Terminating 75 Ω, ⅞ inch Hardline with SO-239

Make good use of readily available low loss cable TV coax.

Bob Locher, W9KNI

At my last two locations, for various reasons the optimum site for the tower was some distance from the house. My run from transmitter to antenna at my last location was 360 feet. At my current location, the distance is on the order of 600 feet.

There are good reasons for this. The most important is that by running that far I get to the top of the hill at the back of our property, good for an extra 45 feet of elevation over the next best site, already 300 feet from the rig. In addition, the remote antenna eliminates family problems. RFI virtually disappears — receive interference from computers, light dimmers and other household sources are greatly reduced or eliminated. RFI problems from the transmitted signal are also minimized. The downside of a remote tower is the attenuation of the RF, both in receive and transmit modes. If I were to use 600 feet of the ubiquitous RG-213 as a feed, I would experience a loss of about 7.8 dB on 10 meters — obviously unacceptable.

Free Low Loss Coax — One Answer

But I got lucky — the local cable TV provider at my last location was wiring in several new neighborhoods. They were kind enough to give me well over 1000 feet of beautiful ⅞ inch outside diameter 75 Ω aluminum hardline roll ends. The cable turned out to be the type with a closed-cell poly foam dielectric. The piece lengths ran from about 75 to 130 feet. The reason they were glad to give it away was that those lengths were economically not worth splicing, so were headed for the recycling bin or the dump. I saved them the trouble, cartage and refuse fees.

But how do you make the 75 Ω hardline work into a 50 Ω antenna installation? Some people use it and simply accept the 1:5:1 SWR penalty. Unfortunately, some radios start reducing power at that SWR. An even greater problem is how to terminate the line with regular coax connectors.

Making the Connections

In trying to figure out some way to mate an SO-239 connector to the hardline, I discovered something interesting — the chassis mounting holes in the SO-239, if held up to a 1⅛ inch piece of aluminum tubing with a 0.058 wall (the standard wall thickness for nesting joints in aluminum antennas), show a partial covering of the hole. It then occurred to me that if I screwed a #4 self tapping screw into each hole, it would force the SO-239 to center over the tubing and pull it up tight. I tried it and it worked. See Figures 1 and 2.

Figure 1 — The screws are started into the aluminum tubing.

Figure 2 — The screws are tightened and the connector is secured to tubing.

Table 1
Materials Needed for Termination of Hardline

Stainless steel Phillips pan head sheet metal screws, #4 × ½″.
SO-239 connector.
Aluminum tubing, 1.125″ diameter, 0.058″ wall, 2¼″ long.
Aluminum tubing, 1″ diameter, 0.058 wall, 3½″ long.
Solid copper wire, 12 or 14 gauge, 4″ long.
Liquid electric tape.
Hot melt glue.

I developed a method of fabricating a connector system based on the above discovery. The best part of the approach is that all tools needed are pretty much standard hand tools plus an electric drill and a hot melt glue gun. The required materials are listed in Table 1.

Having now had some practice in it, I can fabricate a connector assembly in under an hour. Note that both aluminum tubing pieces must have at least one end cut perfectly flat, which is easily done with a standard rotating tubing cutter. Tubing ends must be clean and deburred, and any deforming on the inside surface must be removed with a knife or file.

The stainless steel sheet metal screws seem to be readily available at most hardware stores. The length is not critical — between ⅜ and ¾ inch long — buy whatever is cheapest.

Select your SO-239 connector with care. There are a lot available that are of shoddy construction — make sure you use a quality one, and that it will readily accept solder for the center conductor. Amazingly, not all do.

Step by Step

Begin by making sure that the last 4 inches of the hardline is absolutely straight. This is important. If the coax already has a bit of a curve in it, as it often will from being rolled, you need to straighten it. Probably the best way is to put it in the middle of two right angle pieces of steel and squeeze it. If that is not available you may be able to get the end into a vise and gently straighten out the bend. If you try this, be very sure you do not deform the tubing.

Once the hardline is straight, strip back 4 inches of the plastic insulation. Cut the hardline aluminum jacket ½ inch back from the end using a tubing cutter. When the aluminum jacket is completely separated, use lineman's pliers to twist off the jacket and as much of the dielectric as will readily come away from the center conductor.

Add the Outer Tubing

Take the 1 inch outside diameter (OD) piece of tubing listed in Table 1 and slip it back over the hardline aluminum jacket. If the hardline is absolutely straight it should slip right on — if the hardline is not you will know it, in which case you need to get it straight. The tube must slide back far enough that the end is at least flush with the end of the aluminum jacket of the hardline. Slip the 1.125 inch OD tubing over the 1 inch OD tubing.

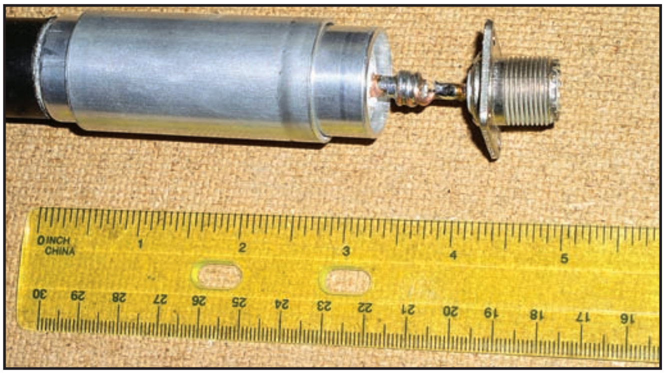

Figure 3 — Detailed view of center conductor connection method.

Connecting the Inner Conductor

Now, clean the ¾ inch copper clad aluminum wire sticking out the end of the hardline, being careful to remove all insulation. You should have a bright clean copper surface, plated over the aluminum center conductor. Wrap the solid copper wire tightly several turns around the exposed center conductor, and form it so that it sticks out in front. Using a 40 W or greater soldering iron, solder the wire to the center conductor. Make sure you get the joint hot enough for the solder to flow freely. Cut the end of the wire so that it sticks out about ⅜ inch from the end of the hardline center conductor. Solder the end of the wire to the center terminal of the SO-239 as shown in Figure 3.

Figure 4 — The outer tubing sections secured with shortened sheet metal screws.

Bring the 1⅛ inch tubing forward so that it butts up against the SO-239. Insert the #4 stainless steel sheet metal screws into the holes, and rotate them about 2 turns. When everything is centered the SO-239 connector should look like Figure 1. Tighten the screws, turning perhaps two turns on a screw, then to the screw on the opposite corner, then the other corners; continue until all screws are tight. The SO-239 flange will likely deform very slightly — this is okay.

Securing the Outer Tubing

Position the 1 inch tube inside the 1⅛ inch tube so that 2 inches stick out the back. Using a center punch, mark off six holes in a line, three on the 1 inch tube to penetrate the hardline aluminum jacket and three to connect the 1⅛ inch tube to the 1 inch tube, and also through to the hardline aluminum jacket.

Using a 3/32 inch bit, drill the six holes. Note that you only want to penetrate through the aluminum hardline jacket, and no deeper. So use some finesse. Note that since aluminum is a relatively soft material you should use a slow drilling speed.

Once the holes are drilled, begin to screw in one of the #4 stainless sheet metal screws through the 1 inch tubing. Once the screw threads are formed, back the screw out. Using lineman's pliers, cut the screw short, so that it is about ¼ inch long. Now, screw it back in, all the way. By doing this you will not penetrate far into the hardline. Repeat with the other screws as shown on Figure 4.

You may well shear one or more screws in doing this — the screws do not seem to be terribly strong. If you shear a screw with enough sticking out, it is usually possible to back it out by gripping it hard with pliers and twisting it out. Then use another shortened screw. If the screw shears at the surface of the tubing, leave it and go to the next hole. This is more likely to happen when you are trying to screw through both layers of tubing and the hardline aluminum jacket.

When you have all six screws in, center punch a new line of 6 holes 120° around the connector assembly and repeat, then finish with a third row.

Now, center punch and drill one last hole ¼ inch in from the flange of the SO-239. You should first drill the hole out to 3/32 inch, then open it to 3/16 inch. Do so slowly and carefully — you do not want to get any aluminum shavings inside.

Sealing the Fittings

Get the hot melt glue gun good and hot, and begin squirting hot melt glue into the ⅜" hole to fill the cavity at the end of the assembly. Continue squirting in glue until the glue starts coming out at the cracks on the tubing end. Stop, wait a minute, then squirt more glue in, as the shrinking glue opens a void. You may need to do this several times. When finished, wait half an hour, then use a knife to scrape off any glue that is sticking out.

The last step is to paint the whole assembly with the liquid electrical tape. Prior to doing so, mask off the SO-239 threads with masking tape. Make sure all cracks are sealed. You will almost surely need two or three coats to finish the job.

Of course, before you finish, and indeed at several points along the way, use an ohmmeter to confirm continuity where important and confirm that there are no shorts from center conductor to shield. Heat shrink tubing could be used for additional protection, although I haven't used it here.

Using the System

So, now you have a piece of 75 Ω hardline terminated with SO-239s at each end. How do you use it in your antenna system?

I use 4 × 4 inch pressure treated lumber posts set into the ground as terminal points. If a splice is needed, I bring both pieces of the hardline to the post. I use electrical conduit straps to secure the hardline to the post, and interconnect with a short RG-11 coax jumper. Be sure to use RG-11 or the equivalent 75 Ω coax. The use of 50 Ω coax creates an impedance bump that does not go unnoticed on your SWR, especially on the higher HF bands.

Matching Impedances

Most antenna and radio systems are designed for 50 Ω termination. To provide the appropriate match, I use the excellent 50 to 75 Ω transformers, catalog number AS-75:50-1 offered by Array Solutions and WXØB (**www.arraysolutions.com**) at each end of the cable run. These transformers offer a remarkably flat and very low loss conversion from 75 to 50 Ω and vice versa, and are rated for 5 kW. I strap on an assembly of the Array Solutions transformer, a 75 Ω RG-11 jumper and the 50 Ω coax going to the shack to a post. The 4 × 4 post is normally covered by one of the ubiquitous 5 gallon plastic buckets, keeping rain out and birds away.

I have been using this approach for more than 5 years with considerable success and no failures. Note that different vendors' hardline coax may be of somewhat different dimensions than the one I used, but the techniques used should adapt to most any size of common distribution cable.

Bob Locher, W9KNI, was first licensed in 1956 as KNØHGB. Bob's interest has always been HF DX, primarily on CW. Bob is the author of The Complete DX'er*, which has sold 24,000 copies to date. Bob was a co-founder of Bencher, Inc and also is the founder of Idiom Press. He remains active in both firms. Bob is also a private pilot and lives in Grants Pass, Oregon where he is putting up a new antenna farm, of course using 75 Ω TV hardline. You can reach Bob at Box 1985, Grants Pass, OR 97528 or at* **bob@thelochers.net**.