

Five-Element T-Match VHF Yagi

Excellent performance characteristics on 2 meters.

by Marty Gammel KA0NAN

I finally decided to get started on a long-overdue new yagi for my rooftop antenna farm, here in Minnesota. I needed a clean pattern with about 9 to 10 dB gain for FM repeater and simplex work.

I have tried several different types of antennas in the past, but I've never tried using the "T" match with a half-wave balun. So, I looked in the *ARRL Antenna Book*, 15th edition, for guidance. The balun looked easy.

Due to our harsh winters, I needed to enclose the balun, and I also needed a good solid mount for the "T" match feed point. I chose a plastic box from Radio Shack that measured 2-1/2" by 4-5/8" to house the balun. The beam itself was easy, using a 5'-long square boom from an old TV antenna as a starting point. After removing the old elements, I decided to use a close standard spacing of 13" for reflector-to-driven-element spacing. I wanted a close-spaced first

director, so I used 9" for driven-element-to-first-director spacing. For second and third directors, I used 15-1/2" and 17" spacing. The 1"-square boom was big enough for this small, 5'-long antenna. I used 3/8" diameter aluminum tubing for all the elements and the "T" match bars.

As an extra feature on this antenna, also from the *ARRL Antenna Book*, 15th edition, I added a ferrite bead choke on the quarter-wave line section of the balun. The local electronic surplus house proved to be a source for cheap ferrite beads. I also



Photo A. Balun assembly, ready to install.

wound the half-wave section of coax into a four-turn choke to fit into the plastic box. The combination of the ferrite beads and the four-turn choke gives good isolation of the feedline and avoids radiation from the feedline shield. The dimensions for the "T" bars came from standard design lengths for gamma match parts. The "T" match design gives a very clean design, without skewing.

Building the Beam

Once all the old elements have been removed from the boom, mark where you need to drill to mount all five elements. I found that by mounting the elements in the center of the boom, the spacing for the "T" bar straps was more manageable. The beam will also look better. If you can use a drill press to make the element holes, they will probably be more exactly perpendicular to the boom. After the holes are drilled, try

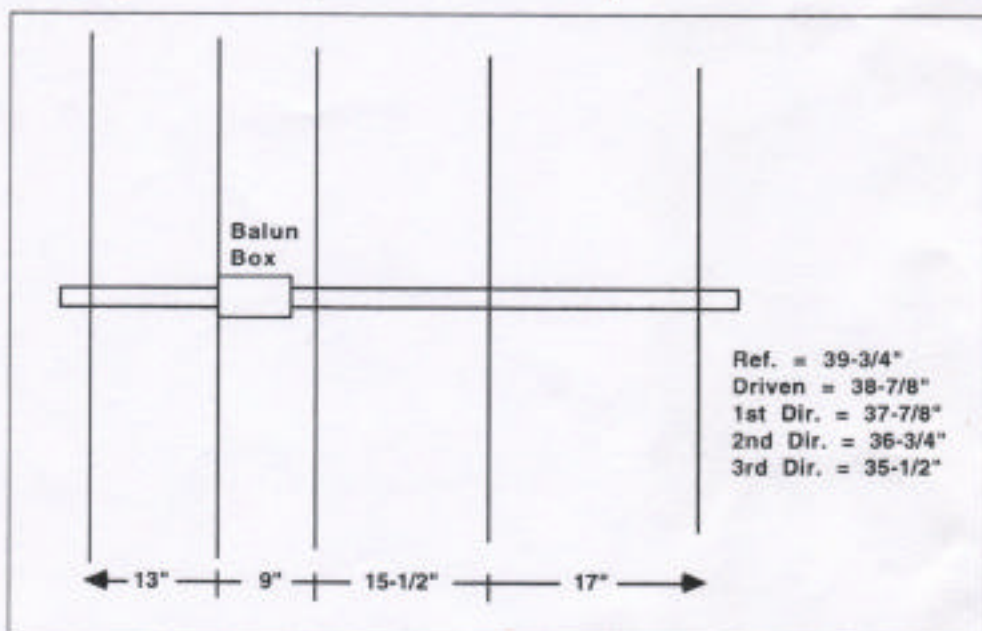


Figure 1. Five-element 2 meter beam.

fitting the 3/8" tubing in each hole and check for squareness to the boom with a square.

Cut all the elements to length, and flatten one end of each of the two 6-1/2" match bars—about 1/2" will do. Drill a 1/8" hole in the flattened area and round off the corners (see Figure 2). Attach all five elements to the boom using the 1" stainless steel screws.

Now drill holes for mounting the SO-239 and the 1" #8 bolts in the plastic box, and attach the SO-239 with three of the four bolts (see Photo B).

Assembling the Choke and Balun Assembly

Start with a piece of RG-59U about 14" long and prepare both ends as shown in Figure 2. Do the same to a 26-1/2" piece for the other balun section. Allow 3/4" on each end of both coax sections for dressing the ends. Wind the longer section of coax into a four-turn coil. Tape the coil temporarily in a couple of places, just to hold it until the finished balun is installed in the plastic box. Solder the shields from both sections of coax together (see Photo A). Install the balun assembly in the balun box; be certain all connections are correct. Install a closed-end crimp-type connector on each end of the center conductor of half-wave coax. Install the 1" #8 bolts through the crimped connectors using washers, and apply a washer and nut to the outside of the plastic box. After doing this, remove the tape from the coil. Install as many ferrite beads as you have room for on the end of the quarter-wave coax section; I had room for six ferrite beads. Solder a closed-end crimp-type connector to the shield and then connect it to the fourth mounting bolt for the SO-239 panel-mount fitting. Solder the center conductor to the center terminal of the SO-239.

Apply Crystal-Cote or some other type of sealer to everything in the balun box. Attach the "T" match bars to the balun box, and bend the ends of the metal strapping around the driven element and match bar. Then drill holes to bolt the straps to the tubing (see Photo B). You will need about 1-3/8" between the "T" bars and the driven element. Spacing for the strap should be about 4" from the center of each 1" #8 stainless steel bolt on the balun box. Fashion a mounting bracket to connect the SO-239 to the boom. It must be a metal bracket to provide the needed electrical connection between the boom and the balun. I used a piece of plumber's perforated strapping that was in my junk box, and cut it to shape with tin snips. Mount the bracket to the boom with a sheet metal screw (see Photo B). Drill a weep hole in the lowest corner of the balun box for drainage once the box has been mounted on the boom.

Check all connections, nuts, bolts, and screws, and then mount the antenna on a non-conducting mast, ready for tuning. Tape the coax to the boom and bring the coax

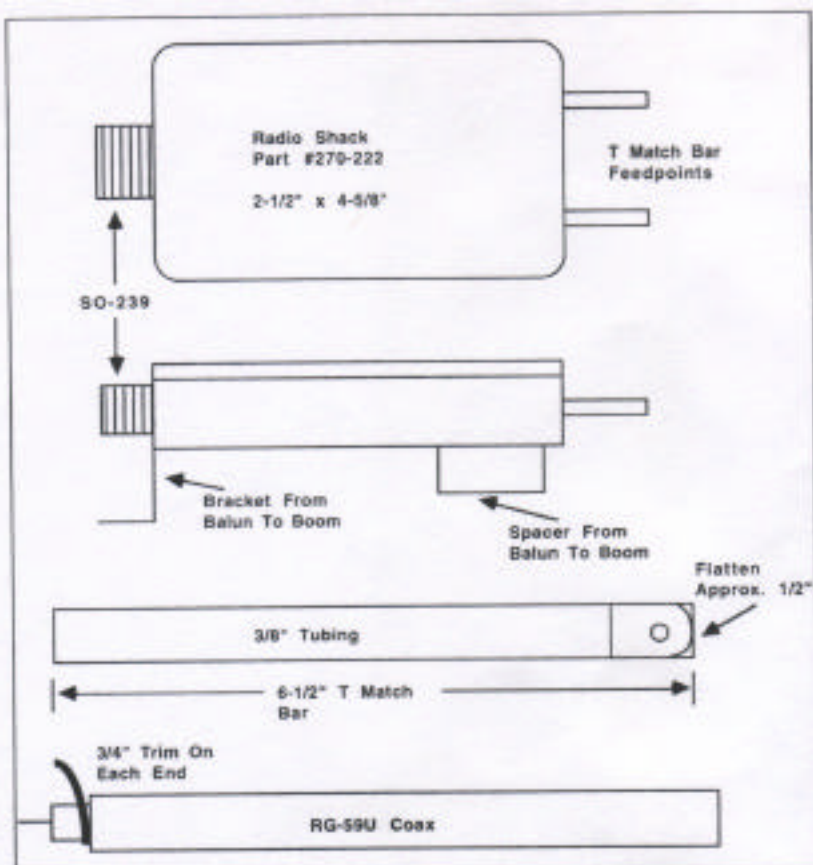


Figure 2. Balun box for 2 meter yagi.



Photo B. Close-up of balun box. Note the "T" match bars and the driven element.

down the mast, away from the antenna.

Tuning the Completed Antenna

Tuning the antenna is easy. Connect the coax, SWR meter, and your radio to the antenna. Check the SWR at the top, center,

and bottom of the frequency area of design. By noting the pattern of the SWR curve you will know whether to move the match bars in or out for the best match. Move only about 1/8" at a time, rechecking the SWR curve as you go.

Mine was very close to the center of the designed-for frequency, and only had to be adjusted about 1/8" from the text. *Be sure to make all adjustments of the straps on the "T" bars equal.*

Builder's Notes

I bought the ferrite beads and the plastic box to make a clean weatherproof feed point, but all the aluminum came from my stockpile of old TV antenna parts. All hardware is common, and can be bought from any local hardware or building supply store.

"Be careful when you are cutting the coax to measure the lengths, and check the velocity factor for the coax you use."

I cut all the aluminum to length with a tubing cutter; this gives a more finished end than if you cut it with a hacksaw. Each element is installed through the center of the boom and fastened with a 1" #8 stainless steel screw (two screws are not needed for each element). Any type of non-metal spacer that you have may be used for supporting the balun box, to give the proper spacing for the "T" bar straps. I put a 1" sheet metal screw through the plastic box and spacer to hold them in place. If you cannot find an old TV boom, most local scrap metal dealers sell aluminum square and round tubing.

Be careful when you are cutting the coax to measure the lengths, and check the velocity factor for the coax you use. My RG-59U had a velocity factor of 66%. The number of ferrite beads is not critical, but they do stop radiation back down the coax shield. Be sure to drill or file the hole for the center of the SO-239 just big enough, but not so big that you get a sloppy fit—it does have to seal out the weather. Tune the antenna before you weatherproof and seal up the plastic balun box in case you may not have wired the connections right. Make

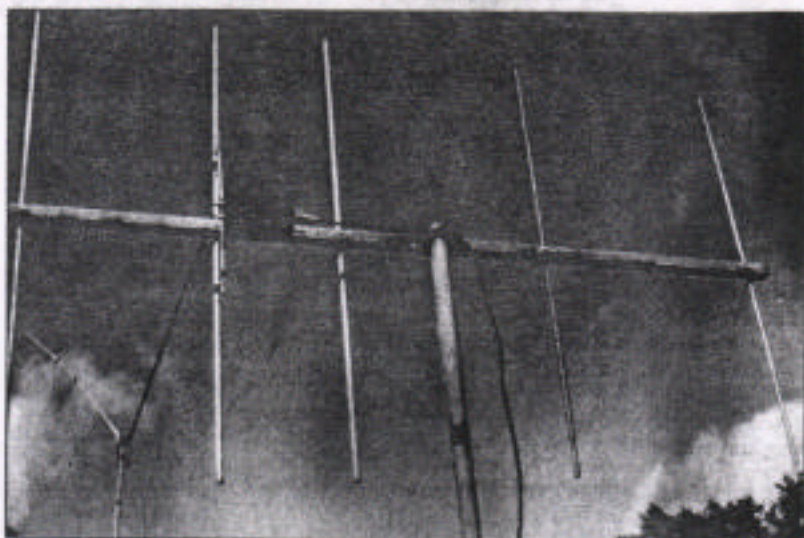



Photo C. Completed five-element vertical yagi.

Tools List

Electric drill
 3/8" drill bit (for holes in boom for elements)
 1/4" drill bit (for removing old elements from boom)
 3/32" drill bit (for #6 bolt holes for SO-239 mounting)
 5/32" drill bit (for #8 screw holes)
 Tinsnips
 Electrical tape
 Waterproof sealer (for balun; can be spray or brush-on)
 Plumbers' strapping or thin copper or aluminum (for balun, and "T" bar to driven element mounts)
 (Optional) drill press for drilling all holes
 (Optional) 9/16" drill bit for SO-239 to balun box center hole, or you can use a 1/2" drill bit and file as I did.
 Solder and soldering gun (for crimp type connectors inside balun)

nice neat pigtailed on your coax ends so that they will be easier to attach. This design, with its close spacing, gives a very clean pattern of radiation, with at least 9 dB gain and a front-to-back ratio of 32 dB.

Many thanks to John Berglund KØUBA for his help in editing. If you have any questions, send them along, with an SASE, to me at 1703 Hewitt Ave West, St. Paul MN 55104-1128. 73 and happy hamming. 

Parts List

5'-long 1"-square aluminum boom (old TV antenna type)
 2-1/2" by 4-5/8" plastic box (Radio Shack #270-222)
 3/4" by 1" spacer (wood, plastic, etc. for balun box mounting)
 5 to 8 ferrite beads to make a ferrite choke (see text)
 12.5' section of RG-59U coax (finished length) (see text)
 25' section of RG-59U coax (finished length) (see text)
 2 pieces 3/8" by 6-1/2" aluminum tubing ("T" match bars)
 1 piece 3/8" by 39-3/4" aluminum tubing (reflector element)
 1 piece 3/8" by 38-7/8" aluminum tubing (driven element)
 1 piece 3/8" by 37-7/8" aluminum tubing (first director)
 1 piece 3/8" by 36-3/4" aluminum tubing (second director)
 1 piece 3/8" by 35-1/2" aluminum tubing (third director)
 2 #8 by 1" flathead bolts for attaching "T" match bars to balun box

6 #8 by 1" flathead self-tapping stainless steel screws (for elements)
 2 #8 by 1" flathead self-tapping stainless steel screws (for balun mounting)
 4 #6 by 3/8" flathead bolts with nuts & washers (for SO-239)
 1 SO-239 panel mount fitting (for feedline attachment on balun box)
 2 1/2" by 3" metal straps (for attaching "T" match bars)
 4 #6 by 3/8" flathead stainless steel bolts with nuts & lock washers
 3 crimp-type closed-end connectors (for coax connections inside balun)

You may have to find a few assorted bolts and washers in your junk box to complete this antenna (see text.)