BALANCED FEED LINE – ROLLING YOUR OWN   by VE1VQ

Some years ago, I had the pleasure of visiting Seab, AA1MY, when he lived in Connecticut, and seeing his 1500 foot horizontal loop and his homebrew feed line made with “whipper-snipper” plastic line as spacers. He demonstrated how he made the line using a soldering iron to form the end loops to hold the two wires.

When I first considered making my own feed line to replace the old commercial twin lead with vinyl in the center, and showing its age, I gave some thought to Seab’s method, but abandoned it when I looked at the cost of the trimmer line around here. My recent ARRL Handbook gave me the formula for spacing and impedance, as did the ARRL Antenna Book (15th edition), but not much in the way of practical stuff that I could use.

One of my computer friends says, “Google knows all”. That might be, but Google didn’t seem to know much about balanced line for RF transmission!

One of the few places where I found any real information was that of L.B. Cebik, W4RNL. His web site has all kinds of good stuff about antennas, tuners and feed lines.[1]

Others talked about using cut up wooden dowel, plastic pipe or rod, or coat hangers for the spreaders. Some used heat to force the bare wire into the ends of the plastic, others used the more traditional method of drilling holes and wrapping wire, and still others updated this with tie-wraps (although at greater cost).

Nowhere could I find an actual process (with pictures) to make balanced transmission line.

GETTING READY

Since I have a 500 foot horizontal loop antenna varying in height above ground of from 25 – 40 feet, and feed it from a homebrew balanced tuner [2], I wasn’t all that concerned with the actual impedance of the finished line, as long as it was reasonably high (somewhere between 450 and 600 ohms).

I picked up some black plastic hangers (See Fig. 1) from the local Dollar Store (five hangers for a $) - black, rather than white or blue, the other choices at the store, as it is supposedly less susceptible to break-down from the sun’s UV.

The shorter sections near the top of the hanger triangle set the maximum size of spacer I could get. All were cut with a power miter saw. You could use a pair of heavy wire cutters or metal snips as well.

Figure 1 – Before and after

Preferring holes rather than slots, I cobbled together a jig out of a couple of pieces of scrap wood and a pair of clamps and drilled the spacer ends using a drill press. I allowed a distance of about an eighth of an inch in from each end of the plastic. The drill bit was chosen to provide a slip fit over the wire. (See Fig. 2)

Figure 2 – Close up of a spacer

The final length of the spacer ended up at 3.25 inches with wire spacing of just under 3 inches. Calculated impedance, based on the formula in fig. 3, was 540 ohms. Note that “D” is the diameter of the copper wire – not that of the outside insulation!

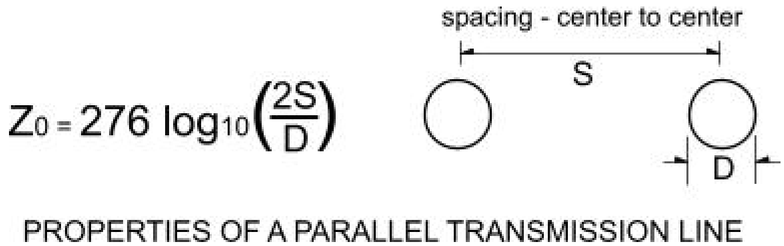

Figure 3 – You too can calculate your impedance!

The wire I used came from Home Depot. It was a few dollars off the regular price, probably due to the blue color. Something they had around longer than they wanted, so hence the price reduction. It is #14 stranded copper with a pvc/nylon cover. Black and white are the two most common colors. Look in the electrical section of your favorite supplier.

Using some scrap lumber I had on hand, I built a jig to provide the correct distance between the plastic spacers. (See Fig. 4)

Figure 4 – The spacing jig

GETTING IT TO STICK

I experimented for some time with extra spacers and pieces of wire to get the right means of making them stick together. Plastic cement didn't work. Super Glue didn't work (it never works to glue anything for me, except my fingers!). PVC cement didn't work. RTV didn't work. Heating the end of the spacer and deforming it against the wire didn't work. Nothing I came up with would stick the plastic to the wire covering. I considered epoxy, but I've seen the five-minute variety break down when exposed to moisture. Regular epoxy might have worked but the curing time was excessive. I started this in August and wanted to get it up before the snow fell!

Bruce, VE5RC/VE5QRP, suggested ELMER'S ULTIMATE GLUE [3], a polyurethane, waterproof glue. A trip to the local Canadian Tire Store got me a 60mL container of my very own.

This adhesive, interestingly enough, requires moisture to cure, but once cured is waterproof. Setting time is listed as 1-4 hours. I find that in three hours the spacer/wire joint is strong enough to move on to the next pair of spacers.

From the spec sheets, GORILLA GLUE appears to be a similar product but I didn't try it.

ALL TOGETHER NOW!

Measure and cut the wires to the length of feed line you need. In my case, it was 50 feet. I coiled each piece separately to avoid tangles and kinks.

Slide the spacers on the pair of wires all at once, as shown. (See Fig. 5) As you glue one, just move the rest along.

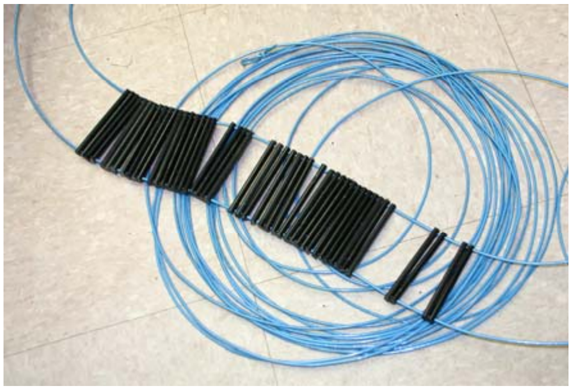

Figure 5 – Plastic spacers on the wire pair

Using a medium grade of sandpaper, lightly roughen the area of the wire covering surface where the spacer will be glued. If you don't do this, the bond will not be as strong because of the slickness of the outer insulation.

With a small artist's brush, wet the roughened area with water. Slide the spacer back and forth to distribute the water more or less evenly.

Pull the spacer back out of the way and smear a drop of glue on each wire. Again, slide the spacer back and forth to spread the glue over the wire and inside the hole in the spacer end.

Glue the first spacer to the wires, leaving about 6 inches of wire free.

After the glue has set (3 - 4 hours) on the initial spacer, clamp it to the jig (point "A"), move two more spacers into position behind the wooden blocks (at points "B" and "C"), clamp the wires (point "D") and pull them tight. (See Fig. 6) If you are impatient and the glue hasn't set, the joint will break. Re-position the spacer and apply another drop of glue on each side of the spacer holes, and *wait* this time!

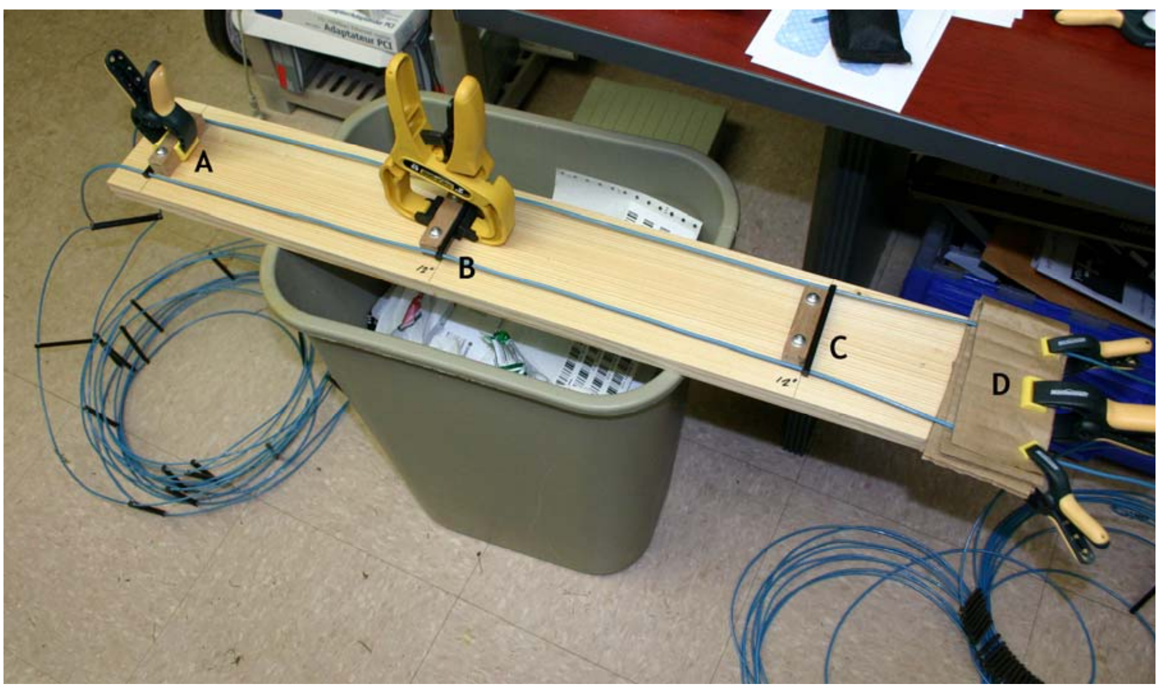

Figure 6 – Production area

Clamp the spacer to the middle block (point "B"). I found the wire spread kept the third spacer in position at the last block (point "C").

I realize I could have placed the blocks so that the plastic spacers would all be on the same side, rather than the first one on the left of the block (point “A”) and the other two (being glued) on the right sides (points “B” and “C”). The idea was to have the wires tightened against the first spacer and block together, rather than the spacer and clamp alone.

Whichever way you make the jig, ensure that the spacers, when pushed against the blocks for gluing are whatever insulator spacing (center-to-center) you want (in my case - 12 inches).

The four thicknesses of cardboard and three clamps shown on the right side in figure 6 (at “D”) provide tension on the lines while the glue sets. It also lifts the two lines up a bit so any excess glue doesn’t stick the spacer to the base of the jig. If the glue does seep between the plastic and the block or the base it will break free with a little gentle persuasion. Clean the glue off with a knife before starting the next set.

LETTING IT ALL HANG OUT

Once the transmission line is finished, the next step is to connect it between the antenna and the transmitter. That’s the easy part; the hard part is keeping it there.

Unless you have some form of strain relief at both ends of the line, the copper wire will eventually work-harden and break [4]. Movement and vibration caused by the wind will take its toll.

The strain relief at the antenna end (See Fig. 7) is a plate made from some nylon pieces left over from a job. The nylon tie-wraps make sure that any strain is taken off the mechanical junction of the antenna wires and the feed line conductors. They would have been better in black, but these were all I had on hand.

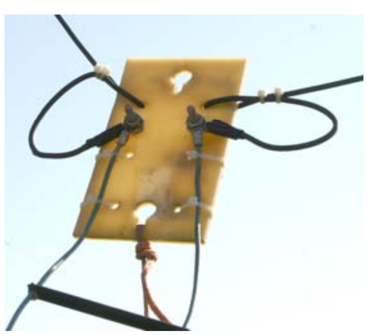

Figure 7 – Antenna end. The thing hanging from the bottom hole is a length of twine used to pull the antenna down to working level.

The same function on the building end (See Fig. 8) is performed by a piece taken from a flat sided plastic bucket.

For a good solid connection at both ends, I used ring terminals soldered to the copper wire.

Figure 8 – Transmitter end. Inside the PVC box are threaded ¼" steel rods in PVC pipe going through the wall to the tuner.

THINGS I'VE LEARNED – THE HARD WAY!

1. When cutting plastic rod with a miter saw, the rod really needs to be clamped well. Also, wear safety glasses or other eye protection. Those little plastic pieces really move out when they catch in the blade!
2. Some wire coverings are really hard for any glue to stick to. Bare wire would have been much easier to use. But then, you have the copper exposed to the elements for faster failure.
3. Copper wire used for antennas or feed line will break – its just going to happen. Use stranded to make it last longer between failures.
4. Stay away from steel wire, unless it has a copper coating and is free.

NOTES:

1. W4RNL' s web site article on parallel transmission line - http://www.cebik.com/trans/par.html
2. AG6K's web site article on balanced tuners - http://www.somis.org/bbat.html
3. Information on Elmer's "Ultimate Glue" http://www.elmers.com/products/product/product_page.asp?pCode=P9411
4. More information at W4RNL's web site on parallel transmission lines - http://www.cebik.com/gup/gup31.html