC.

A small dollop of solder added to directors D1-4 and the reflector (REF) prevents the elements from sliding through holes drilled in the boom.

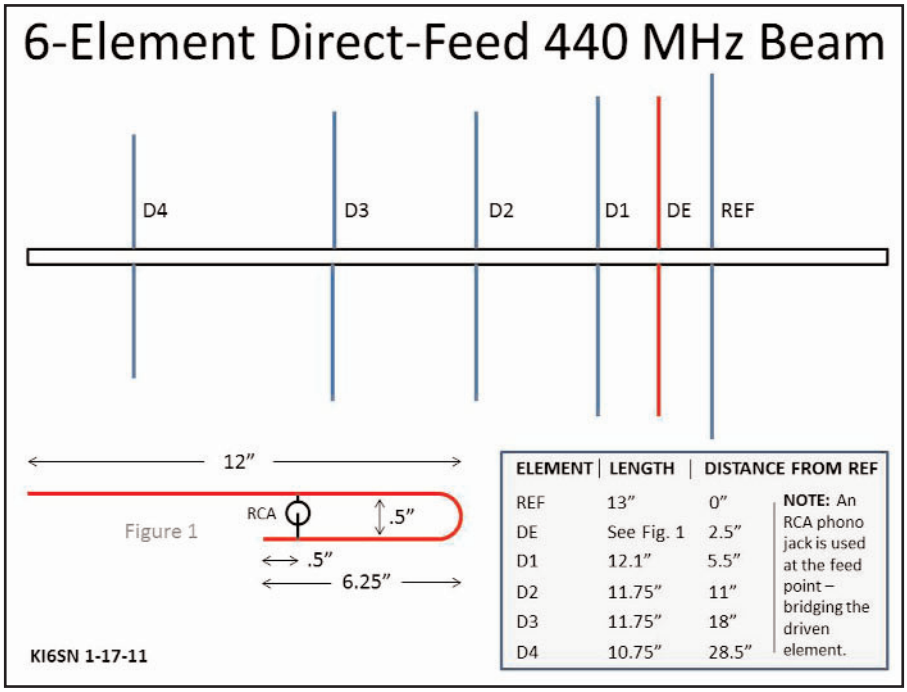
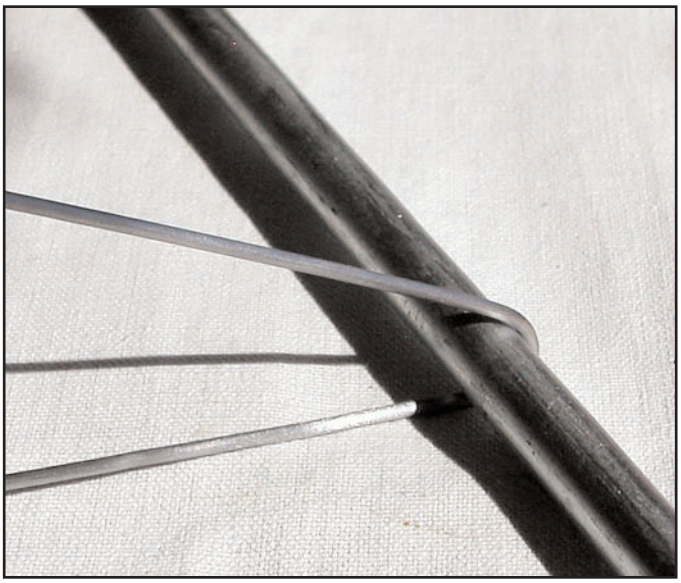


Figure 1.



A half-inch diameter metal rod was used as a "former" at KI6SN to provide the hairpin bend in the driven element, as illustrated in Figure 1.

Remnants of the "chalk line" – drawn by hand using a pencil and straight edge – can be seen along the antenna's PVC boom, where pass-through holes for the elements were drilled.

In the holes 2.5-inches up the boom, slide the long side of the U-shaped driven element. Next, add directors 1 through 4 in their respective holes along the boom. Match their length to the designation listed in the accompanying illustration. For the most part, they get progressively shorter as you move up the boom. If your through-hole markings are good, everything should line up nicely. They did at KI6SN. *Whew!*

Testing 1, 2, 3

With everything in place, only the coax from our ancient Radio Shack HTX-404 5-watt handi-talkie needed to be connected to the RCA feed point. Then it was into the back yard for testing. Using a simple field strength meter, we found this little beam's front-to-back ratio to be excellent.

There are several open 440 MHz repeaters in the Los Angeles area the '404 could sometimes break with the *rubber duckie.* Holding the beam so its elements were vertically polarized, our signal easily got into all of them with reports of full quieting. *Horray!*

With the antenna pointed east, other repeaters were accessed that the '404 hadn't been able to access at all. Good things were happening.

Oops, Back to the Bench

After 15 minutes of jostling, though, the elements were succumbing to gravity, sliding out of alignment through their holes, or falling to the ground. *This would never do.*

A trip back to the workbench resulted in an easy fix. A small dollop of solder on REF and D1-4 at the point where they pass through the hole *on the top side* of the PVC created a stopper or brake to prevent the coat hanger pieces from slipping out. Hardware on the driven element already kept it in place, so no additional solder was needed. It's best to mark the solder point for REF and D1-4 with a felt-tipped pen, removing the element from the PVC and adding the solder dollop. This will prevent the PVC from being melted by the heat of the soldering iron.

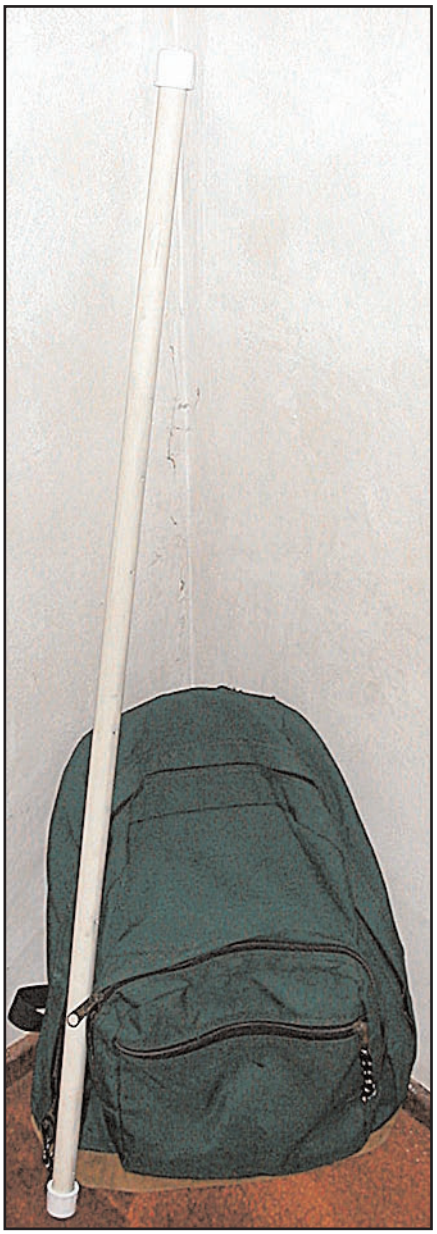
The solder dollop arrangement not only prevents misalignment, but still allows for the beam's complete dismantling when you're ready to hike home.

'CQ Contest, CQ Contest . . .'

Using half-inch diameter PVC allowed REF and D1-4 to be carried inside the PVC pipe during travel. Be sure the PVC end caps are on good and tight. Unfortunately, the driven element is too wide to fit in the same space. It's carried in the backpack for safe keeping.

A hike up 1,329-foot-high Mount Rubidoux in Riverside, California for the ARRL January VHF Sweepstakes yielded gratifying results for the new antenna and '404. Although there was little simplex activity on 70cm, our signal accessed even more Southern California repeaters than before. Stations we contacted were asked to listen for us on the machines' input. More often than not, they could hear us simplex loud and clear. *A great day, indeed.*

If 440 MHz FM simplex activity is lagging in your area, why not consider this simple beam for a group or club project? It couldn't be much easier or inexpensive to build, and after hanging your FM signal on this coat hanger antenna you'll likely be pleasantly surprised by the results.



With end caps firmly in place, D1-4 and REF slide easily into the 440 MHz beam's boom for transport. At 40 inches in length, the PVC makes a fine "walking stick" when hiking to a lofty destination for some UHF fun.