Simple Gain Antenna for 903 MHz

Build it for under $25.

by Phil Salas AD5X

Building antennas for the UHF and low microwave bands generally requires quite a bit of metal work and some tricky adjustments to get good results. However, you can overcome some of these problems with a few relatively simple modifications to an inexpensive, commercially available TV antenna.

The antenna I used was the Radio Shack U-75 UHF corner reflector antenna (RS 15-1660), which costs just $16.95. It consists of one driven element and seven directors. (This antenna is actually called a "corner-Yagi-Uda-hybrid" antenna, which is a corner reflector antenna with directors.) The trick was to match this antenna to 50 ohms and optimize it for the 902–928 MHz ham band.

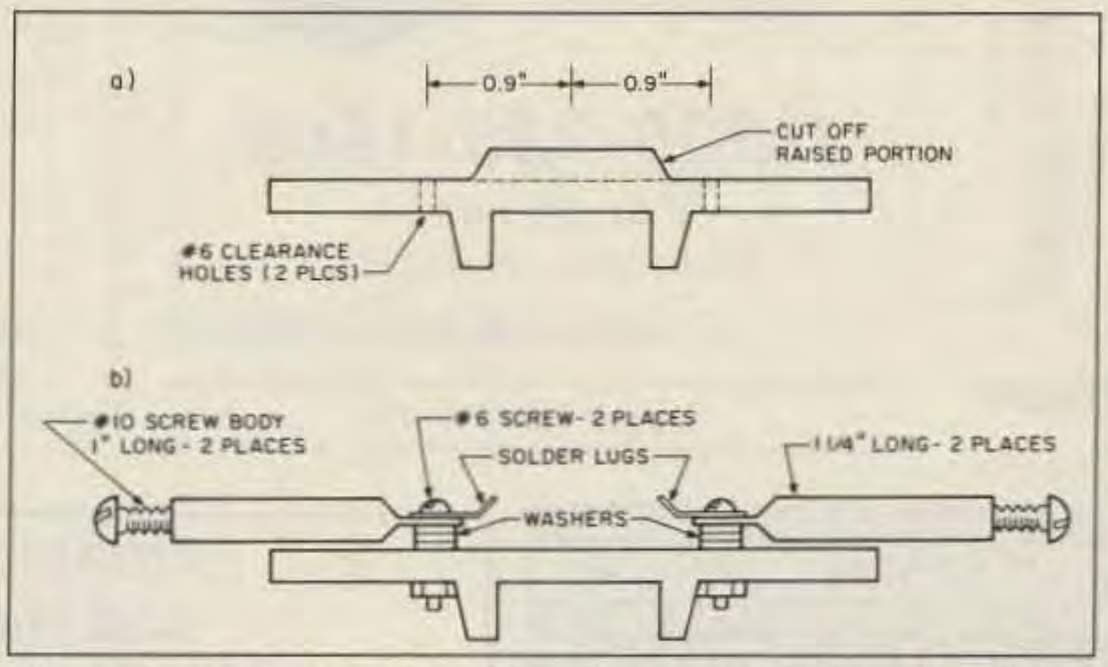

Figure 1. (a) Preparation of the plastic center piece. (b) Driven element preparation.

The Modifications

First, you must remove the insulated driven element by drilling out the center rivet holding it in place. Next, remove the aluminum elements from the insulated driven element by drilling out the two rivets holding them on. You should now be left with just the blue insulated piece. Now, referring to Figure 1(a), cut off the raised portion of this insulated piece with a hacksaw or band saw. Finally, measure 0.9 inch from the center hole and drill two holes for clearing #6 screws. This completes the modifications to the insulator.

Referring to Figure 1(b), cut two 1¼-inch pieces of ¼-inch copper tubing and flatten ½ inch of one end of both pieces. Drill a #6 clearance hole in the flattened portion on each tube. Attach these two tubes to the insulator with two #6 screws, nuts, solder lugs, and six #6 washers, as shown. Next, take two #10 x ¾-inch brass screws and insert them about halfway into the two copper tubes. Crimp the copper tubes so that the screws are snug in place. A type "F" TV connector crimping tool is excellent for this. This completes the driven element. Now, turn the screws completely into the tubes.

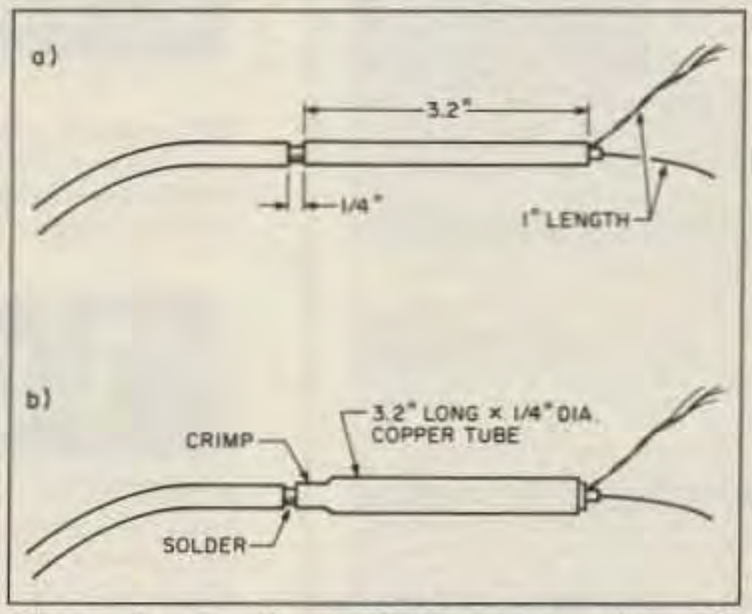

Figure 2. (a) Sleeve balun construction. (b) Crimp the balun and solder equal length leads onto the balun sleeve and center conductor.

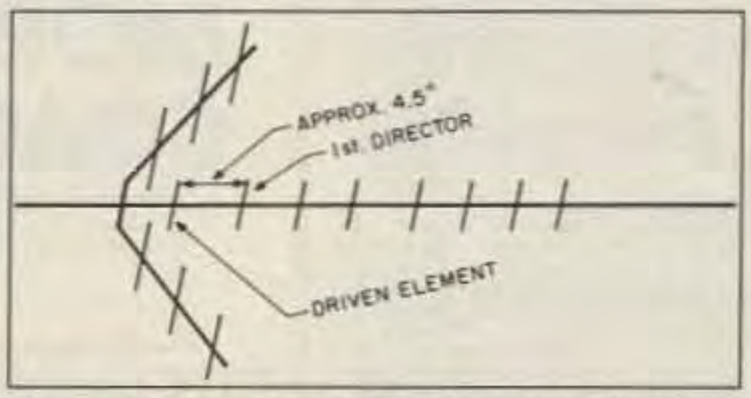

Figure 3. Mount the driven element to the boom about 4.5 inches behind the first director.

The Match

The driven element will just be a simple half-wave dipole which should give a good match to 50 ohms. However, the dipole is balanced and the coax is unbalanced so a 1:1 50 ohm balun is in order. Figures 2(a) and 2(b) show the construction of the balun. Use RG-8M coax cable (available also from Radio Shack). RG-8M is a miniature RG-8 coax which has an impedance of 50 ohms and the same diameter as RG-59. The loss characteristics of RG-8M are far superior to RG-58 and it is a perfect fit in the ¼-inch copper tubes.

Referring to Figure 2(a), prepare one end of the RG-8M by first stripping off 1 inch of insulation and exposing the braid and center conductor. Next, measure 3.2 inches more and remove a ¼-inch section of insulation, as shown. Now, cut a 3.2-inch piece of ¼-inch copper tubing and insert it over the cable, as shown in Figure 2(b). Overlap about half of the exposed braid and crimp the copper tube to hold it firmly in place. Using a 100 watt or more soldering iron or gun, carefully solder the tube to the section of braid. The open end of the tubing should be comfortably removed (0.1 inch or more) from the braid and center conductor. Now, cover the exposed braid/soldered tubing end and the entire piece of copper tubing with heat shrink tubing (from Radio Shack) and heat to shrink in place. You have just created a quarter-wave (3.2 inches at 915 MHz) 1:1 sleeve balun.

Now, solder the center conductor to the solder lug on one of the elements of the driven element assembly, and solder the braid to the other solder lug. Keep the lengths of the braid

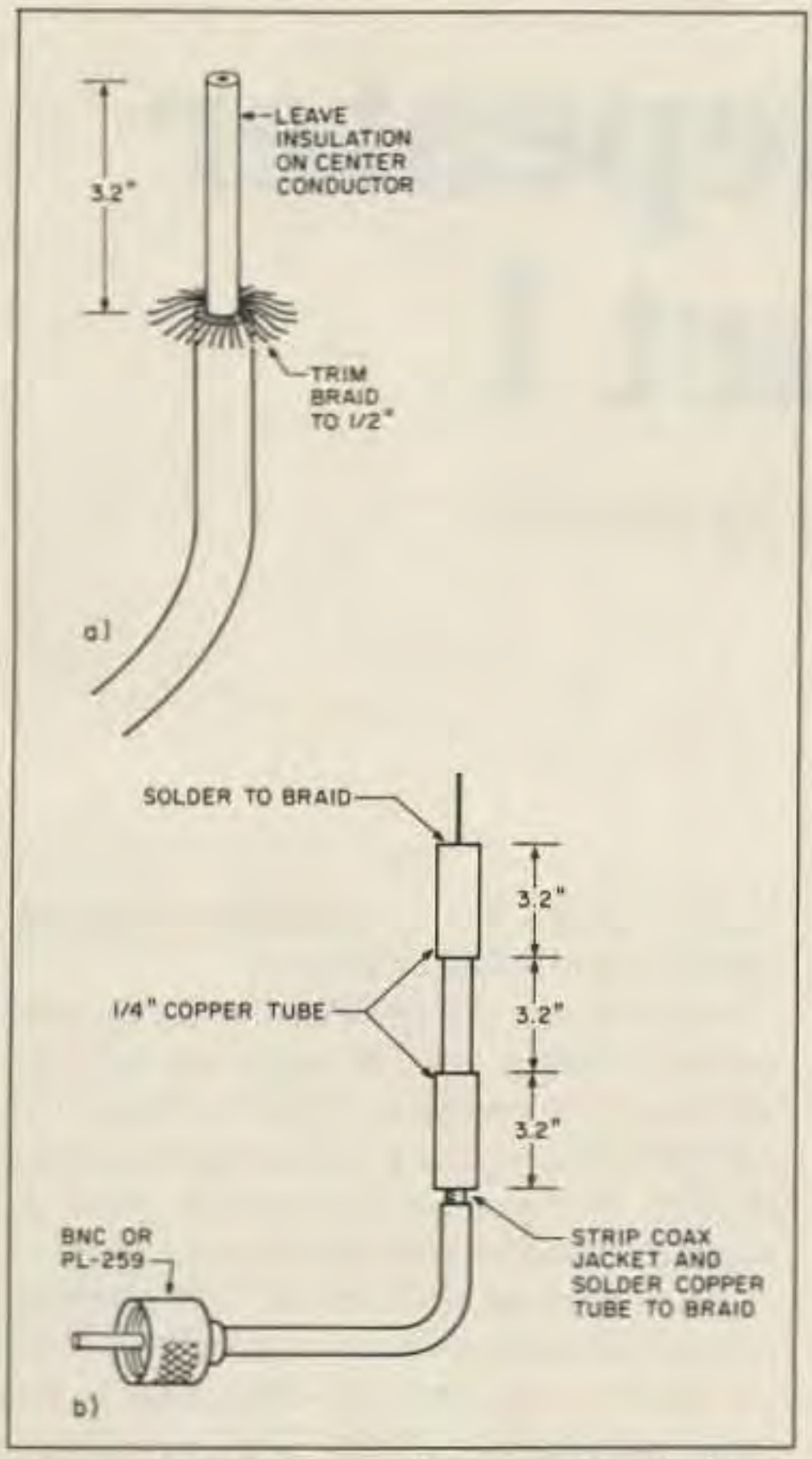

Figure 4. (a) Prepare the coax for the half-wave reference antenna. (b) Attach the sleeve and the RF choke sections of tubing as shown.

and center conductor as short as possible and equal in length.

At the other end of the RG-8M, add either a BNC or a PL-259 UHF connector. In either case, purchase a connector for RG-59 cable as it has the same basic dimensions as the RG-8M coax. A PL-259 with RG-59 reducer is the easiest connector to install. If you use a BNC connector, you will have to trim several of the center conductor strands from the RG-8M cable in order to insert the RG-8M coax center conductor into the BNC pin.

Finally—The Adjustment

To adjust the antenna, you will need a signal source and either an antenna bridge or an SWR meter. First, hold the driven element assembly out away from you and adjust the screws in no more than quarter-turn increments for minimum SWR of less than 1.5:1.

Now, place the driven element assembly on the antenna 4.5 inches behind the first director, as shown in Figure 3. Hold it in place with an 8-inch nylon wire tie (Radio Shack 278-1652). Watch the SWR and minimize it by carefully sliding the driven element assembly. If necessary, adjust the screws in the driven elements slightly. You should be able to get very close to a 1:1 SWR. Now, use either epoxy or hot glue to hold the driven element assembly permanently in place. You could also drill a new mounting hole through the boom and bolt the element in place. Also, re-crimp the copper tubing over the brass screws to make sure they stay put and make good electrical contact.

Reference Antenna

To see how much gain this antenna was really giving me, for comparison I built a half-wave sleeve dipole with an RF choke to isolate the coax from the antenna field. Figures 4(a) and 4(b) detail its construction.

Expose 3.2 inches of the INSULATED center conductor from a length of RG-8M coaxial cable. Unravel the braid and trim it to a length of ½ inch. Cut two 3.2-inch lengths of ¼-inch copper tubing. Slip one piece over the center conductor and down over the coax cable so that the RG-8M braid is under the tubing. Crimp the tubing with an "F" type crimping tool to hold it in place, and solder the tubing to the braid.

Slip the other 3.2-inch piece of copper tubing over the other end of the coax cable, positioning it 3.2 inches from the first tube. Carefully remove a band of insulation from the RG-8M, then crimp the tube over the braid and carefully solder the copper tube to the braid. Cover the entire assembly with heat-shrink tubing. Finally, add either a BNC or a PL-259 connector to the end of the RG-8M coax cable.

Attach a signal source and an SWR meter and snip off small increments of the center conductor until you have an SWR of less than 1.5:1. If you overshoot, just solder an extension wire to the center conductor and try again.

Measurements

My antenna-measuring setup consists of an ICOM R-7000 receiver with a Smith Design Spectrum Probe™ connected to the R-7000 10.7 MHz IF output. This gives me a tunable spectrum analyzer. I use a telescoping whip antenna for the R-7000 receiving antenna. Anything will work for this antenna as you are just going to look at the relative difference between the reference antenna and the corner reflector.

First, I supported the reference antenna about 20 feet from the R-7000. Then I connected a signal source to the reference antenna and made a note of the level on both the R-7000 S-meter and the Spectrum Probe oscilloscope output. Next, I connected the corner reflector and made boresight gain, side lobe suppression, and front-to-back ratio measurements. My setup is fairly crude, but I believe that the following figures are accurate to within 3 dB:

Gain:	8 dB
Side Lobe Suppression (90 degrees):	10 dB
Front-to-Back Ratio:	15 dB

An Inexpensive Solution

The gain antenna itself can be built for less than $25. Two higher gain corner reflector antennas are available from Radio Shack should you wish higher gain. The construction and set-up techniques in this article should be applicable to any of these antennas. 73

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