Figure 1:Copper tape helically-loaded 2M dipole

Spirally-Loaded Copper Tape and PVC Dipole

Easy to build, ultra-simple, continuously loaded shortened 2 Meter vertical dipole quickly made from PVC pipe and copper tape and only 40% as tall as a J-pole.

By John Portune W6NBC

Here is a remarkably simple, great starter antenna for a new ham. Figure 1. Yet it's one that offers experienced-ham performance. Also, it's stealthy – only 18 in. tall – less visible to neighbors and home-owners associations. It's also a good temporary base station antenna for net control at parades and bike-a-thons. Further, it would be a good radio club build-it-yourself project. Here you see its basic form. It may also be painted or enclosed.

Not many hardware-store Do-It-Yourself materials are more attractive to home-brew hams than PVC pipe and copper. This ultra-simple antenna is made from these only. It is the offspring of a fun rag chew at a recent ham radio breakfast. We joked over coffee and donuts, "What would be the simplest 2m antenna using only these ham favorites?" Enter the Spirally-Loaded Copper Tape and PVC Dipole.

This little gem is an 18 in. tall corkscrew of 1 in. adhesive-backed copper foil tape, wrapped spirally around a 3 ft. length of $1^1/_4$ in. PVC pipe. Voila, our coffee-klatch special. The tape is available at most hardware stores, used by gardeners to keep snails out of planters. I was tempted to call it the Snail-Tenna. How about corkscrew, candy cane or barber pole antenna instead? Equally suitable adhesive copper tape, used for RF shielding, is also available from several internet suppliers. Be sure to purchase it in a 1 in. width.

How Does it Work?

Most hams know about using a loading coil to shorten an antenna, such as for an HF mobile whip. Our "candy cane," instead uses "continuous" loading. The entire length is just a stretched-out loading coil, a helix of 1 in. x 1.5 mil copper. The wide tape has low Ohmic resistance, important in a small antenna. Aluminum tape can also be used, though you should select a slightly thicker gauge. Lastly, the 1 in. wide turns are separated by a further 1 in. to minimize skin effect loss, common in loading coils. The result is an antenna with better than 90% efficiency.

Performance

Figure 2 shows the EZNEC Pro-4 radiation patterns. Our barber pole antenna is vertically polarized and omni-directional toward the horizon, with a maximum gain of 1.64 dBi. The familiar much taller 5 ft. copper-pipe J-pole, for comparison, has essentially the same radiation pattern and only trivially half a dB more gain. The small difference is due to the broader elevation radiation pattern of the short helix.

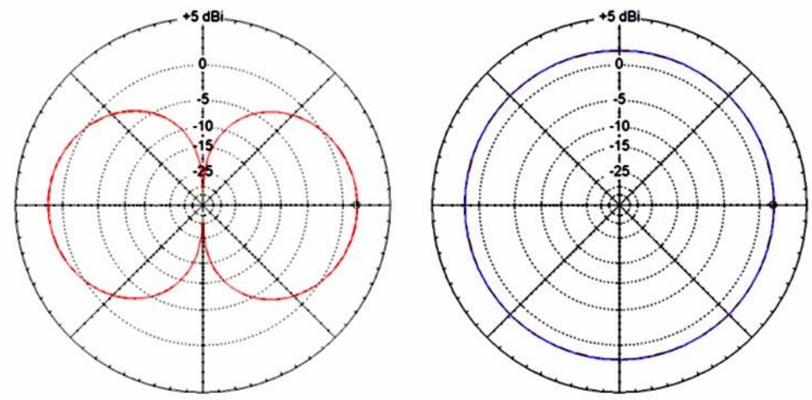

Figure 2: (red) elevation, (blue) azimuth, free-space radiation patterns.

Figure 3 shows the SWR and bandwidth at 2 Meters, plotted with a Rig Expert A-1400. The wide copper tape contributes significantly to the bandwidth shown – excellent at less than 1.5:1 across the entire band.

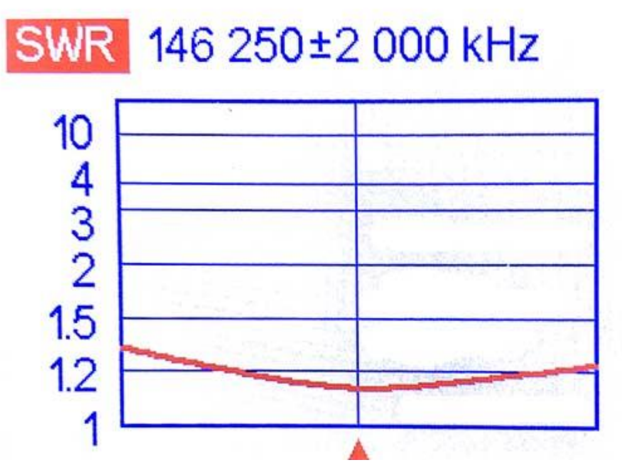

Figure 3: SWR in 2m band. Rig Expert A-1400.

Cost

I purchased a 45 ft. roll of 1 in. x 1.5 mill copper RF shielding tape from Amazon Prime for $10.99. Only 5 ft. are needed, at an adjusted cost of $1.22. The remaining tape is useful for other radio projects. A 10 ft. length of $1^{1}/_{4}$ in. PVC pipe is roughly $20. Some stores sell shorter lengths. This antenna requires 3 ft., at an adjusted cost of $6.00. 6 ft. of RG-58 on the internet is priced at roughly

$1.20 at $0.20 a foot. Mini-8 comes in a $1.50 at $0.25 a foot. A PL-239 connector is roughly $2-4. So not considering the useable remaining materials, this antenna has a modest price tag of circa $10.

Construction

Begin with a 36 in. length of 1¼ in. Schedule 40 PVC pipe. Schedule 80 and ABS DWV pipe are okay too. The top 20 in. are for the helix, the space at the bottom is for mounting. Alternately, a unique possibility is to seamlessly integrate the antenna with its mast for no visible mounting brackets. CC&R-restricted hams may find this option useful.

Adhesive-backed materials are difficult to position accurately, therefore you will need to make up a temporary guide strip for drawing an accurate guideline on the PVC pipe/mast. This can either be a 54 x 2 in. strip of card-stock or flexible plastic material. If necessary, align and tape together shorter strips. I cut mine carefully to 2 in. on a paper cutter, from the front covers of heavy 8½ x 11 in. plastic report folders cut.
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Marking the Guideline

Initially, tightly wrap a single turn around the PVC pipe at the lengthwise center of the guide strip, likewise at the lengthwise center of where the helix will be on the pipe. Butt the strip edges of the together and temporally secure this single turn with household tape. Then complete the wrap being careful to keep the edges butted together. [A little rap music, Maestro, if you please.] Secure the entire wrap with tape.

Next draw the guideline along the edge of the strip with a Sharpie permanent marker, unwrapping one end a little at a time. See Figure 4.

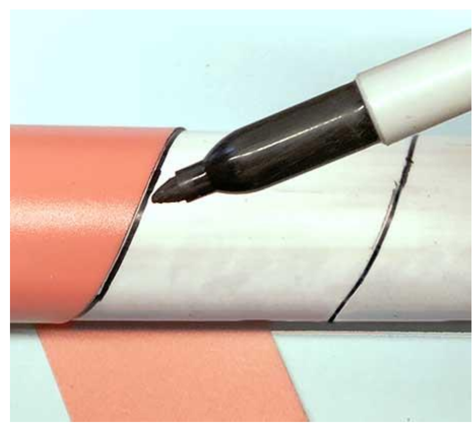

Figure 4: Drawing the guideline for accurately applying the copper tape

Figure 5: Feedpoint detail

Now using the guideline marked on the PVC pipe, carefully adhere 54 in. of copper tape along the guideline. Begin 1 in. from the top, progressively folding back the paper backing that protects the copper tape's adhesive only in short lengths as you proceed.

Feedpoint and Feedline Pigtail

Next, remove 1 in. of foil at the lengthwise center of the helix and then drill a ¾ in. hole through the PVC pipe in the gap, Figure 5. The feed coax runs coaxially up through the PVC pipe from the bottom and exits at this hole to connect to the helix.

Figure 6: Coax pigtail ends.

Next prepare a 6 ft. RG-58 or Mini-8 coax feedline pigtail. Separate the center conductor and shield wires into two individual conductors, Figure 6. Weatherproof the ends with heat-shrink tubing.

Add #6 ring terminals for the feedpoint screws, leaving roughly ½ in. of the conductors exposed to facilitate a sharp bend at the feedpoint. Drill and tap the PVC pipe, through the helix ends, for 6-32 x 3/8 in. stainless screws and flat washers. Stainless sheet metal screws may also be used.

It is advisable to use heavier coax for the downstream run from the pigtail to the shack: RG-8, RG-213 or LMR-400. At VHF, the loss in small diameter coax is not trivial.

Feedline Spacer

We also need to keep the coax centered inside the helix and PVC pipe to prevent it from adversely affecting the antenna. Plastic foam is suitable as a spacer. A better choice is 12 in. of ¾ in. PVC pipe with end caps and centered end holes for the coax. Use end caps that will fit and hold tightly the spacer snugly inside the main pipe. Some caps may require a little filing or a drop of PVC glue. Push the spacer snugly right up to the feedpoint. It is just visible at the bottom of the hole in Figure 5.

CAUTION: Be sure to connect the coax shield wire to the bottom helix turns and the center conductor to the top turns. If these connections are reversed, tuning will be difficult.

Balun

The antenna needs a 1:1 current choke balun just below the helix. You may use a stack of VHF-mix ferrite beads on the pigtail inside the PVC mast or an external six turn 1 in. ring of bundled coax secured with zip ties. You may alternately drill holes in the PVC pipe for the coax to exit and wrap four times around the PVC pipe for the balun.

Tune and Match

My antenna tuned up at 146 MHz with a good SWR, trimmed to 3½ helix turns on top and 4½ below the feedpoint. The reason for a non-centered feedpoint is this. A shortened dipole has a natural center feedpoint impedance of less than 50 Ohms. A 1:1 match will be found slightly off center on either side.

Tuning will vary with operating conditions. To allow for initial adjustment, the 54 in. length of the copper tape above is intentionally too long. The initial frequency will be low. One merely removes small amounts until the desired frequency and SWR are achieved. The number of turns on top compared to the number at bottom adjusts the SWR. The total length adjusts the frequency. Consequently, remove (or add) foil only at the top to adjust the SWR. Add or remove similar amounts simultaneously at both ends to change the frequency.

Rule of thumb for all antennas: adjust the SWR first and then the frequency. Once low, the SWR will change little when you next adjust the frequency.

Begin the tune-up of your helix by removing copper tape until there are 3½ turns at the top and 4½ at the bottom. From experience, this ratio puts the initial SWR in the ballpark. From there, fine tune for the best SWR. If you remove too much foil just add back a short piece, overlapping the ends by 1 in. the capacitive coupling of the overlap prevents the tape adhesive from interfering.

Final Issues

Cut off excess PVC pipe at the top and install a cap to keep out the weather. If you wish, you may either paint the antenna or leave it as it is. Painted white it will be less noticeable, however, unless you wish to set up shop as a barber (hi, hi). If left exposed, Figure 1, the copper will darken with time, but will not diminish tuning or performance. Alternately, you can enclose the antenna in a radome of 2 in. PVC. If left exposed, at least the feedpoint should be weatherproofed with self-curing plastic tape, heat-shrink tubing or RTV clear silicone sealant.

This little candy cane or barber pole antenna is an excellent choice for a new ham's first-time DIY antenna project or for a radio club group build-it-yourself session. Despite its simplicity and small size, it is a good performer and moderately stealthy. For hams attending Pacificon in October in the San Francisco area this year, there will be a DIY booth where you can make one for yourself. You may correspond with the author at jportune@aol.com or 519 W. Taylor St. Unit 111, Santa Maria, CA 93458.